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CHAPTER I

HISTORY OF THE PROGRAMME AND MANAGEMENT STRUCTURES

1. Onchocerciasis, or river blindness, is transmitted in West Africa by blackflies, belonging to the Simulium damnosum complex, which breed in rapidly flowing sections of many rivers. This disease, which is particularly severe in the Sudan and Guinea savanna zones, brings with it debilitation and blindness. In parts of the West African savanna onchocerciasis constitutes an important deterrent to human settlement and the subsequent economic development of many valleys which lie uninhabited and unproductive.

2. In 1974, at the beginning of the Onchocerciasis Control Programme (OCP) covering nearly 700,000 square kilometers in the Volta River basin, it was estimated that 10% of the population was harbouring Onchocerca volvulus, the parasite causing onchocerciasis, and that about 70,000 people were blind as a consequence of the disease. It is not possible to assess the exact number of blind in the Programme area, but it is more relevant to take into consideration the geographical concentration of blindness due to onchocerciasis in certain areas, when estimating the impact of the disease. The epidemiological pattern of ocular onchocerciasis, with extremely high blindness rates in relatively young age-groups in small rural populations, explains the important socio-economic consequence of the disease.

3. Awareness of the extent of the problem had been steadily developing since the 1940s. Systematic surveys to assess the magnitude of the problem and studies to develop and evalute potential control measures were carried out in many of the countries concerned since the early 1950s, thus providing

improved background information on the epidemiology and socio-economic importance of the disease. Control operations aiming at the destruction of the vector were carried out during the 1960s, beginning on a modest scale and culminating in a campaign involving three countries and 60,000 square kilometers, under the aegis of the Governments of Ivory Coast, Mali and Upper Volta in association with the European Development Fund (EDF), and the Organisation de Coordination et de Coopération pour la lutte contre les Grandes Endémies (OCCGE).

4. In 1968 the World Health Organization (WHO), in joint sponsorship with the United States Agency for International Development (USAID), and OCCGE, convened a technical conference in Tunis to consider the problem of onchocerciasis The conference concluded that control by means of larviciding was technically feasible and chances of success would be greatest if the operations were carried out in ecological zones sufficiently large to obviate the need for continuous control of the whole area in order to protect it against reinvasion by the onchocerciasis vectors. It was recommended that priority be given to launching a large-scale control programme in the Volta River basin area, involving adjoining parts of Benin, Ghana, Ivory Coast, Mali, Niger, Togo and Upper Volta, to protect populations severely affected by the disease and to constitute the corner-stone of future coordinated action against onchocerciasis, and in favour of associated development, in Africa south of the Sahara.

5. In 1969 a meeting was organized in Brazzaville by the WHO Regional Office for Africa to refine further the approach needed for preparing the proposed campaign. Experts from the Government of Ghana, OCCGE and USAID, in addition to WHO representatives, attended these discussions. Shortly thereafter, in 1969 and 1970, several of the interested countries submitted formal requests -

emanating from the highest authorities - to international and bilateral sources of technical cooperation and funding which were thought to be interested in contributing to such an ambitious undertaking. Among those organizations were, the Food and Agriculture Organization of the United Nations (FAO), the International Bank for Reconstruction and Development (IBRD), the USAID and WHO. Simultaneously, the United Nations Development Programme (UNDP) manifested its interest in broadening its existing involvement in onchocerciasis studies and control in the Volta River basin area.

The preparatory phase

6. On the basis of the requests received and at the suggestion of IBRD, WHO and UNDP sponsored a meeting of interested parties in Geneva in 1970 to draw up the terms of reference of a mission designed to carry out complementary investigations in the seven countries concerned, as well as to plan and cost the proposed Onchocerciasis Control Programme. This Preparatory Assistance to Governments (PAG) mission was funded by UNDP with FAO as Associate Agency.

7. Meanwhile, in 1972, the Director-General of FAO, the President of IBRD, the Administrator of UNDP and the Director-General of WHO, in view of the importance and complexity of the scheme envisaged, decided to set up a Steering Committee, comprising a representative of each of the four sponsoring agencies, to ensure the coordination of the action taken by these agencies in the planning and implementation of the Programme.

8. The findings of the PAG Mission and the data originating from other preliminary investigations were combined to form a report[1], which was presented during 1973 to the Governments of Benin, Ghana, Ivory Coast, Mali, Niger, Togo and Upper Volta. This report formulated a plan of work for onchocerciasis control in the Volta River basin area which could lead to the repopulation, settlement and economic development of the endemic zones. The report was also presented to various agencies, institutions and government.

9. The Plan of Operations proposed by the PAG Mission report was endorsed during the conference held at Accra in November 1973 which brought together the seven Governments involved, and the four sponsoring agencies. At the conference the Agreement governing the operations of the Programme (Operational Agreement) was formally signed by the participating Governments and WHO. This Agreement, which set out the basic arrangements for the management of the Programme, was supplemented in 1974 by individual Country Protocols defining the specific contributions of each Government.

10. As Executing Agency, WHO was assigned the task of implementing the Programme which was formally established from 1 January 1974 with Headquarters in Ouagadougou, Upper Volta. The first year of activity was devoted to setting up the structures, the recruitment and training of staff, the development of infrastructure, the purchase of equipment and supplies, complementary surveys and the intensification or research. Actual control operations began in February 1975.

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[1] UNDP, FAO, IBRD and WHO (1973) Onchocerciasis control in the Volta River basin area. Report of the Preparatory Assistance Mission to the Governments of : Dahomey, Ghana, Ivory Coast, Mali, Niger, Togo and Upper Volta OCP/73.1 + Annexes 0-1 to VI-5, 2400 pp.

11. The machinery established to manage the Programme included, at the country level, National Committees for Onchocerciasis (NOC), comprising representatives of the main national services concerned. The role of these committees is principally, to coordinate the action of all national services involved in the Programme and the subsequent economic development projects, and to ensure liaison between the Government and Programme Headquarters.

12. At the agency level, a Scientific Advisory Panel (SAP), amde up of nearly 200 technical and scientific workers, was formed by WHO to be called upon, as necessary, for advice on all aspects of the disease and its control.

13. An Ecological Panel (EP), comprising a small group of experts with wide experience in river basin ecology, the epidemiology of diseases in river basins and the ecological effects of pesticides, was set up by the Steering Committee to guarantee satisfactory protection of the environment.

14. At the Paris meeting of donor and participating Governments and sponsoring agencies, in June 1974, it was agreed to amplify the management structures of the Programme. The additional structures included, in particular, a Joint Coordinating Committee (JCC) composed of representatives of the seven countries, all contributing parties and the four agencies[1]. The role of the JCC was to exercice general supervision over the policies to be adopted in the planning and execution of the Programme and to follow the development of activities. The Committee, which would be presided other by an Independent Chairman and served by a joint WHO/World Bank secretariat, would meet once a year for this purpose.

15. To provide the JCC with a continuous independent evaluation of the technical aspects of the Programme, WHO formed a Scientific and Technical Advisory Committee (STAC) composed of 12 members of the Scientific Advisory Panel. This Committee would meet twice a year to review scientific and technical aspects of the Programme and to prepare an annual report containing its findings and recommendations for submission to the JCC through WHO and the Steering Committee.

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[1] Belgium, Benin, Canada, France, Federal Republic of Germany, Ghana, Ivory Coast, Japan, Kuwait, Mali, Netherlands, Niger, Norway, Togo, United Kingdom of Great Britain and Northern Ireland, United States of America, Upper Volta, the Africa Development Bank, the United Nations Development Programme (UNDP), the Food and Agriculture Organization of the United Nations (FAO), the World Bank (IBRD) and the World Health Organization.

16. Finally, the Steering Committee established an Economic Development Advisory Panel (EDAP) to assure the continuous review of information relating to the economic development aspects of the Programme. This Panel, composed of economists and specialists in agricultural and rural development would meet twice a year and would present an annual report on its findings and recommendations to the JCC through the Bank and the Steering Committee.

17. These additional structures were described in a Memorandum of Understanding which was approved by the JCC at its first session in Abidjan, Ivory Coast, in February 1975.

18. Following the assurances received from contributing parties at this first session of the JCC, an Onchocerciasis Fund Agreement covering the financing of the first six years of operations was signed on 7 May 1975 by nine[1] donor Governments, the African Development Bank, the IBRD, IDA, UNDP and WHO.

19. In 1976, following the consolidation of the Programme activities in the field, and within the context of the new orientation being given to the functions of the Organixation as a whole, the decision was taken by the Director-General to transfer the responsibility for the Programme from WHO Headquarters to the Regional Office for Africa. This transfer implied both a new approach to management and a reorganization of the supporting services. Thus, in December 1976, a new Director was apointed and the Headquarters in Ouagadougou assumed full responsibility for the implementation of the Programme under the authority of the WHO Regional Director for Africa. The Office of the Programme Director in Ouagadougou was enlarged by the transfer of staff from the support unit in Geneva, and a liaison office was established in Brazzaville.

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[1] The Kingdom of Belgium, Canada, the Republic of France, the Federal Republic of Germany, Japan, Kuwait, the Kingdom of the Netherlands, the United Kingdom of Great Britain and Northern Ireland and the United States of America. These contributors were later joined by Norway.

20. The transition was smooth. Experience so far indicates that the centralization of activities in the field has had the effect of creating a closer association with the different levels of structure including with the participating countries, and a greater flexibility for the management.

21. The inter-agency Steering Committee for Onchocerciasis Control in the Volta River basin area, which had been particularly active during the preparatory and launching phases of the Programme, has proved to be a valuable tool for concerted action and rapid decision-making.

National Onchocerciasis Committees

22. By mid-1974, each of the Participating countries had formally established a National Onchocerciasis Committee (NOC). These Committees played a major role in resolving logistical problems during the first years of operations.

23. The first joint meeting of the NOC's which was convened in Abidjan in June 1977 was extremely constructive. It was unanimously agreed that such meetings should become a regular feature and at the invitation of the Government of Benin a second meeting took place in Cotonou in June 1978.

Advisory bodies

24. During the first four years of activities the Programme has benefitted from the guidance and support of the advisory bodies.

25. In the initial stages, visits were made by members of the Ecological Panel (EP) and Scientific and Technical Advisory Committee (STAC) to the Programme area for discussions with the field staff, and to obtain first hand knowledge of the environment and of the operations. With the expiry of the

mandate of members of STAC at the end of 1976, the composition of the Committee was reviewed and slightly modified to meet the changing needs. Following the transfer of management, a joint meeting of both groups took place in Ouagadougou in 1977, followed by a meeting of STAC at the WHO Regional Office, Brazzaville, in 1978.

26. The Ecological Panel has been reviewing the data collected by the hydrobiology research workers under the aquatic monitoring programme and has drawn attention to factors which might be detrimental to the environment.

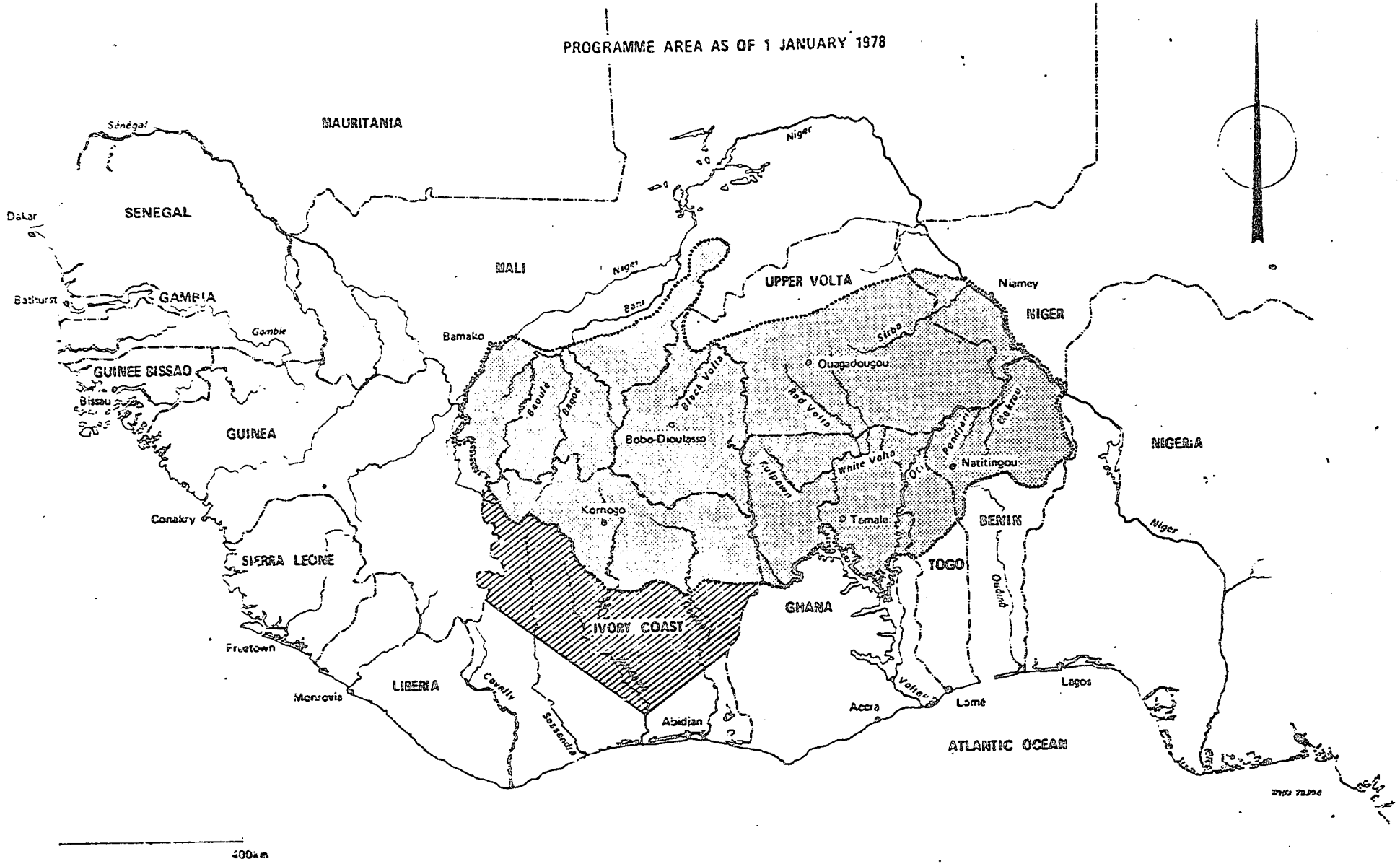
27. Of equal value has been the role of STAC in evaluating the technical aspects of the Programme and, notably, giving guidance in research.

28. Although efforts were made to minimize duplication through joint meetings and through cross-representation at meetings, some overlap between the roles of the Scientific and Technical Advisory Committee and the Ecological Panel has not been completely avoided and solutions to this continue to be sought. One possibility might be to make joint meetings a permanent feature or to merge EP into STAC.

29. As Administrator of the Onchocerciasis Fund the World Bank is responsible for mobilizing and managing the funds required to carry out the Programme. Advances from the Fund to WHO are made on a quarterly basis on receipt of a written submission of the estimated payments to be made during the following quarter. At half-yearly intervals, the Bank provides to each of the contributing parties and to the Steering Committee, a statement of contributions, receipts of and disbursements from the Fund.

30. As of December 31, 1977, the amount of advances by the World Bank was $30,200,000 of which $20,200,000 for the 1974-1976 period and $10,000,000 for 1977/

PROGRAMME AREA AS OF 1 JANUARY 1978



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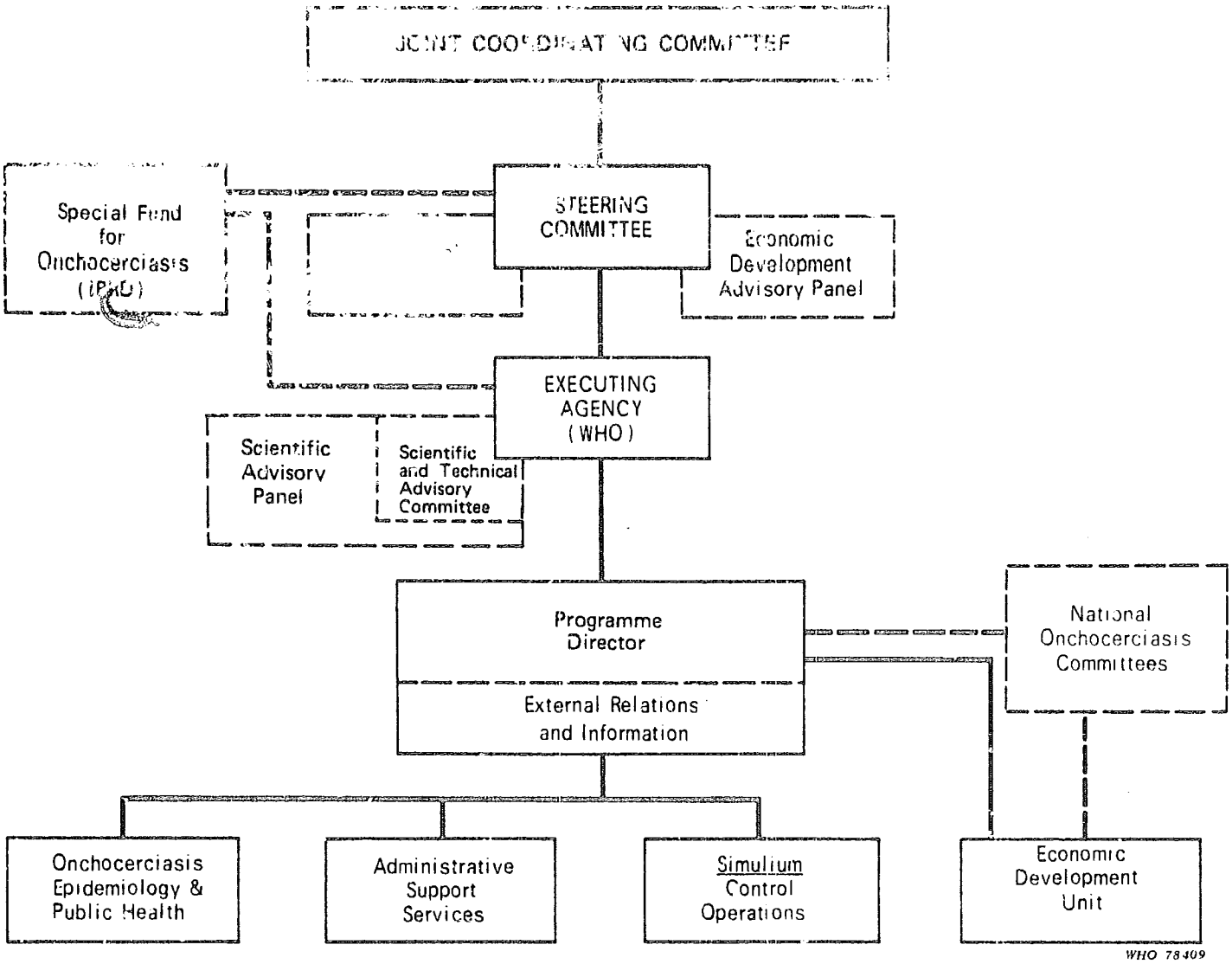
MANAGEMENT STRUCTURES



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CHAPTER II

THE PROBLEM OF ONCHOCERCIASIS

The disease and the parasite

1. Onchocerciasis is a parasitic disease caused by a nematode of the filaria group, Onchocerca volvulus. The parasite is strictly associated with man and has no known animal reservoir. It is transmitted by several dipteran flies of the Simuliidae family, which includes the West African vectors, the species complex Simulium damnosum. The Simulium or blackfly is both vector and intermediate host : a microfilaria ingested from a human has to complete a development cycle within the blackfly; in about seven days it becomes an infective larva, the only form which can infect man. There is no possibility of propagation of the disease except by forms of the parasite that have completed this obligatory intravectorial cycle.

2. Adult Onchocerca volvulus worms male and female, live in human tissues either in the free state or encapsulated in fibrous formations known as onchocercomas, cysts or nodules. The free worms and deep-seated nodules are normally undetectable. The superficial nodules, which are visible and palpable, are mostly located in the subcutaneous tissues overlying bone: costal margin, iliac crests, trochanters, sacrum, knees, shins, skull. Each cyst contains one or more pairs of worms. As a rule patients have several cysts or groups of cysts, and in nodulectomy campaigns there have been cases where over 40 cysts have been removed from a single patient.

3. During its lifetime (estimated at 10-15 years) the female Onchocerca produces millions of embryos, microfilariae, which spread throughout the body tissues but with a particular affinity for the skin and eyes. From the skin they may be ingested by a blackfly during its blood meal. In man the microfilariae have a life expectancy of 1-2 years. After this time, unless they have been ingested by a blackfly and are thus able to continue their development cycle, they die in the tissues.

4. The main clinical manifestations of the disease are due to reactions to the presence of microfilariae, and their severity is directly related to the sity of parasite infection. The simplest manifestations are skin lesions which are caused by scratching, and are followed by pruritic papular eruptions. Later on the skin may undergo a variety of changes: thickening and sclerosis in the form of pachyderma (elephant skin), localized or extensive cutaneous atrophy, and depigmentation.

Distribution of onchocerciasis

5. Onchocerciasis is essentially a disease of tropical Africa, where it is prevalent to varying extents between latitudes 15°N and 15°S. However, it also affects two other continents: America, with foci in Guatemala, Mexico, Venezuela, northern Brazil, and Colombia; and Asia, with the focus in northern Yemen.

6. Broadly speaking, the northern limit of the disease in Africa runs from Gambia to the south of Lake Chad; it then rises in the Sudan along the Nile as far as the Abu Hamed region (19°15'N) and drops again into Ethiopia along the tributaries of the Nile. The countries situated between this line and the Equator are the worst affected: the whole of West Africa (except Mauritania), Cameroon, southern Chad, the Central African Empire, southern Sudan, western Ethiopia, and northern Zaire.

7. Further south, the disease occurs in Equatorial Guinea, Gabon, Congo, Rwanda, Burundi, the central basin and southern part of Zaire, Uganda, western Kenya, Tanzania, Angola, and Malawi, where it reaches its southernmost point, 17°S.

The vector and transmission

Vector species

8. The known vectors of human onchocerciasis are flies which belong to the Simuliidae family. The African vectors are members of the complexes Simulium damnosum (throughout the area of distribution of the disease) and Simulium neavei (in certain parts of central and east Africa). As regards S. damnosum s.l., its area of distribution extends northwards and southwards beyond that of onchocerciasis.

The S. damnosum complex

9. It has been known for some years that S. damnosum, once regarded as a homogeneous species, in fact constitutes a complex of different taxa. As a result of studies pursued 24 separate cytological segregates have been identified throughout Tropical Africa. For West Africa nine segregates have been described, six of which ("Nile", "Sirba", "Bandama", "Soubre", "Yah", "Bille") are of direct concern to the Programme because they are found in or closely associated with the Programme area. At a Scientific Advisory Panel meeting on vector complexes the decision was endorsed to consider these as species with the following names already given them in publications, S.damnosum s.s., S.sirbanum, S.sanctipauli, S.soubrense, S.yahense and S. squamosum respectively.

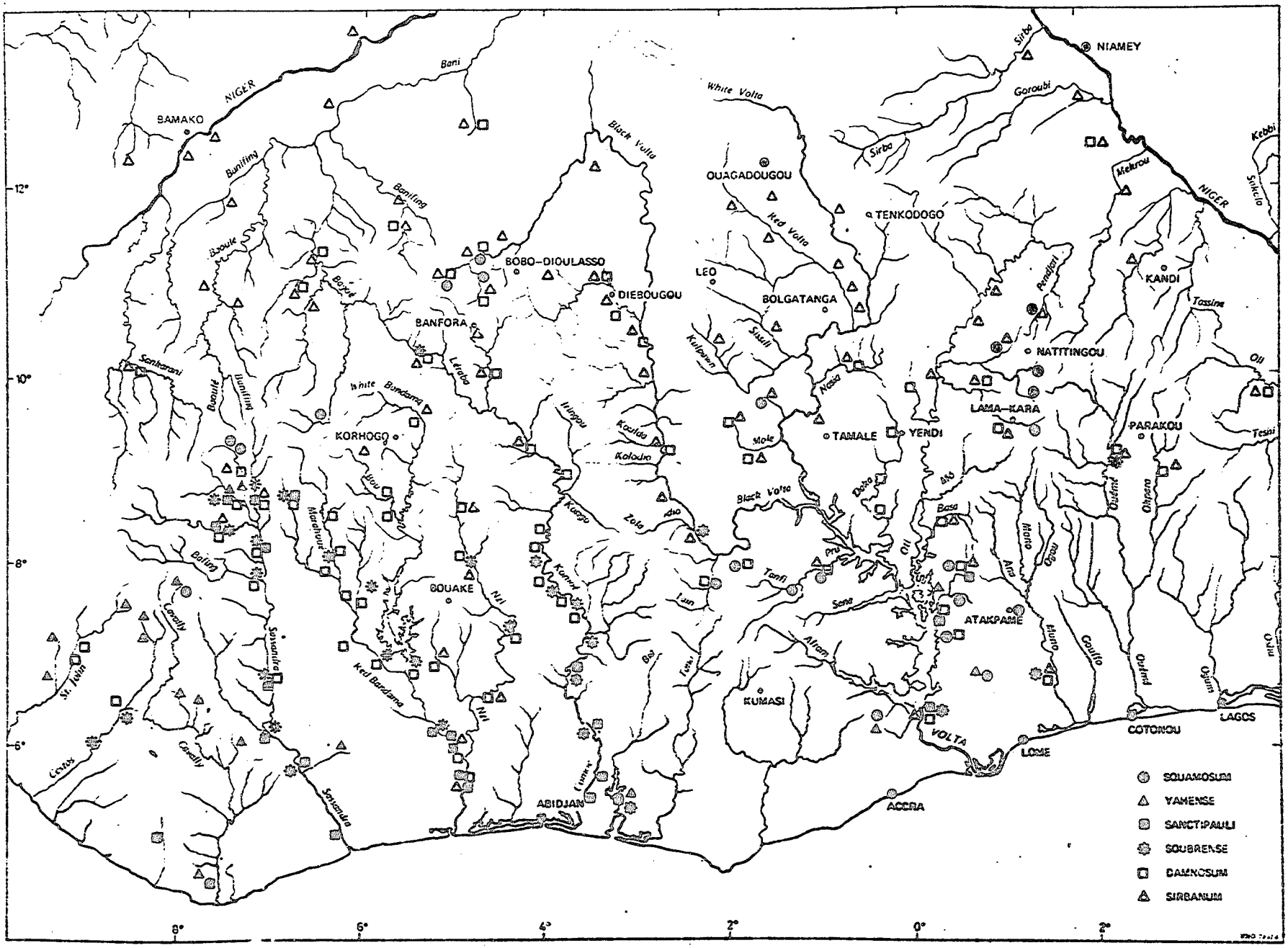
10. Table I and Fig. show the distribution of these six main species for the whole of West Africa and for the Programme area and adjacent zones respectively.

11. Each of the species has a characteristic distribution pattern related to the distribution of the bioclimatic zones of West Africa. Thus S.sanctipauli has never been demonstrated outside the forest zones; S.squamosum and S.yahense are more ubiquitous but mainly confined to certain types of watercourse in well wooded country; S.soubrense mainly inhabits the large rivers in the forest and Guinea

Table 1. DISTRIBUTION OF SPECIES OF S.DAMNOSUM COMPLEX

SPECIES	INDICATION OF DISTRIBUTION	HABITAT
squamosum	Cameroon, Benin, Togo, Ghana, Ivory Coast, Upper Volta	humid forest and riverine forest in Guinea savanna
yahense	Togo, Ghana, Ivory Coast, Liberia, Guinea	humid forest and mountain forest; extends into Guinea savanna
soubrense	Benin, Togo, Ghana, Ivory Coast, Liberia, Guinea, Upper Volta	humid forest and riverine forest, extends into Guinea savanna
sanctipauli	Ghana, Ivory Coast, Liberia	humid forest
damnosum s.s.	Cameroon, Nigeria, Benin, Togo, Ghana, Ivory Coast, Liberia, Guinea, Mali, Niger, Upper Volta	humid forest and Guinea savanna; extends into Sudan savanna
sirbanum	Cameroon, Nigeria, Benin, Togo, Ghana, Ivory Coast, Guinea, Gambia, Upper Volta, Mali, Niger	Sudan savanna; extends into Guinea savanna and even forest

DISTRIBUTION OF SPECIES OF S. DAMNOSUM COMPLEX



savanna zones; S.damnosum s.s. is found mainly in the Guinea savanna zones; S.sirbanum has been found in forest areas but it is mainly in the Sudan savanna zone and the Northern Guinea savanna that this species is widespread.

12. Differences in transmission potential have been demonstrated between species and as a function of the bioclimatic zones.

Bio-ecology of the vector

13. Like all blackflies, S.damnosum s.l. develops, during its larval and pupal stages, in running water. Pre-adult development (eggs, larvae and pupae) lasts about a fortnight under tropical running-water temperature conditions. The various species of the complex have somewhat different requirements with respect to the physicochemical conditions of the water of their breeding sites.

14. Among all the biological peculiarities, two fundamental characteristics stand out because they determine the strategy and tactics to be employed against S.damnosum.

(i) The demands of the larvae of the complex are relatively exacting, particularly in regard to their nutrition. This is reflected in limited spatial distribution of the breeding places and is what makes it possible, after a careful survey of those breeding places, to implement a campaign aimed at destroying, within a given area and by sufficiently specific action, all the larval populations of the species.

(ii) This factor, favourable to the execution of a coordinated campaign, is unfortunately counterbalanced by the flying power of the females; whence, on the one hand, the need to continue larviciding over a very long period to obtain only a satisfactory reduction in the parasite population harboured by man; and, on the other hand, the need to apply treatment to a sufficiently extensive protective zone so as to minimize the consequences of possible reinvasions.

Transmission

15. The microfilariae of O. volvulus, the pathogenic agent of human onchocerciasis, have to go through a stage in a vector in order to continue their development. These microfilariae, ingested during a blood meal, undergo several moults in the course of a cycle that lasts an average of seven days. On completion of this cycle, the infective larvae break out of the fly during a subsequent blood meal. In view of the duration of the gonotrophic cycle of the female S. damnosum, it is impossible for the parasite to go through a complete cycle between two successive blood meals and an infected female will not become epidemiologically dangerous until she takes a third blood meal.

16. The dynamics of transmission depend on many factors, the main ones being:

- the absolute quantity of potential vector blackflies;
- the mean age of the vector populations;
- the vector species concerned (adaptation to the parasite, degree of anthropophilly, etc.);
- the transmission season;

- the degree of contact between human and vector populations, which depends on human activities (linked to age and sex) and on the above-mentioned factors;
- the level of infection of the human populations, which are the only reservoir of the pathogen.

Epidemiology of onchocerciasis

17. Not all the determining factors in the spontaneous development of onchocerciasis have yet been found, but a number of general rules can be deduced from observations so far.

Parasite build-up

18. Onchocerciasis is a parasitic infection that progresses slowly as part of a cumulative process. There is a long period of clinical latency after infection (one year on average). Spontaneous cure is belated and is governed by the life-span of the adult worm (10-15 years). Under stable conditions of transmission, the filarial load in the individual steadily increases over the years. The severity of the lesions varies directly with the degree of parasite infection, i.e., with the number of adult worms in the body of the host and the number of microfilariae they release. Level of transmission and length of exposure to blackfly bites are the two factors in man-vector contact that govern parasite build-up.

19. In four villages of the Programme area, it was possible to determine annual transmission potentials (ATP)[1], before the start of the campaign, over a sufficiently long period to have a good idea of the effect of annual variation. Medical examination has shown that exposure to increasing ATP leads to increasingly severe onchocerciasis lesions among a population.

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[1] For an explanation of ATPs and ABRs see footnote on pages 10-11, Chapter III.

20. This cumulative effect also shows itself in the connexion between increasing levels of prevalence and increasing parasite load. The greater the proportion of affected persons in a village, the greater their parasite load, and vice versa.

Geographical disparities

21. Onchocerciasis occurs in foci, each of which is centred on a breeding place, or succession of breeding places, in the immediate vicinity of which the disease appears in its most severe form. The distribution of foci is governed by the hydrogeographical features of the region. Depending on the density of breeding places, foci may be relatively extensive and continuous, or separate and restricted in area in a mosaic pattern.

22. Endemicity in any given focus falls off with increasing distance from the centre. This stratification into levels of endemicity (first-line, second-line and third-line villages) is governed by the frequency of contact between man and vector, which decreases with distance from the larval breeding place and the distance over which the blackfly has to travel.

Role of sex

23. In zones of low or moderate endemicity men are nearly always affected more frequently than women. This difference levels out in hyperendemic zones, where the prevalence of onchocerciasis is the same for both sexes, although microfilarial loads are still generally higher for men than for women.

24. These differences are also evident in the figures for the prevalence of eye lesions and blindness, which are always higher for men.

25. The most valid explanation would seem to be a sociological one. Because of the distribution of tasks and the social division of labour, women are less exposed to contact with the vector. Similarly, in two villages in the north of the Ivory Coast in which women are significantly more affected than men, it has been shown that they alone are concerned in the cultivation of rice along the river banks while the men grow cereal crops further away from the breeding sites.

26. This, however, does not exclude the possibility that other factors, such as hormonal ones, may be involved.

27. Studies conducted in the OCP zone in just over 300 villages have shown that there are two distinct types of endemic situation one at each extreme:

(i) a level of disease that may be considered "tolerable", in which the prevalence of onchocerciasis in the communities considered does not exceed 30%; positive cases have less than 10 microfilariae on average per skin biopsy; there is little or no severe eye involvement; the frequency of blindness is below 1% and results from diseases other than onchocerciasis;

(ii) a level of infection at which the disease is extremely severe; all villages in which over 5% of the registered population is blind have been found to have more than 60% of their inhabitants infected; positives have over 20-25 microfilariae per biopsy; over 10% of ocular onchocerciasis lesions are severe and/or irreversible.

28. Although there are villages in which the prevalence of onchocerciasis is over 60% while the frequency of blindness is less than 5%, that level must be considered as a threshold beyond which a community is at high risk. It would therefore seem logical to redefine the four conventional levels of endemicity as follows:

(i) Sporadic onchocerciasis : fewer than 10% infected, mainly among adults.

(ii) Hypoendemicity : between 10 and 29.9% infected. These generally have less than 10 microfilaria per biopsy and eye complications are rare.

(iii) Mesoendemicity : between 30 and 59.9% infected. This is an intermediate situation in which the population may show varying degrees of parasite infection and in which the risk of eye complications increases with microfilarial load.

(iv) Hyperendemicity : over 60% infected. There is a high risk of eye complications and positives have more than 20 microfilariae per biopsy on average.

CHAPTER III

THE CONTROL CAMPAIGN AND ITS RESULTS

A. BASIC DATA - METHODS OF CONTROL AND TECHNIQUES

1. In default of any therapeutic weapon at present utilizable in a mass campaign, the only feasible method of controlling onchocerciasis is still by control of the vector.

2. Taking into account the genetic, biological and ecological characteristics of S. damnosum s.l., the control of the vector can be approached, in theory, from many angles.

Ecological control

3. The elimination of rapids, which are where the vector reproduces and develops, would be a final and therefore ideal solution to the problem of onchocerciasis. Thus in Africa the great dams built (Aswan, Akosombo, Kainji, Kossou) or now being built or planned (Selingué, Manantali, Noumbiel, Jebba, Bui), by eliminating any possibility of S. damnosum breeding upriver, have had or will have an extremely beneficial effect on the onchocerciasis situation. A study undertaken by OCP has established that the construction of just the one hydro-electric dam at Noumbiel, on the Black Volta between Upper Volta and Ghana, will result, apart from the final elimination of local vector populations along considerable reaches (120 km) of this river and its tributaries, in a saving of $150,000 a year in the cost of conventional insecticiding techniques.

4. However, to construct such engineering works for the sole purpose of controlling a disease, important though it may be from an economic point of view, is out of the question. The topography of the African savanna zones would not permit it in all places where it would be desirable, and the cost of such dams is generally very high.

5. On the other hand, the proliferation of small dams to provide reserve water supplies near rural population centres has often resulted in an aggravation of the onchocerciasis problem because of the favourable conditions for the development of S. damnosum created by their spillways.

Genetic control

6. The introduction of sterile males into natural vector populations has been the theme of many experiments, and has been successfully utilized in campaigns against certain insects.

7. The fact that females of S. damnosum mate only at the start of their adult lives and then, having been fertilized, are able to migrate over long distances rules out the application of this method. There are also currently insuperable problems concerning mass colonization of S. damnosum in the laboratory. The flies cannot be mated in captivity and have difficulty in taking blood and ovipositing.

Biological control

8. Many parasites infest S. damnosum in nature and research efforts are at present being concentrated on the possibilities of utilizing them with a view to reducing or eliminating vector populations. The initial results are not very promising and it is still too early to say whether this technique could be applicable in mass campaigns.

Chemical control

9. This method can be approached in two ways : control measures directed against the adult, and control of the aquatic development stages (eggs, larvae and pupae).

Adult control

10. One of the earliest campaigns against S. damnosum employed this principle, though it was not possible to determine the part played by larvicide action (part

of the insecticide falling directly into the rapids) in the successful results obtained.

11. In fact, because of the possibilities of dispersal of S.damnosum females around their sites of reproduction, particularly during the rainy season, it would not be feasible to conduct an adulticide campaign covering a wide area. However, research is in progress with a view to developing a control technique that would allow protection of localized sites, particularly in reinvaded areas.

Control of pre-adult development stages

12. Eggs and pupae of blackflies are securely fixed to their supports and partly protected from their surroundings by the adhesive jelly in the case of the egg mass and by the cocoon in the case of the pupae. As neither of these stages ingests food particles from its surroundings they could only be destroyed by fairly strong contact poisons. They are not effectively destroyed by any insecticide currently in use.

13. On the other hand the larvae, because of their relative concentration and their mode of obtaining nourishment by filtration of particles in suspension in the water, are the forms most susceptible to insecticides that act mainly through ingestion. In default of any alternative, larval control is therefore the principle upon which most campaigns against blackfly vectors of onchocerciasis have been conducted in Africa.

14. Widely utilized in prior campaigns, and again adopted for the Programme, larval control is governed by the following principles :

- the larvicide solution must be released upstream from each breeding site or set of breeding sites, so as to destroy the larvae of all stages. The range of action of the insecticide wave transported by the current depends essentially on the hydrological and topographical characteristics of the watercourse treated;

- applications must be made periodically, at intervals shorter than the larval life-span of the species. The periodicity has been fixed at seven days, which satisfies both biological and logistical exigencies;
- these applications must continue, in a given area, for as long as the capacity for reproduction of the residual blackfly population poses a threat from the epidemiological viewpoint (transmission rate too high) or in entomological terms (re-establishment of local blackfly populations too rapid).

Techniques

15. Until 1971 the insecticide used was DDT, which is very effective but whose residual properties and effects on the environment were not appropriate to the present ecological requirements. As a result of studies undertaken since 1967, investigators have been able to select several compounds belonging to the organophosphorus group, one of which, temephos (Abate (R), OMS 786), combines in a specific formulation the essential properties of high effectiveness against S. damnosum larvae of all stages, and, because of its relatively specific action, its low persistence and the very small doses applied, low toxicity for the environment.

16. It is this insecticide which has been used since the start of the operations by the Programme, but investigations are continuing with a view to developing new compounds in different formulations.

17. Most of the campaigns prior to the Programme which were based on the principle of larval control by chemical means, had used treatment techniques suited to the small geographical areas covered. However, the treatment appliances, both static (drums with holes to release the insecticide over a given period) or mobile (floating craft of various sizes) very soon proved unsuitable for the treatment of large areas because of the impossibility of utilizing them in all situations.

18. Access to the rivers in all seasons is what constitutes the major, often insoluble, problem that the treatment teams have to face when working on the ground, especially during the rainy season which is generally the period of high transmission in most onchocerciasis-infested valleys. The treatment rounds are therefore done incompletely, not always at regular intervals and at the cost of unremitting efforts. Moreover, for these less than ideal results the resources that have to be deployed are considerable. To take one example, the treatment of the Comoë-Léraba River in the Banfora region (25 000 km^2) required from 1969 to 1972 the presence, five days a week, of four strong ground teams, each consisting of one qualified technician, two labourers and one driver, with cross-country vehicles and equipment for larviciding (boat, out-board motor, etc.).

19. These teams were able to reach all the treatment points only in the dry season, despite the constant maintenance of 300 km of tracks specially built for the purpose.

20. The results showed the effects of these constraints and the level of transmission in the largely inaccessible southern part of this zone remained too high for the maintenance or return of human populations.

21. In view of the strategic exigencies, largely determined by the biology of the vector and necessitating the treatment of extensive areas, these land-based methods could no longer be considered, so in 1967 spraying from the air was started on a trial basis. Later, in turn, the type of aeroplane used for agricultural spraying, then the helicopter, first small and then medium-sized, were tried out.

22. The aeroplane proved very efficient for medium-sized and large watercourses, where gallery forest vegetation does not hamper navigation and treatment. It proved less so for the smaller rivers obscured by forest canopy, where it is replaced with great advantage by the helicopter, whose manoeuvrability is practically unlimited.

B. THE FIRST 6 YEARS OF OPERATIONS

Vector Control Operations

23. After analysis of the various principles, methods and techniques, and in the light of experience with prior campaigns, the Onchocerciasis Control Programme was planned and put into operation according to the following criteria:

- control measures directed against the larvae of the vector, which are its most concentrated and most susceptible development stages;
- utilization of insecticide with little residual action, effective at low concentrations and producing little pollution under the conditions of application;
- treatment from the air, the only method at present applicable which has proved, for practically 100% effectiveness, the least costly.

Aerial operations

24. An Invitation to Bid for a contract to carry out aerial operations gave details of the requirements. This included specifications for the development of equipment for the release of accurately measured quantities of insecticides for both helicopter and fixed-wing machines. The type of machine considered suitable for the work requested as well as the flying hours required were also specified. It was anticipated that it would be possible to treat the large rivers by fixed-wing aircraft and that the smaller rivers would require helicopters. At the end of July, 1974 the contract was awarded to Evergreen Helicopters Inc. from McMinnville, USA, who operated Bell 206 helicopters and a Pilatus Porter aircraft.

25. Work commenced in 1975 in Phase I only, operating from one base in Bobo-Dioulasso, and during that season the following hours of fixed wing and helicopter were flown to dispense 75,630 litres of Abate :

Phase I 1975

	Larviciding	Prospection	Administration	Total Hrs	Abate
Helicopter	1,911	782	89	2,782	47,369
Fixed wing	366	80	94	540	28,261
				Total	75,630

26. In 1976, treatment continued in Phase I and in January 1977 Phase II began with the treatment of the lower White Volta by helicopter. This machine flew across from the Bobo-Dioulasso base each Tuesday and when the rains started in May, all the other rivers which started flowing in Phase II were treated by the same helicopter, assisted by the fixed wing on the White Volta once the flow of water was sufficient for fixed wing treatment.

27. At the end of 1976, with the treatment of Phases I and II, the following hours had been flown:

Phases I & II 1976

	Larviciding	Prospection	Administration	Total Hrs	Abate
Helicopter	3,011	1,192	155	4,358	79,862
Fixed wing	488	95	41	624	50,085
				Total	129,947

28. During these initial 2 years of operation, a system evolved which is flexible enough to deal with the constant adjustments that have to be made.

29. At the end of 1976, the initial aerial contract with Evergreen Helicopters Inc. came to an end. International bidding for the next contract took place in mid June 1976. The contract was awarded to Viking Helicopters Ltd., an Ottawa based firm, on 6 August 1976. The change of contractor provided an ideal opportunity to improve equipment and techniques, based on the knowledge acquired in the first 2 years of operation. With the helicopter equipment, the previous contractor had developed a gravity-fed system and although very effective in the wet season, problems had been experienced in distributing insecticide at difficult breeding sites in the dry season. Consequently, the incoming contractor was asked to develop a "dual" system whereby, by operating a switch in the aircraft, the pilot could elect for the insecticide to be emitted either by the gravity-fed system or through a pressure-fed single nozzle. This newly developed "restrictor" system has proved highly successful, particularly in the dry season.

30. Modifications were also made to the fixed wing equipment. The previous contractor used an underslung cylinder into which the required quantity of insecticide was fed and emitted by the action of a floating piston. With the newly developed equipment, all parts are internal within the aircraft and the only external part is the emission tube. The system is activated by air pressure and has proved accurate and reliable.

31. In the first year of operation with the new aerial contractor, the whole designated Programme area was under treatment for the first time and at the end of 1977 the following hours had been flown:

Phases I, II & III 1977

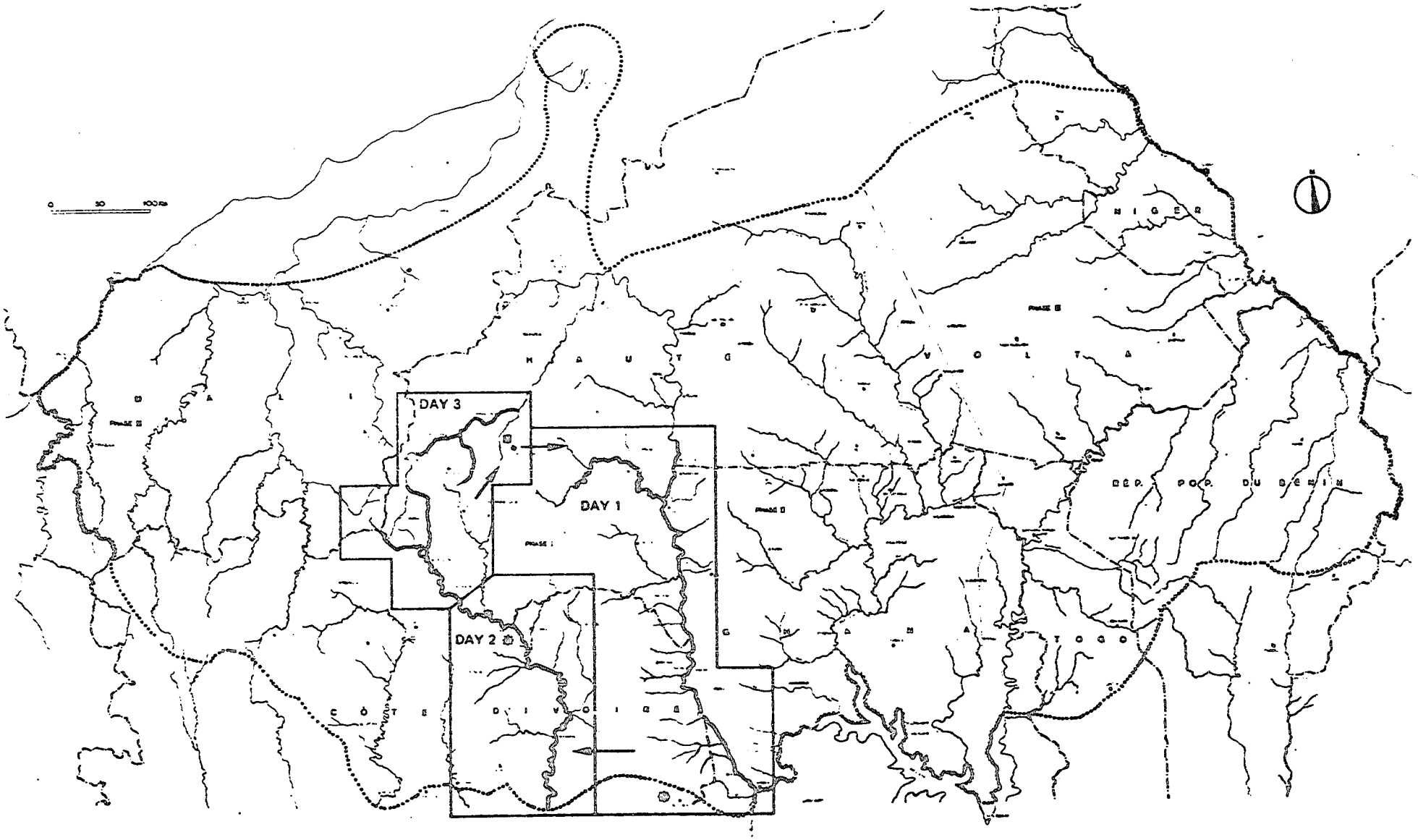
	Larviciding	Prospection	Administration	Total Hrs	Abate
Helicopter	4,424	685	249	5,350	84,318
Fixed wing	854	57	114	1,025	71,297
				Total	155,615

32. The treatment flying was done with six helicopters in spraying configuration and two fixed wing aircraft operating from Tamale and Bobo-Dioulasso. Fifty-four percent of insecticide released was by helicopter and 46 percent by the two fixed wing aircraft. The average release of insecticide per hour (80 l per hour) is four times that of a helicopter (20 l per hour). Also, the fixed wing can be operated for approximately 1/2 the cost of a helicopter.

33. Clearly, as river levels alter, the breeding sites of S. damnosum change and aircraft circuits have to be modified accordingly. It is unlikely that a river treated with a particular quantity of insecticide one week will require the same dosage the following week, and as rivers start to flow, or dry up, they are constantly being added to or taken away from a circuit. Hence, it is necessary to produce new treatment maps each week and this is done every Monday in the aerial operations section of the Vector Control Unit at the two bases of Bobo-Dioulasso and Tamale. Following this, the pilots are briefed on the circuit to be flown that particular week and aircraft then leave these two bases early on Tuesday morning to fly the planned circuits. The pilots carry with them the 1 : 500,000 treatment maps which indicate the rivers to be treated and the dosages required and 1 : 200,000 maps which show the release points of the breeding sites to treat. Circuits normally take three to four days (Figs.).

34. There are eight major fuel distribution points in the Programme area from where the subsidiary caches are supplied. At six of these points bulk fuel is available from airport pumps but at the other two, fuel has to be brought in from elsewhere. There are 80 subsidiary caches of fuel and insecticide in the Programme area (Fig.). Both fuel and insecticide have to be made available in drums. Maintenance of adequate stocks at these caches and the keeping of accurate records are large-scale logistical exercices.

AIRCRAFT TREATMENT CIRCUITS

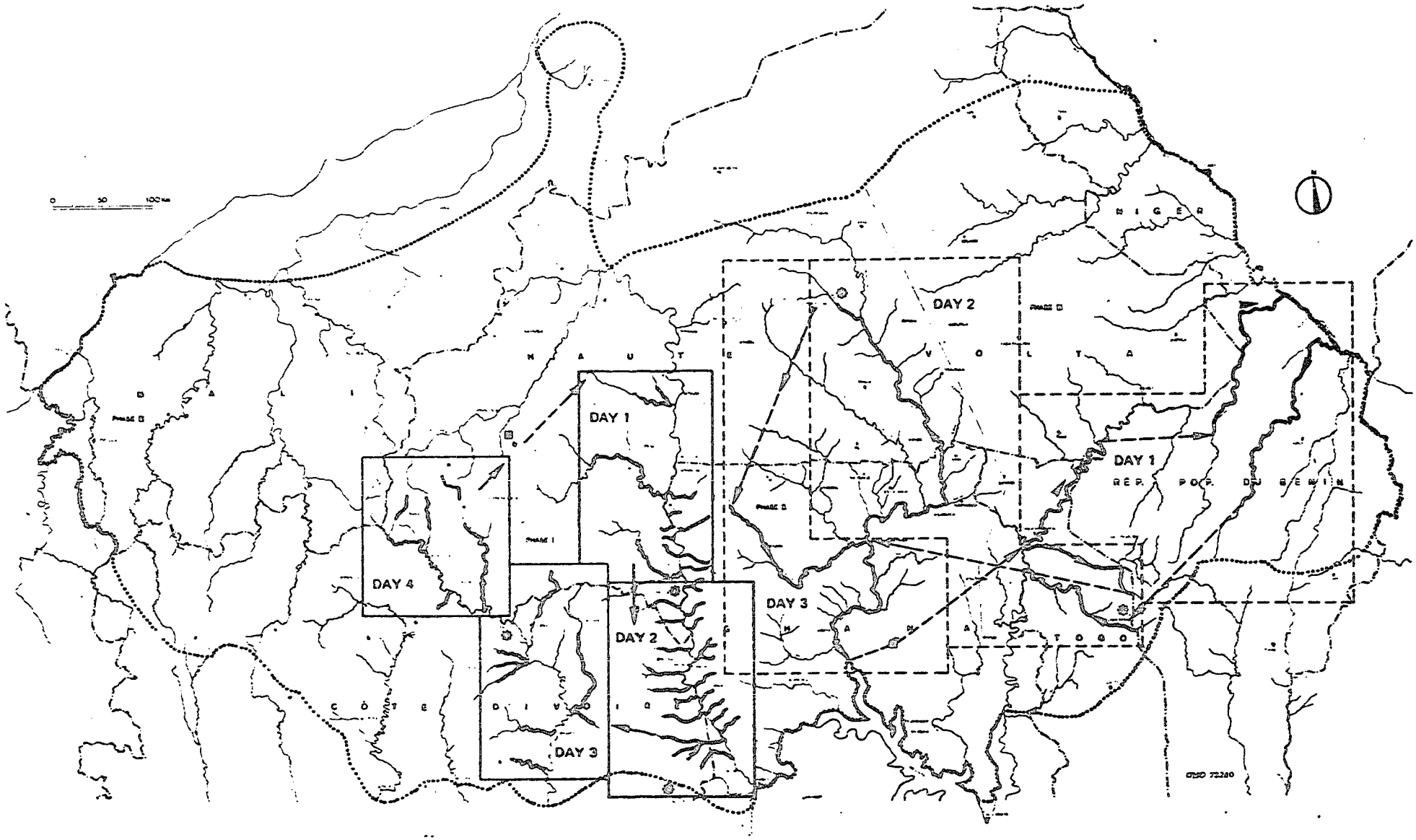


2 1/2 DAY DRY SEASON HELICOPTER TREATMENT.
ABATE DISPENSED USUALLY 400 LITRES.
THESE RIVERS ARE DONE BY FIXED WING IN WET SEASON.

NIGHT STOP

BASE

AIRCRAFT TREATMENT CIRCUITS



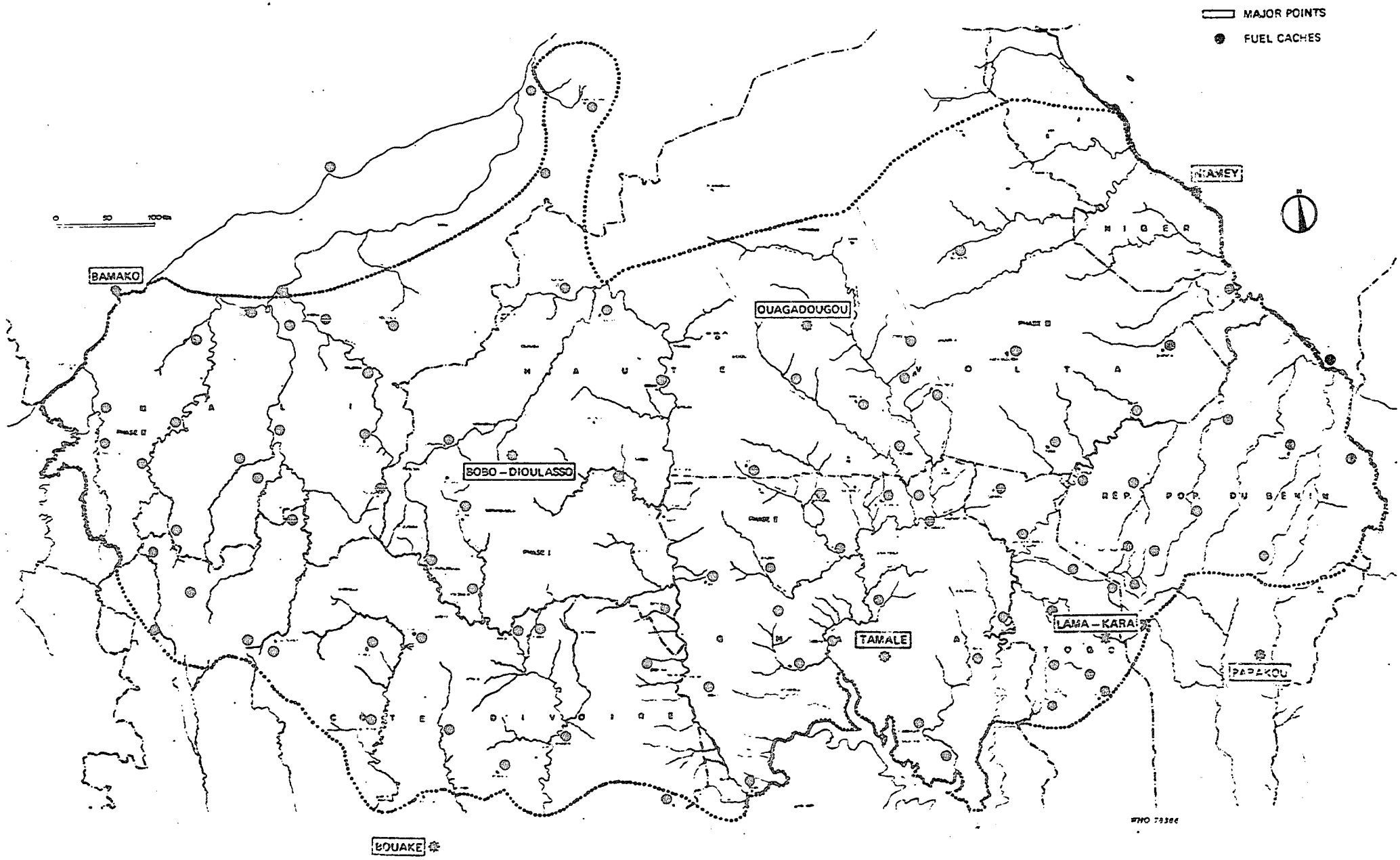
4 DAY WET SEASON HELICOPTER TREATMENT.
ABATE DISPENSED USUALLY 1000 LITRES.
LARGE RIVERS DONE BY FIXED WING IN WET SEASON.

3 DAY FIXED WING TREATMENT IN WET SEASON.
FIXED WING NOT USED IN DRY SEASON WHEN THESE RIVERS ARE DONE BY HELICOPTER.

NIGHT STOP

BASE

REFUELLING POINTS IN THE PROGRAMME AREA



Entomological Surveillance

35. The original plan for entomological evaluation (PAG Mission Report, Annex V-3) envisaged a network of 7 sectors and 24 sub-sectors from each of which would operate approximately 2 teams of vector collectors. Additional teams were to be attached to each of the Sectors to give a total of 58 teams. Each team was expected to consist of 3 vector collectors, a driver and vehicle; 141 regular catching points were to be visited at fortnightly intervals. At each visit two consecutive days (11 hours) catching would be undertaken. In addition shorter catches would be made at other less important sites and larval searches made at known and suspected breeding places.

36. This basic plan has been modified in several respects:

a) the vector collecting team has been reduced from 3 to 2 collectors.

b) the collections at regular catching points have been made at weekly instead of fortnightly intervals.

c) the number of catching points has been considerably increased, and almost all catches are for the 11 hour period.

37. These alterations to the original plan were considered to be necessary to provide satisfactory operational information. As the control operation is based on a weekly cycle, hydrological data collected by the surveillance teams must be transmitted by radio from the sub-sectors each week. Most of the hydrological stations are important catching points which must be visited weekly regardless of whether a catch is made. Similarly, each team must return to base each week in order to pass on its vital hydrological information. Thus the utility of operating the surveillance network on a weekly cycle is obvious. In addition the entomological data concerning both larval searches and adult collections is invaluable in planning the aerial control operations. A fortnight's delay in acting on this information is too great when dealing with a vector whose immature stages are completed in less than that time.

38. In addition to this operational role the entomological evaluation, at this stage, is designed to provide (i) a measure of the effectiveness of the Programme in the period before reliable epidemiological changes can be demonstrated; (ii) statistically valid data to compare biting and transmission rates with the human parasitological and ophthalmological findings; and (iii) data for use in research into the reinvasion phenomenon.

39. In order to fulfil these requirements fifty vector collecting teams were employed during 1975 and 86 during 1976 and 1977, falling to 78 in 1978. In addition another 20 teams were employed on a temporary basis for an intensive programme designed to study reinvasion problems in 1977 and 1978.

40. In setting up the entomological evaluation network, 525 catching points have been studied in varying degrees of detail and the catching results stored in the HQ computer. These are distributed as follows:

Phase I	227
Phase II	108
Phase III W	70
Phase III E	120

41. Increasing knowledge has indicated that more intensive catching at fewer sites is likely to yield the most valuable results, especially when reinvasion problems are being studied.

42. Thus, during 1977, an average of 270 (range 213-302) catching points was visited each month and over 1 400 days catching undertaken per month to give an average of 5.3 days catching per site per month.

Establishment of Criteria

43. Interpretation of the entomological data presents a number of problems. Clearly, in the complete absence of the vector no further transmission will take place. However, with a vector such as S. damnosum which under certain circumstances may migrate (paragraphs 50 - 54), this situation is unlikely to be achieved or maintained for long periods over wide areas. It has thus become necessary to determine the level of biting fly populations and potential transmission of O. volvulus which is considered acceptable from the medical and economic viewpoints. In order to make a judgement concerning the success or otherwise of the Programme and to provide criteria for assessing the advisability of settling populations in zones of severe onchocerciasis, OCP convened a Scientific Advisory Panel Working Group in June 1977. The Panel carefully considered the available entomological data concerning the transmission situation before vector control activities, together with the known resultant degrees of the disease. The Panel decided that an Annual Transmission Potential (ATP)[1]

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[1] This is the annual total of the estimated individual monthly transmission potentials obtained from the formula :

$$\frac{\text{No. of days in month} \times \text{No. of infective larvae}}{\text{No. of days worked}} \times \frac{\text{No. of flies caught}}{\text{No. of flies dissected}}$$

Calculations for the ATP in the Programme area are based solely on the numbers of infective larvae indistinguishable from O. volvulus in the flies heads. Where Simulium biting densities are low, as in the Programme area, ATP's calculated in this way are liable to wide fluctuations resulting from the numbers of infective larvae in single flies.

of 100 was extremely unlikely to result in any untoward medical or socio-economic effects. Available data also suggested that an ATP of 800+ was likely to be accompanied by severe onchocerciasis. In order to cover the situation where previously uninhabited areas are to be subjected to human settlement, it was also necessary to determine what level of biting fly populations might give rise to unacceptable levels of ATP. The Panel concluded that an Annual Biting Rate (ABR)[1] of less than 1 000 was most unlikely to give rise to an ATP of over 100 and this could be considered safe, and that with an ABR of above 8 000, a hyperendemic onchocerciasis situation was likely to develop, should a human population containing some onchocerciasis carriers be settled. The Panel clearly appreciated that with knowledge which should become available after the second or third passage of the Epidemiological Evaluation teams, it might be possible to safely increase the acceptable levels of ATP's and ABR's.

44. An analysis of the results during three years for the Phase I and II area shows a steadily improving situation.

	% of ATP's below 100		% of ABR's below 1 000	
	Phase I	Phase II	Phase I	Phase II
1975	68	70	61	50
1976	81	85	72	80
1977	86	92	79	85

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[1] This is the annual total of the estimated individual monthly biting rates that have been obtained from the formula:

$$\frac{\text{No. of flies caught x No. of days in month}}{\text{No. of days worked}}$$

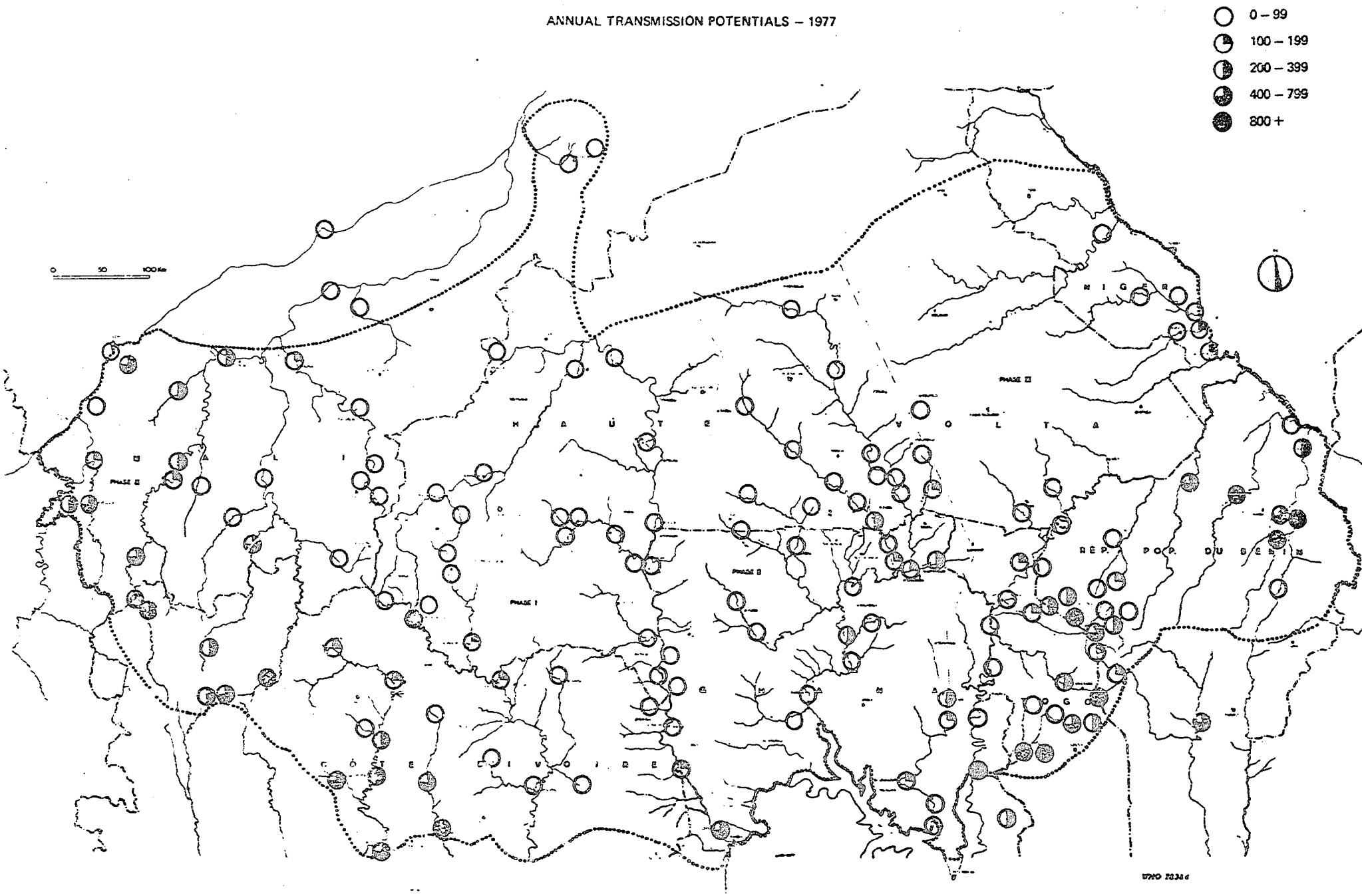
45. In 1975 Phase I was under insecticidal control whilst Phase II was not. However, it seems most likely that the control activities in Phase I influenced the results in Phase II where, at the few catching points from which several years' data were available, the lowest ever ATP's and ABR's were recorded. The superior results of Phase II in subsequent years arises from the fact that this area is little subjected to reinvasion by epidemiologically significant numbers of flies from outside the control area, whereas about 40% of Phase I is so reinvaded.

46. In many cases results in the heart of the Programme area are excellent. For example at Wayen (point 04Q7) sited on the White Volta river just east of Ouagadougou, no vector flies have been caught since the start of the control campaign yet in the pre-control times the ABR exceeded 8,000 and the ATP exceeded 200. In most of the Black, White and Red Volta and Sissili valleys in Upper Volta transmission of onchocerciasis has almost certainly ceased since the start of the control campaign. Further south, in the Black Volta Valley, control has improved markedly each year, e.g. at Chache (point 1303) the situation for the three years of control is as follows :

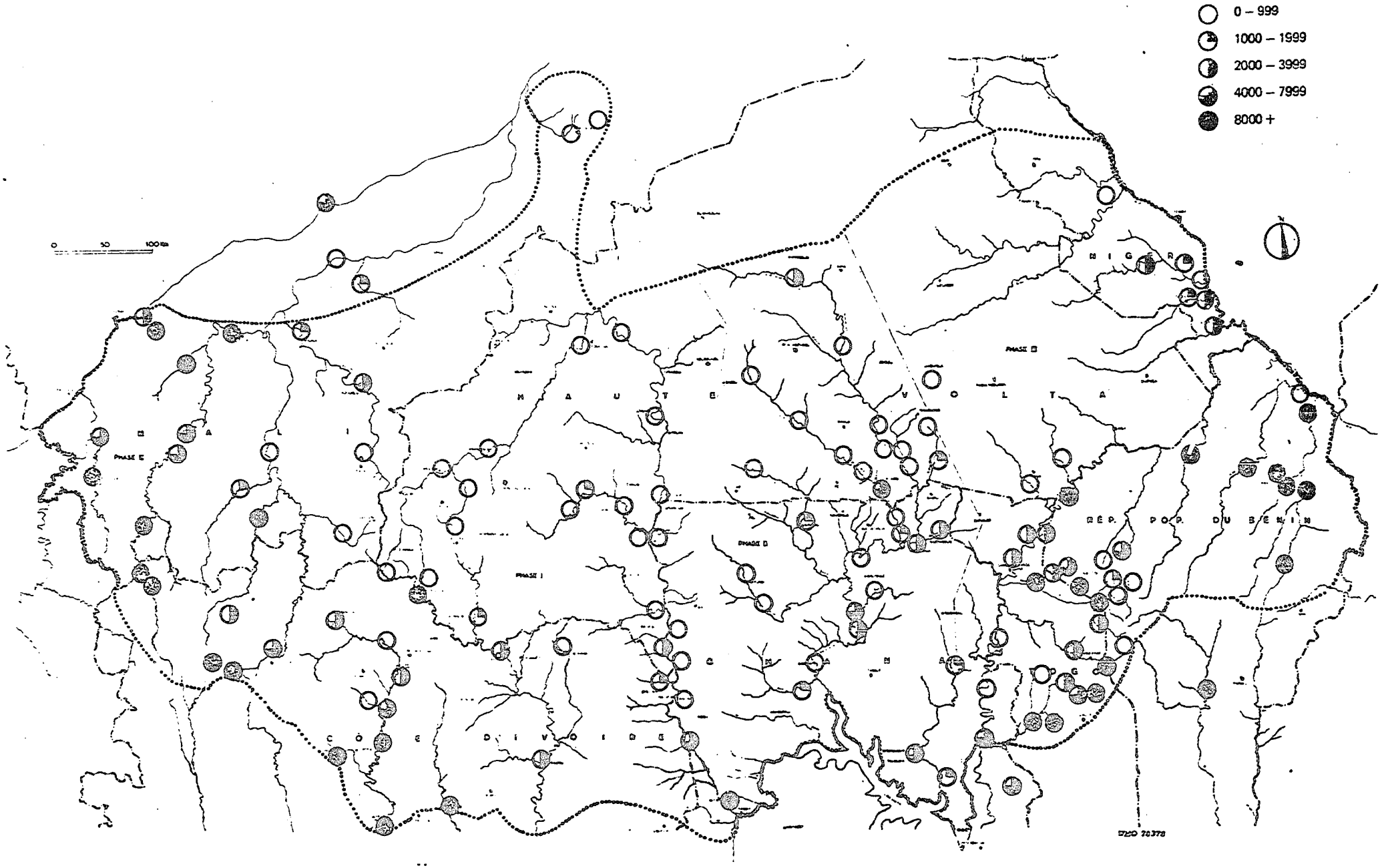
	ABR	ATP
1973-4	34,000	N.A.
1975	12,015	825
1976	1,957	80
1977	657	15

47. The 1977 data concerning ABR's and ATP's at 157 well studied points have been analysed and plotted on Fig. . Similarly all useable pre-control data have been plotted on Figs. . The ABR data has been plotted for 114 points and ATP data for 96 points.

ANNUAL TRANSMISSION POTENTIALS – 1977



ANNUAL BITING RATES – 1977



48. Control in Phase III West was implemented only in March 1977 and for parts of Phase III East only in August 1977 (not at all in the easternmost valley - the Sota Valley), therefore the data for 1977 in figs. and include three or more months of pre-control in these areas. Analysis of the pre-control and 1977 ATP's shows the following breakdown:

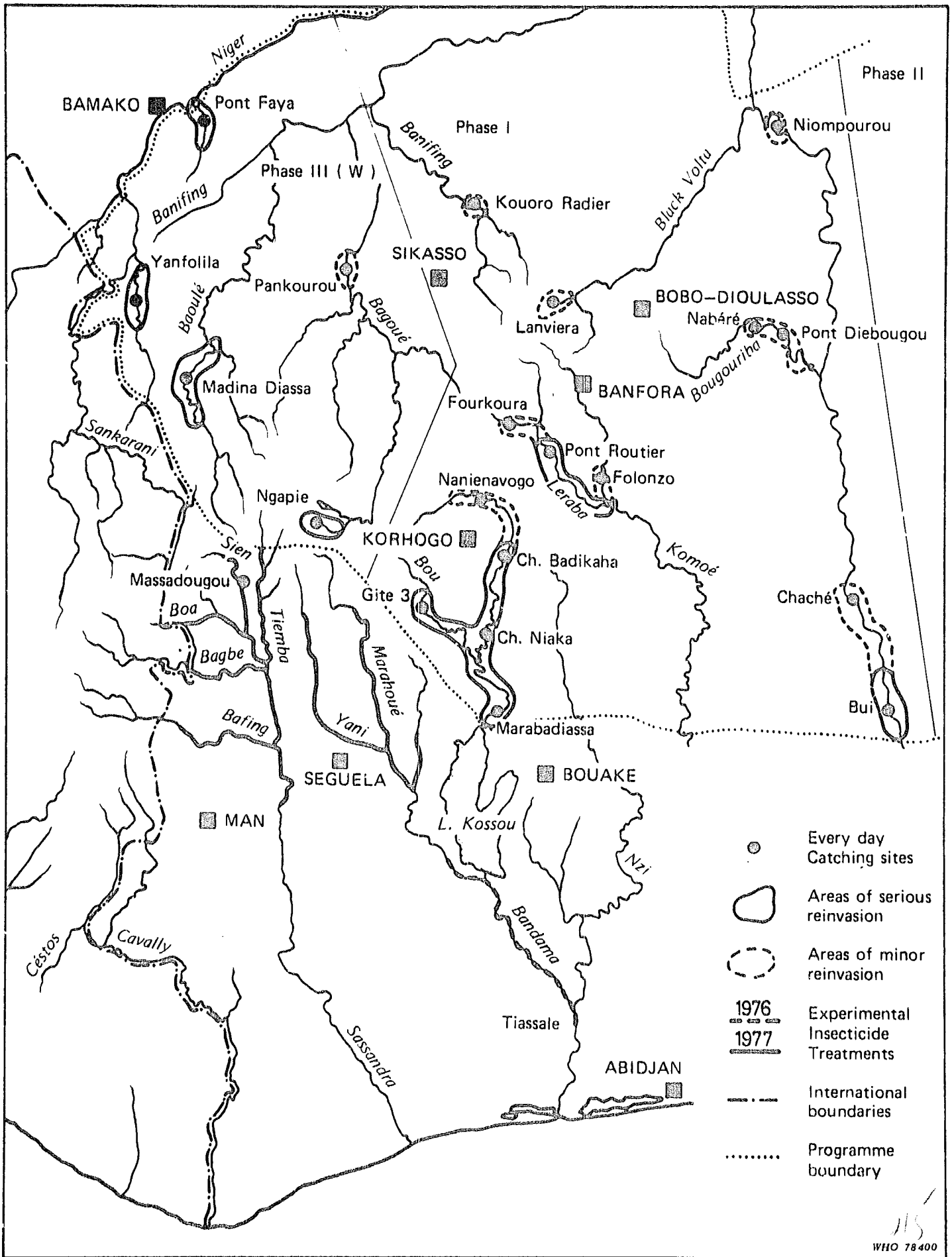
	1977		Pre-control	
ATP	No. of points	% of points	No. of points	% of points
0-99	91	58	12	13
100-199	20	13	6	6
200-399	19	12	19	20
400-799	16	10	12	12
800+	11	7	47	49
	157	100	96	100

49. The pattern of results when ABR's are considered is very similar with a few more points registering results which do not fall below the critical level (1 000).

The reinvasion phenomenon

50. Shortly after the commencement of control in the Phase I area, fly populations dropped sharply and in most cases became zero within 3 or 4 weeks. However, with the onset of the rainy season large numbers of flies reappeared at certain sites in the south-west of the Programme area. Detailed investigations showed (a) that there was no active breeding in the area; (b) that virtually all the flies were parous (were in fact several days old and had already taken at least one blood meal before they were caught by the vector collector); (c) flies in many cases were carrying infective stages of the parasite *Onchocerca volvulus*. The flies appeared to be a reinvading population moving in the same direction as the prevailing monsoon winds. Each year a similar reinvasion has occurred in the same

AREAS OF REINVASION, CATCHING STATIONS AND EXPERIMENTALLY TREATED RIVERS.



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areas which are indicated on Fig. . These are areas where there is an epidemiologically significant influx of infective flies. Flies probably penetrate to all parts of the Programme area but/generally in numbers which are epidemiologically insignificant. The results of the reinvasion study are shown in Annex .

51. Sources of reinvading flies are probably located to the south-west of the reinvaded zones. Experimental control in the Marahoue and Sassandra valleys in June-July 1977 seemed to greatly curtail the reinvasion of the Upper Bandama and Leraba rivers. Control operations currently being carried out on the Marahoué and Sassandra rivers in Ivory Coast during 1978 are beginning to confirm this observation.

52. The reinvading flies have proved to be only savanna cytospecies. Extension activity in Ivory Coast to cover all savanna regions should result in an improved situation in the Bandama valley, as already mentioned, and in the Bui region of the Black Volta.

53. A comparison of the reinvasion map (Fig.) with the map of ATP's in 1977 (Fig.) shows that most of the catching points registering unsatisfactory ATP's fall within the reinvasion zone.

54. The actual zone affected by reinvasion is less than 30% of the total original Programme area, (see Fig.) and with alterations to the southern extension of the Programme area in Ivory Coast this is likely to be considerably reduced.

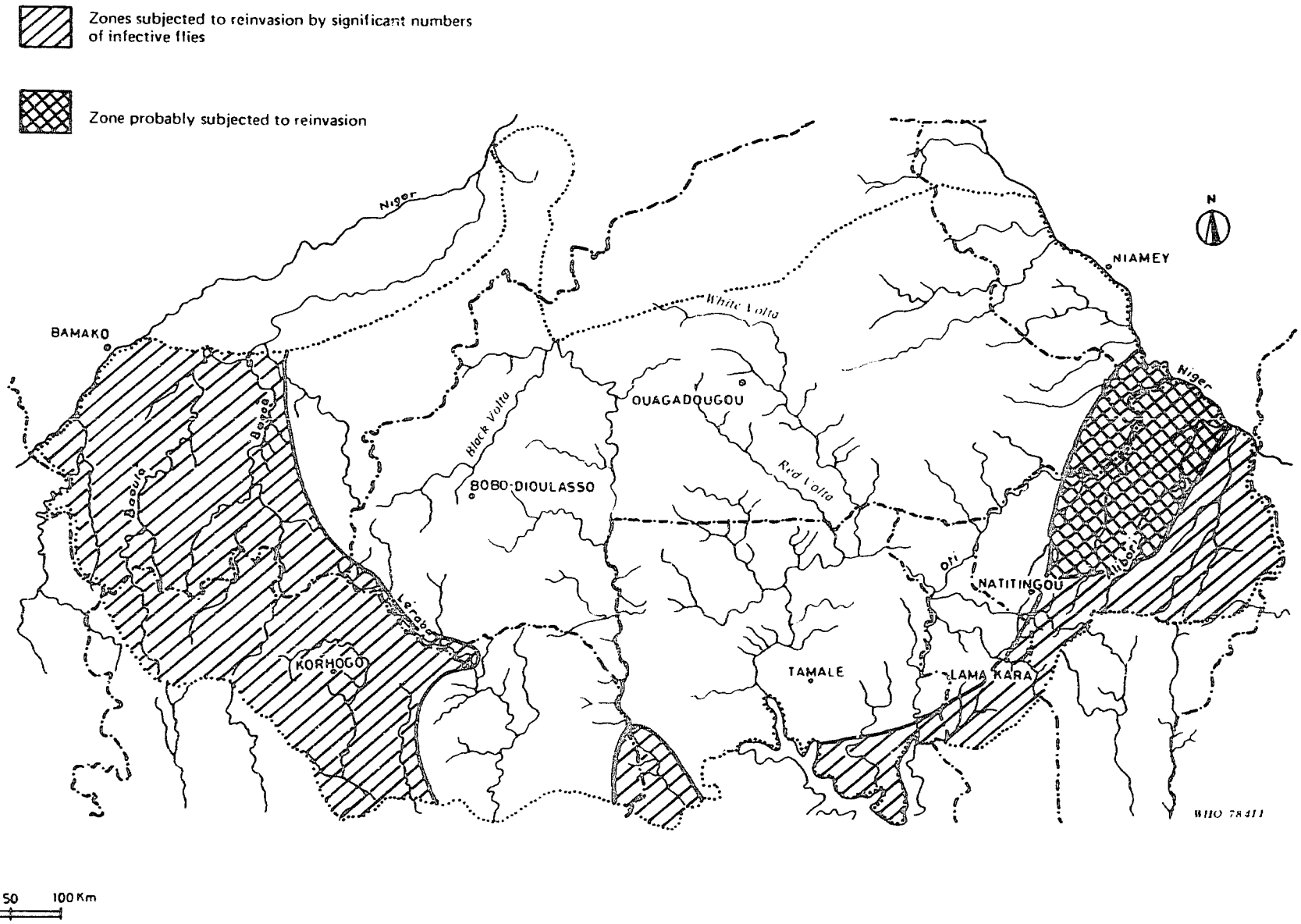
Epidemiological Evaluation

Aim and methods

55. The outline in the PAG report for the epidemiological work to be done by the OCP was as follows:

(a) Surveillance of 0.33% of the population of the region of the Programme, i.e. 33,000 persons distributed in the seven participating countries of which the population concerned is estimated at about 10 million.

REINVASION AREAS



(b) Stratification according to endemicity levels of the localities or regions if these are known, in such a way that 2/3 of the sample are situated in zones of meso- or hyperendemicity because "the primary aim of the surveys is to determine the effects of the control programme in areas with high levels of endemicity".

(c) Initial selection, on the basis of data previously collected, of a random sample composed of N clusters of 300 persons until the required number in each country is obtained.

(d) Longitudinal follow-up, during the implementation of the programme, at three-year intervals, of each of the individuals forming the evaluation clusters.

(e) Annual detailed examination of 8-10% of the sample; complete ophthalmological examination, complementary laboratory tests.

Sample design

56. It soon became evident that the focal distribution of the disease would not allow for a valuable random selection.

57. It was considered that in endemic situations which were far from being homogeneous and where one could see a distinct pattern of foci in relation to the profile of watercourses, a careful choice was necessary and in 1975 it was decided to utilize the following criteria, agreed upon by STAC:

(a) The "villages" must be representative of all the ecological, hydrological and geographical zones of the basins and watercourses where breeding-places occur. The villages selected must be representative of all the known foci. As a result they are scattered throughout the 14,000 km of watercourses covered by the Programme.

(b) They should be interdependent with the entomological evaluation programme, i.e. they should be selected close to the permanent collecting points, particularly when entomological considerations so require, or else their distance should be taken into account.

(c) Full attention should be paid to sociological factors, longitudinal studies being incompatible with a high drop-out rate and presupposing social homogeneity and an adequate level of population stability. Accordingly, administrative and commercial centres (which have too high a proportion of foreigners, temporary residents and non-residents), agricultural (including processing) businesses and projects dependent on migrant and seasonal labour, and nomadic communities were all excluded. On the other hand, groups resettling the onchocerciasis-freed areas were included.

(d) The different levels of prevalence need to be represented in the samples. Bearing in mind the PAG Mission's recommendation that two-thirds of the villages in the sample should have a prevalence of more than 33%, it was found preferable to select 75% of the sample from hyperendemic villages (prevalence 60%) and the other 25% from villages where prevalence is low or sporadic.

(e) As a result, of the total of 300 subjects recommended for the clusters, it was necessary sometimes to combine several small villages to form one cluster, sometimes to restrict the survey in excessively large villages of 100-1500 inhabitants to one or more districts, assuming the districts were sufficiently distinguishable, or to exclude such villages. Moreover, in some villages particularly

relevant to evaluation, the numerical criteria had to be changed. In the end the cluster size was between 200 and 500. The figure 300 is not always feasible, and also there are psychological difficulties in getting the inhabitants of a village to accept a methodology that does not cover all of them.

(f) As far as possible, the selection of villages should take into account the economic development zones.

(g) Random selection was replaced by selection based on the accepted evaluation criteria.

(h) Communities from non-endemic regions who come to settle in the reclaimed areas, such as the territory of the Volta Valleys Development Authority (AVV) in Upper Volta, and who form a control population not foreseen in the PAG Mission report, had to be included in the evaluation programme.

(i) Finally, the need for control data led to the inclusion of control villages situated outside the Programme area.

Current methodology

58. Since the beginning of the campaign, baseline data have been collected in the seven countries. On the basis of the criteria mentioned above, the following conclusions can be drawn.

Geographical dispersal: all river basins treated by the vector control unit are represented in the sample.

Relation with entomology: whenever possible the villages close to a permanent *Simulium* catching point were chosen in order to assess the degree of correlation with the entomological results. In certain cases the investigations were conducted upon the request of the entomologists. The different levels of transmission (ATP) are represented in the sample.

Quantitative aspect: the basic sample established in the 7 countries totals 80,000 people, out of a population of 11 million inhabitants. This represents a sample of 0.75% of the population, which is considerably greater than the number originally envisaged (0.33%). This decision was taken in consideration of:

- The need to retain a sufficiently large sample in order to secure significant results in the longitudinal surveys of villages over a period of 10 years or more, in view of the high absentee rate of 20% at each examination. Also, the larger sample initially chosen now contains a sufficient number of villages from which valid conclusions can be drawn on the transmission resulting from infected flies imported from outside the OCP area.
- The need to ensure adequate geographical coverage as required by the entomological control.
- The need for mapping of foci and chemotherapeutic trials.

59. For operational reasons, the epidemiological evaluation has been carried out at two different levels, simple and detailed surveys. The simple survey consists of a parasitological assessment of prevalence and intensity of onchocerciasis by means of examining 2 skin snips, plus a simple screening procedure for visual impairment and blindness. In the detailed survey a careful clinical and ophthalmological examination is also included. Because of the time-consuming technique, the detailed examinations have been carried out on only approximately 15% of the total sample, allowing for certain special studies concerning ocular lesions to be undertaken.

Migrants:

60. In the AVV where there is a population of non-infected immigrants, 3,600 individuals have been registered for a special study aimed at checking the persistence of any residual transmission.

Periodicity of examinations: In general, the rule of an interval of three years between each visit was also retained for the detailed evaluation sample.

61. As of March 30, 1978, the total population examined by the Epidemiological Unit was as follows:

	simple evaluation	detailed evaluation	Total	of which ophthalmo. exams
Mali	11,891	1,359	13,250	1,061
Upper Volta	26,353	3,300	29,653	3,004
Ivory Coast	7,412	2,812	10,224	2,235
Niger	1,406	799	2,205	624
Togo	7,392	1,801	9,193	1,262
Ghana	11,303	1,915	13,218	1,531
Bénin	6,056	1,445	7,501	675
Total	71,813	13,431	85,244	10,932

Preliminary medical results of entomological operations

62. The first check of the results of operations in Phase I began in 1978. Sixteen Upper Volta villages were reexamined and the reliability of survey and diagnostic methods confirmed: the disease was found again in more than 99% of the people where it had been observed three years earlier; the few negative cases can be accounted for either by an error of identification or by mishandling, or by carriers with a very low parasitic load that randomizes the demonstration of microfilariae (the diagnostic error risk is lower than 1%).

63. Eight hyperendemic villages were reexamined along the Bougouriba and Black Volta Rivers, in an area where vector control was not completely successful in 1975 (ATP = 183 in 1975 in Mabere village) but where as early as 1976 ATP's were below the threshold of 100 larvae/man/year.

64. In the 0-4 years age group, the prevalence of onchocerciasis has decreased from 5,3% to 1,6% within three years and among the 140 children born since the beginning of operations, only two were found infected (they were born in early 1975). A slight decrease even tends to appear in the 5-9 years age group. Although the magnitude of these changes is too small to have any significant implications at the level of all the villages they confirm the general trend towards a 2 or 3 point decrease in the overall prevalence of onchocerciasis in this sample. The average microfilarial density remains stable among the infected people.

65. Seven other villages were visited again in late 1977 in the Upper Comoë basin where the control is reported to be excellent since January 1975, that is for almost three years. No positive cases were found among children born during that period. Of the 277 children examined in the under five age group, none had onchocerciasis whereas 3 out of 267 (1.1%) were infected before the campaign began. In the meantime, the prevalence has dropped from 9% to 6% in the 5-9 years age group.

66. Finally, in Dangouadougou, a village located on the route of the reinvasion phenomenon, the ATP is still higher than 1,000. The disease in the village is becoming more severe: the overall prevalence is increasing slightly, but the individual microfilarial loads are growing on an average of one-third (32 inf. instead of 20), two children under four were found infected and the prevalence has increased from 3,5% to 7% in this age group.

67. These medical results clearly confirm the validity of the findings of the entomological evaluation. The tendency to a setback of the disease is still more significant if one considers that the transmission has been reduced to a lower level. The ATP values established in 1976 allow an optimistic view of the overall

epidemiological results which will be observed after a 5 or 6 year period of control. The ageing of adult worms will then lead to a significant decrease of the parasitic load to which will be added the effects of the renewal of generations among the population.

68. In terms of ophthalmology, four villages have been reexamined after a three year period. Preliminary results do not show any significant difference as regards the prevalence of ocular onchocerciasis or the number of severe cases, but, generally speaking, overall rates have diminished slightly. However, in three of these villages where entomological results are satisfactory, there is a tendency to a decrease of ocular microfilarial loads in data for 1978, as compared to 1975 data. Also, the number of patients with aggravated ocular impairment is remarkably low. This might explain why the blindness rate has decreased from 12,3% to 8,2% in one hyperendemic village: the number of new cases of blindness was low and the blind of the village had been subjected to high mortality.

69. All these results, and especially the assumption that the interruption of the transmission of onchocerciasis might have already had a favourable stabilizing impact on the ocular lesions, have to be checked on a statistically reliable sample. This will be done in 1979. A study of the risk factors of blindness among onchocerciasis patients in a protected area will be undertaken. Such a study will be most valuable for the future assessment of the number of blind people in the OCP area.

70. As to the future, the observations collected by the epidemiological evaluation and which concern about 80,000 people have been stored as baseline data. These results are summarized in Annex .

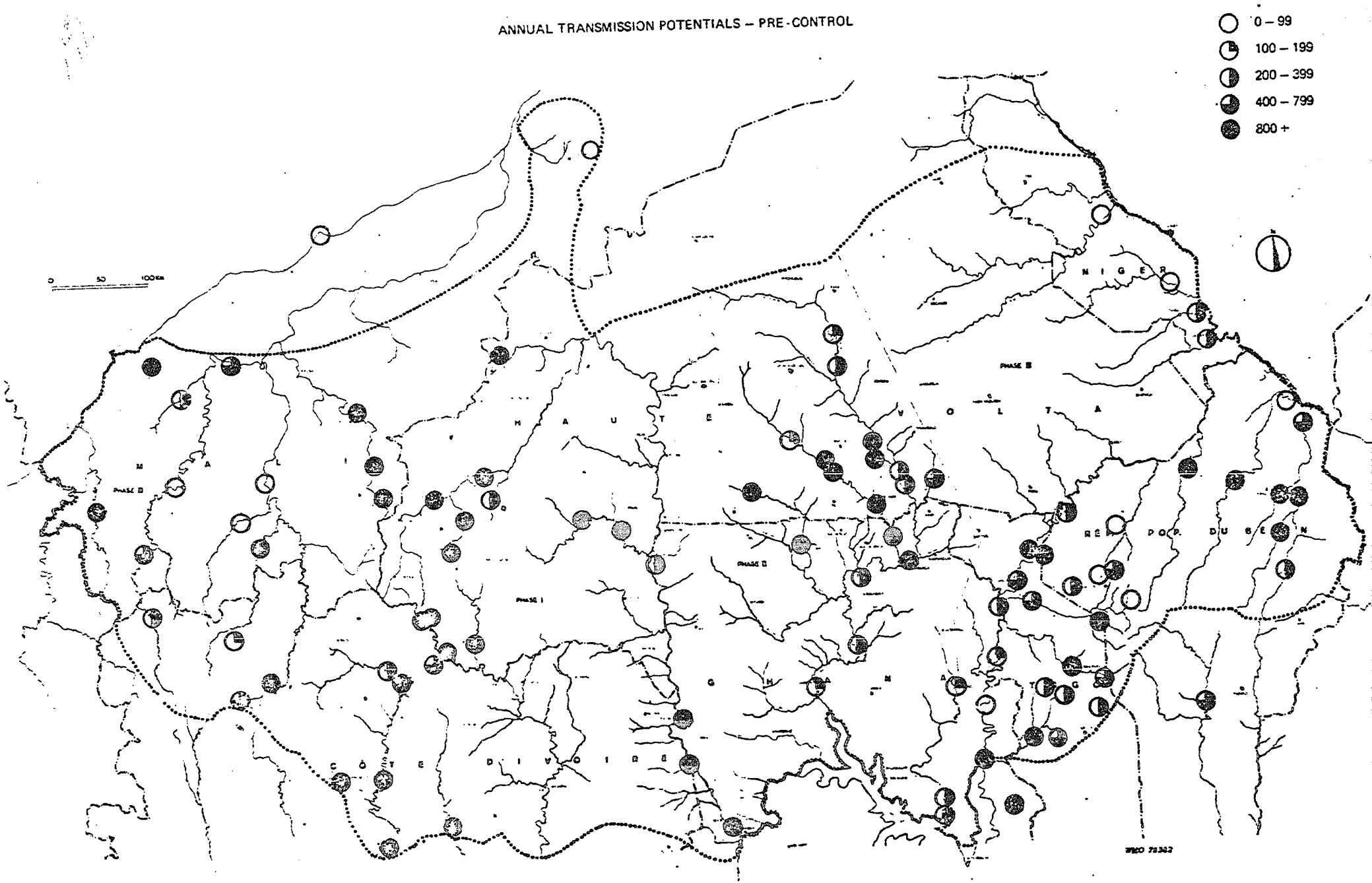
71. For the evaluation of the vector control operations in the OCP area, only a fraction of the sample will be used.

- A sample of about 1,000 - 1,500 individuals will be put under annual surveillance. Similarly in the "V territory in Upper Volta the entire uninfected migrant population will be examined annually.
- Less than half of the hyper- and meso-endemic clusters will be examined after 3 years in order to demonstrate the possible effect of the vector control.
- A certain number of hypo-endemic villages will be examined in order to estimate the life-span of the adult worms.
- Children born after the start of the Programme will be surveyed in some villages to confirm the interruption of transmission, due consideration being given to the possibility of intra-uterine transmission. This type of survey can be extended if required, to other villages.
- The follow-up of the villages with a sporadic endemicity will probably never serve any useful purpose.
- Villages will be eliminated from the network of regular visits, when useful epidemiological criteria cannot be fulfilled.

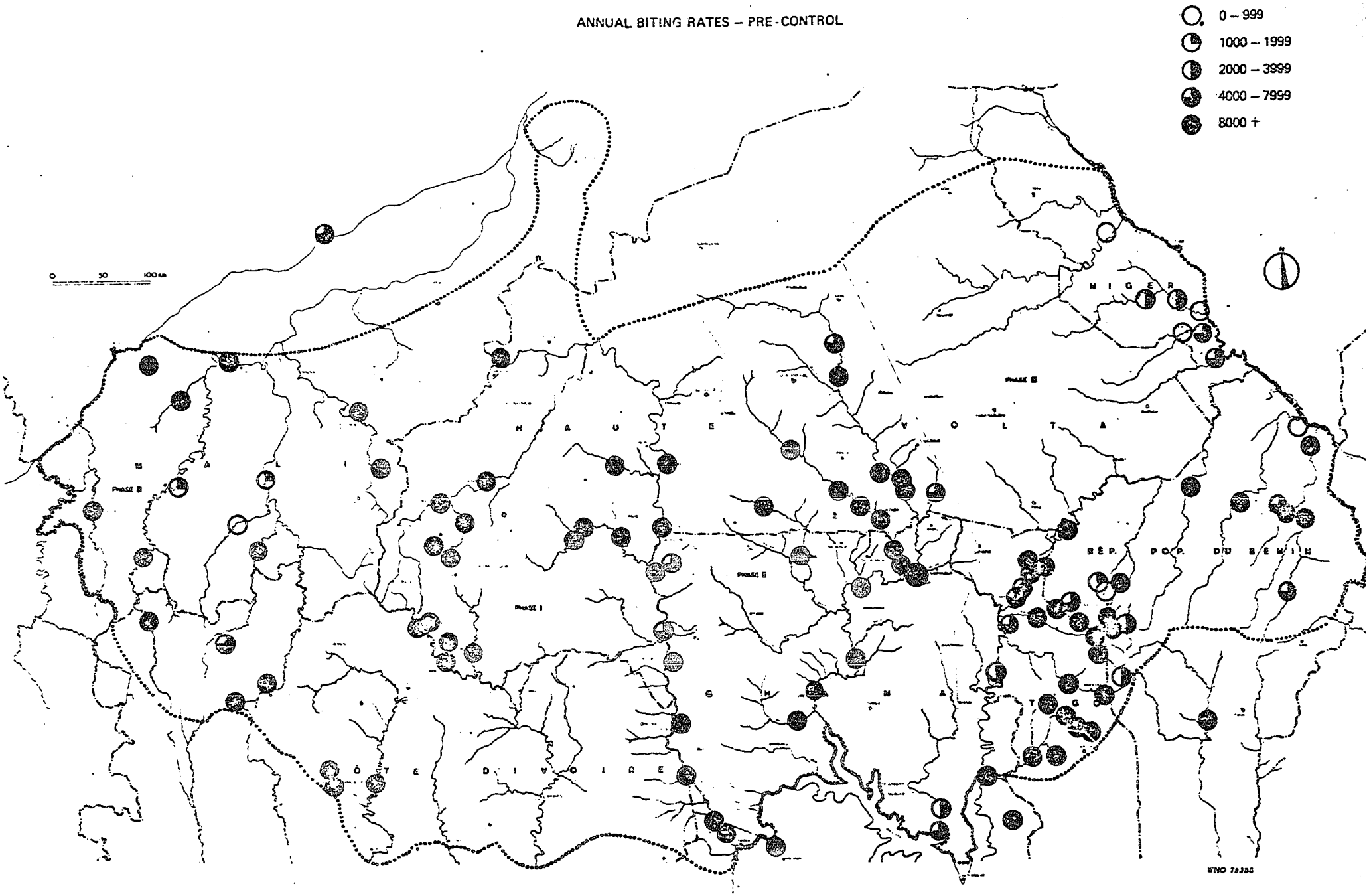
72. Practically, the surveillance network will be established as follows:

Niger	6 villages
Upper Volta	40 villages.
Ivory Coast	20 villages
Mali	30 villages
Togo and Ghana	to be determined

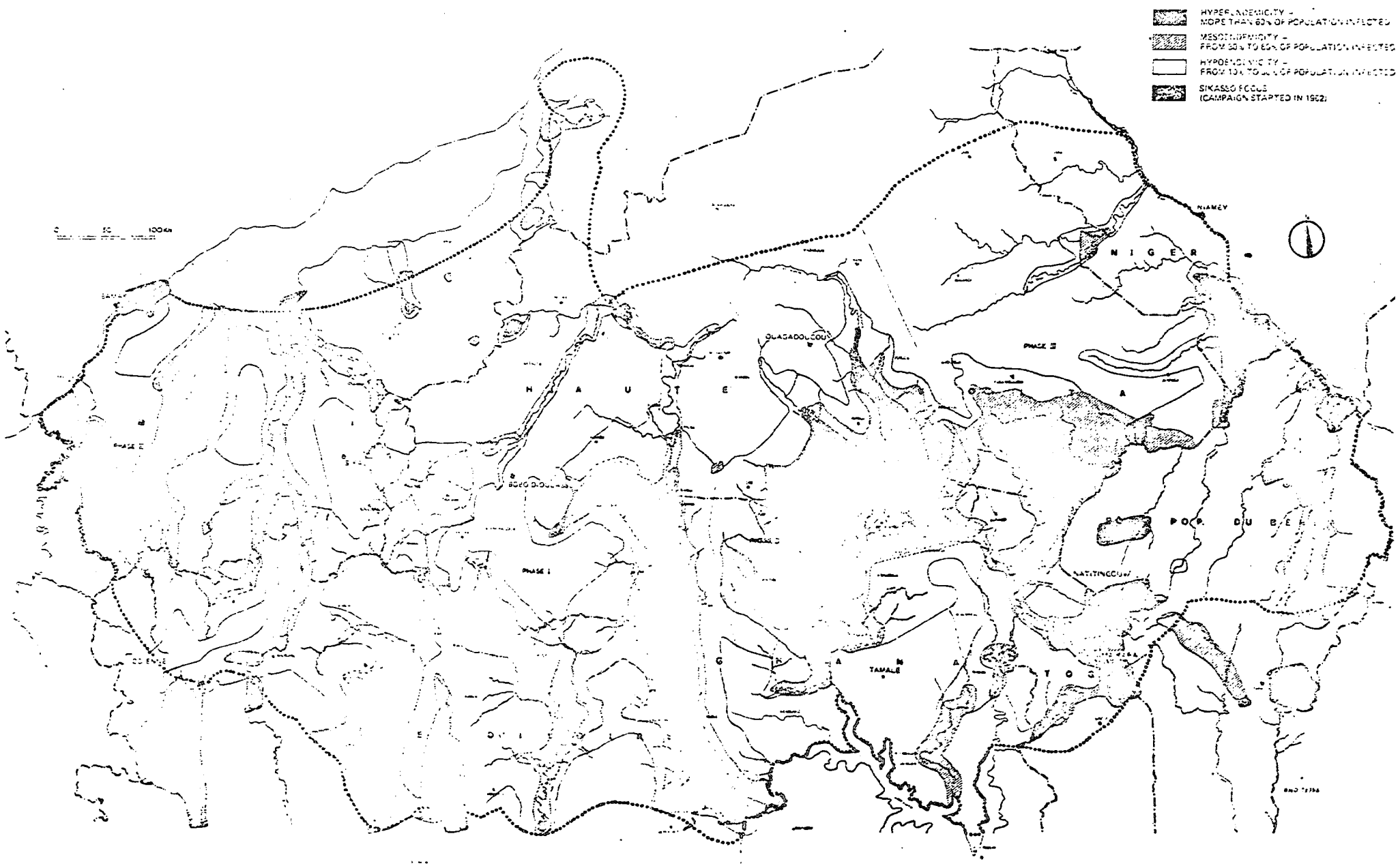
ANNUAL TRANSMISSION POTENTIALS – PRE-CONTROL



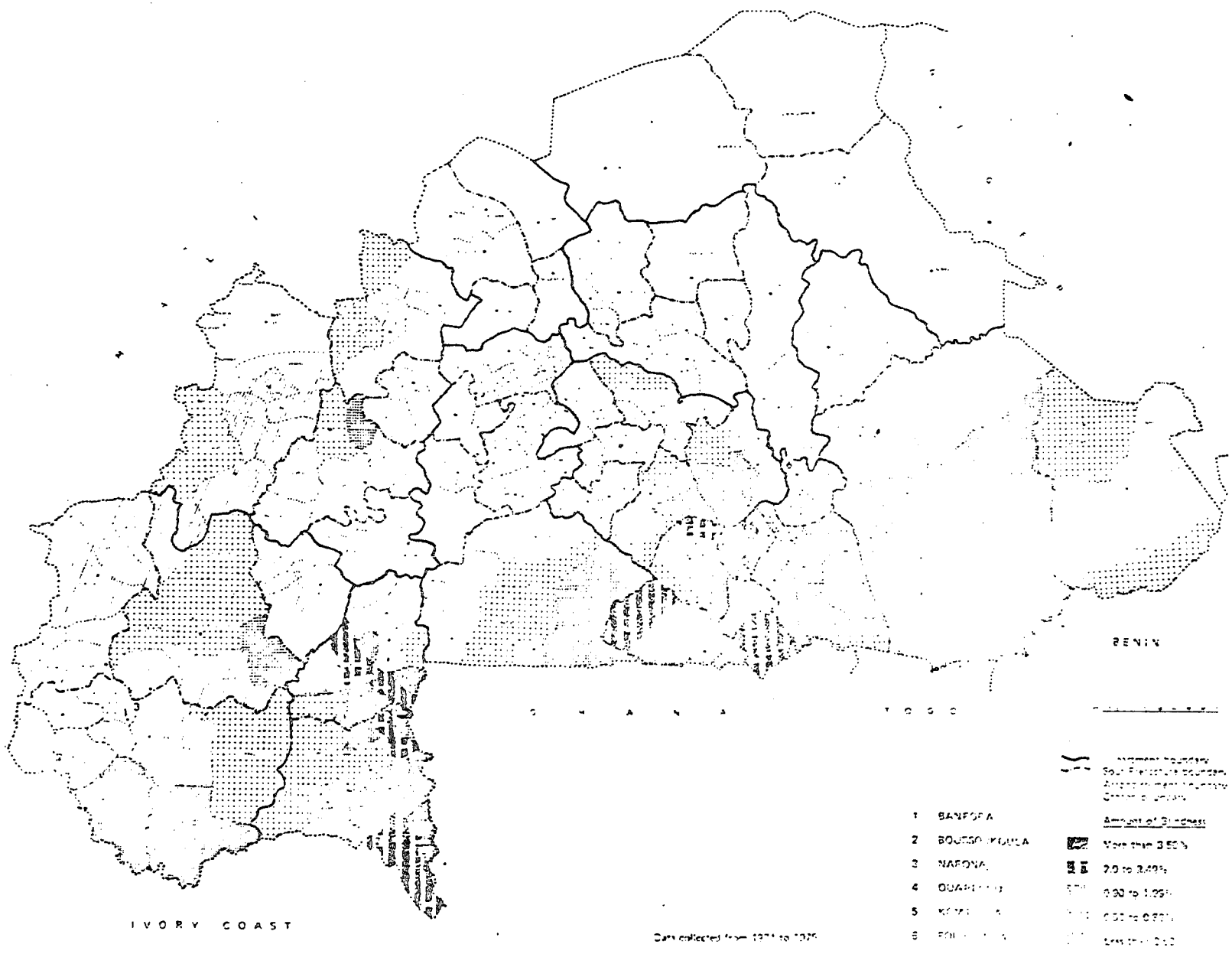
ANNUAL BITING RATES – PRE-CONTROL



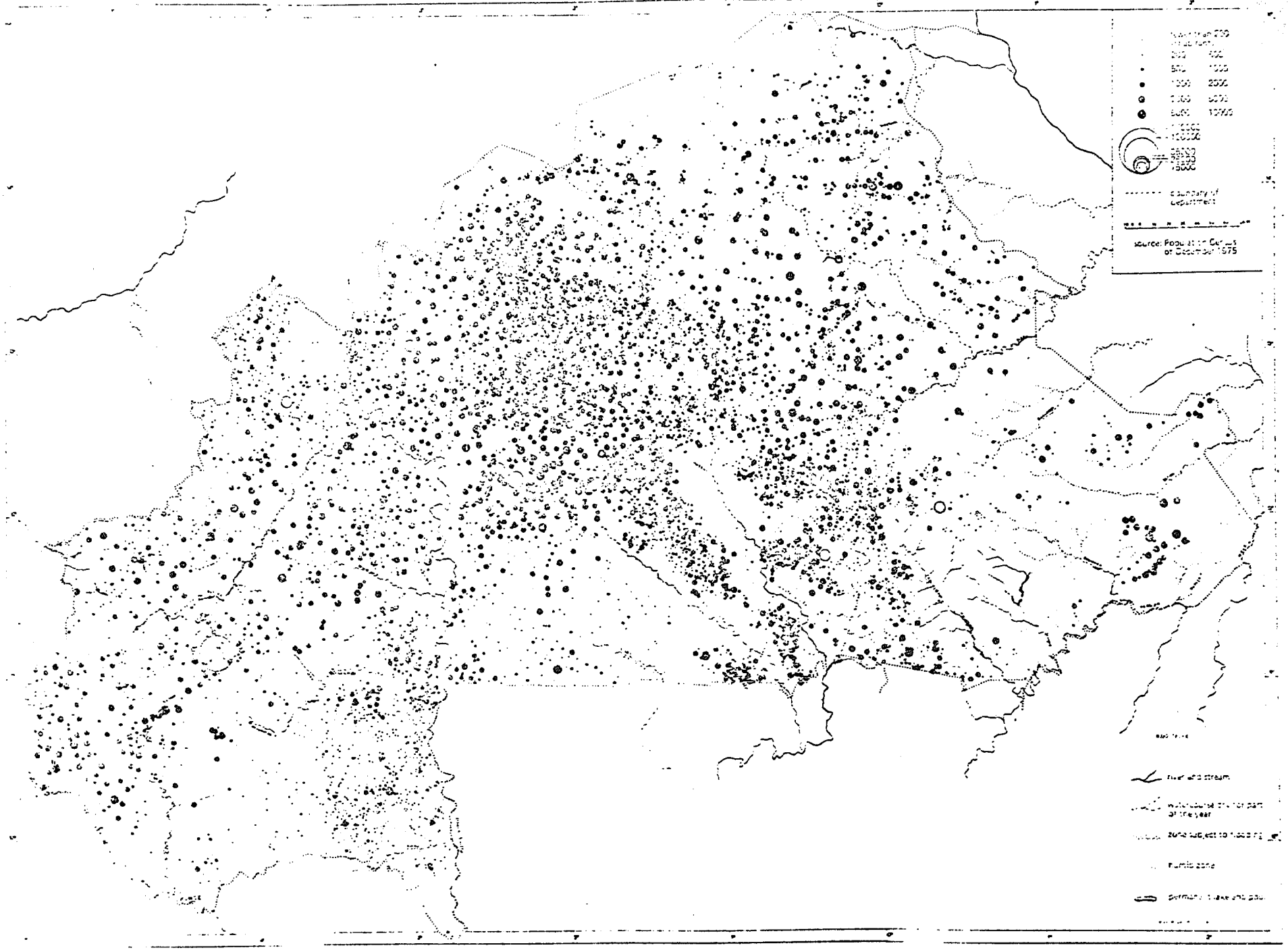
ENDEMICITY OF ONCHOCERCIASIS IN THE PROGRAMME AREA BEFORE BEGINNING OF CONTROL OPERATIONS



DISTRIBUTION OF BLINDNESS IN UPPER VOLTA



POPULATION DISTRIBUTION - UPPER VOLTA



CHAPTER IV

ECONOMIC DEVELOPMENT

1. There was general consensus that the Economic Development Unit of the Programme should assume an information-gathering role as well as liaison functions.

2. The Unit started functioning in February 1976. The first few months were spent on familiarization tours within the Programme area, establishing contacts with the ministries and officials concerned with development activities and projects in the oncho zones of the respective countries, with representatives of the United Nations Development Programme, FAO, WHO and other specialised agencies of the United Nations, and with other multinational aid agencies as well as bilateral aid agencies.

3. Close association was established with the regional development organizations in the Programme area, in particular those based in Ouagadougou, and also with the CILSS and the Inter-African Centre for Hydraulic Studies.

4. During the course of the year the functions of the Unit were more specifically defined to be information and liaison, namely to:

- collect and disseminate basic socio-economic data which may be useful for planning and development actions by both beneficiary and donor countries;
- on the basis of the socio-economic data collected, assist in the establishment of a socio-economic data bank for the Programme area;
- study and advise on development projects being executed or planned for the oncho zone, articulating all relevant socio-economic aspects and consequences;
- maintain contacts with all parties to the Programme and interested agencies (beneficiaries, donors, sponsoring agencies, bilateral and multinational aid and financing agencies).

5. Following on this definition a standard questionnaire for collection and transmission of information to the Programme on a regular basis was devised and circulated to the Programme countries.

6. The responsibility for preparing an annual report on socio-economic developments in the Programme area, which had hitherto been assumed by the United Nations Development Programme, passed to the Unit at the end of 1976. With the assumption of this responsibility, the staffing of the Unit was effected on a multidisciplinary basis in order to ensure the proper integration of the various aspects of development. The areas covered by the staff were sociology, agroeconomics, development economics and public health. By combined use of the questionnaire and personal visits by members of the Unit, information was assembled for compilation of the annual socio-economic report for 1977.

7. The experience gained by the Unit during its first three years has highlighted the importance of the following essential components for development of the oncho zone:

(a) a basic socio-economic infrastructure, particularly basic health services, schools and roads, especially in resettlement areas;

(b) the need for integration of public health components into development projects;

(c) integration of the oncho zone into the national economy of each country through regional development and planning; and

(d) the necessity for anticipating development problems and bottlenecks by keeping these under continuing study and review in order to prevent their becoming critical issues.

The question for the 1980-85 period, therefore is one of discerning the directions in which the Unit's functions may develop in that period.

8. For example, the economic review mission has suggested that the unit could expand its research and policy analysis activities by undertaking research and analysis on its own and by organizing research to be done by others. It should specialize substantially on socioeconomic subjects directly related to the vector control programme. One appropriate subject is resettlement and migration, an area where the need for programme and policy-related research is acute, particularly in Upper Volta. Another possible area for socioeconomic research is health and health care delivery.

9. Also, on several occasions the participating countries have suggested that the Unit gives particular attention to putting in evidence the economic benefits derived by the countries from the vector control activities.

CHAPTER V

RESEARCH[1] AND ENVIRONMENTAL PROTECTION

1. The research sponsored by the Onchocerciasis Control Programme has had a strong operational bias. While most of the work has been entrusted to institutions and universities under contract, two research scientists have been employed on the Programme. Altogether about $2,300,000 have been spent on research, equivalent to almost 7% of total expenditure, and within this amount sixty-one contracts have been negotiated for about $1,640,000, or approximately 5% of expenditure.

Entomological research

2. The greatest input has been in vector ecology and vector control. The distribution of the species of the S. damnosum complex along the rivers inside and outside the Programme area has been mapped. The savanna species, S. damnosum s.s. and S. sirbanum, have been clearly incriminated as the principal vectors of concern to OCP. Whereas originally the species could be separated only by cytological examination of the larvae, keys have been developed to enable the morphological identification of the adult flies.

3. Progressive studies to find mechanical means of sampling the adult and larval populations have resulted in the development of devices for use in everyday observation of the behaviour of S. damnosum but not for monitoring actual field operations. For example, the "windowpane" interception trap has provided additional information on flight behaviour and the aluminium sheet trap has proved useful in attracting physiological stages other than those seeking a blood meal. Also, as with the Simulium complex research, the methods have proved useful in the reinvasion studies.

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[1] For additional information on research see Annex.

4. Studies carried out on the larval sampling methods have led to a greater understanding of the spatial distribution of the larvae in the water ; their feeding behaviour and the size of particles ingested have also been studied. Such detail is of value in the development of alternative insecticide formulations.

5. Attempts have been made to develop a laboratory colony. Operationally, it has been found that the rearing of single generations of different species to provide material for more accurate identification has been usefully exploited, but the continuation into multiple generations has made slow progress. Enzyme polymorphism studies, while of value academically, have not produced an operationally viable tool. Likewise, source identification of vector material using X-ray Fluorescent Spectroscopy has been found to have marginal value to the Programme at this stage.

6. With the Programme reliant on only one insecticide, priority has been given to finding alternatives. A significant advance in this field was the development of a floating trough method enabling different products to be tried in situ without contaminating the whole river. Accordingly, it has been possible to show that the number of larvicides potentially available to OCP is very restricted and, in fact, to date only one, Chlorphoxim, has gone forward to large-scale field testing. The main difficulty is to find an insecticide that combines maximum effect against S.damnosum with minimum effect against other aquatic non-target organisms.

7. Studies undertaken on the dispersion of the Abate formulation in the rivers have shown its property of adsorbing a colloidal matter in the rivers. Gas liquid chromatographic methods have also been developed to study the amount of Abate to be found in water, mud, oysters and fish.

8. To obtain a fuller understanding of some of the subjects and to assist the planning of the research programme, a series of Scientific Advisory Panel Working groups have been convened. These have considered (a) the development of a laboratory colony of S.damnosum, (b) the reinvasion phenomenon, (c) trapping devices, (d) the S.damnosum complex and (e) the development of larvicides.

9. The future research component of OCP will continue to be closely linked to its operational requirements. In this respect the search will be intensified towards (a) finding alternative control agents, not only larvicidal, but also adulticidal, if the resting sites of the adults can be located ; (b) the development of other technologies, where appropriate, to control or maintain the control of the vector ; (c) the study of S. damnosum movements and the factors influencing migration.

(b) Medical research

Epidemiological, clinical and parasitological research

10. On the medical side, most of the research has been undertaken in the course of the epidemiological evaluation activities, producing a greater insight into the implications of the disease. To provide comparative data on the dynamics of onchocerciasis transmission and on the pathogenesis of the disease from a similar, uncontrolled area, a longitudinal study has been undertaken in Northern Cameroon over a period of three years.

11. The applied research undertaken by the Epidemiological Evaluation Unit has been mainly concerned with operational epidemiological aspects of onchocerciasis in order to improve the field survey techniques used. In the field of parasitology, several different methods for the examination of skin snips were compared to determine a suitable technique both for large-scale field surveys and for the detection of new and light onchocercal infections. Microfilaruria, which is an important sign of systemic onchocerciasis, was investigated and a simple field technique based on filtration of urine was developed.

12. Histological examinations of skin snips have been carried out to assist in the identification of skin lesions due to onchocerciasis.

13. Although it has been recognized for some time that there are apparent differences between the O. volvulus found in the forest and savanna areas and that the infective stages of the parasites found in the vector may be other than O. volvulus, until recently no technique was available to enable clarification. Recent advances in histochemical staining techniques are now beginning to provide methods which could have future operational consequences and possibly lead to a more precise entomological evaluation of transmission potentials.

14. In the ophthalmological field, different vision tests were explored to ensure reliable results on impaired vision in the villages examined. Systematic screening of the intra-ocular pressure in patients with onchocerciasis was

undertaken, and an analysis made of the importance of a co-existing glaucoma as a cause of blindness. Another important operational aspect of onchocerciasis is the definition of cases at high risk of blindness. For this purpose the relationship between the ocular parasite load and severe onchocercal eye lesions was investigated, as well as the importance of optic nerve involvement in onchocerciasis and its influence on the visual fields. Finally, investigations were carried out in selected villages in the Programme area in order to define a tolerable level of onchocerciasis, based on operational, medical and entomological criteria.

(ii) Therapy

15. Within the Programme area a trial was undertaken to determine the possible advantages which might derive from nodulectomy. Initial results indicate that such a practice could be beneficial in certain cases, for example, in children with head nodules.

16. In the absence of a suitable drug for mass treatment a chemotherapeutic research programme has been progressively implemented. Field trials have been undertaken to determine whether suramin and diethylcarbamazine can be used when prescribed in different regimens which may make them more tolerable. Some results from trials within the Programme area indicate that the effect of diethylcarbamazine on the cutaneous microfilarial load may be more persistent when transmission has been interrupted.

17. A bibliography on suramin 1970-1975 was published.

18. Other drugs trials using metrifonate, levamisole and nifurtimox have been carried out in the Programme area and in Cameroon.

19. In order to strengthen and accelerate the studies of current and potentially suitable drugs, a Chemotherapeutic Research Centre was established in Tamale in northern Ghana in 1976. However, with the launching of the Special Programme of Research and Training in Tropical Diseases (TDR) and the development of its intensive programme of drug development in onchocerciasis, it was decided that TDR would take over the responsibility of Tamale Research Centre from mid-1978.

Environmental Protection

18. The weekly application of the larvicide used to control the vector, Abate emulsifiable concentrate, could have an adverse effect on non-target organisms. Therefore, in the early stages of the operations, an aquatic monitoring programme was set in motion. Unfortunately, no data was available as a basis for future comparison ; thus, studies of the rivers covered by the first phase of operations commenced almost at the same time as the larviciding. Only on two rivers not brought under treatment until the third phase waspre-control data obtained.

19. Despite these problems, the protocol developed for the aquatic monitoring and followed consistently on eight rivers principally in the southern section of the Programme area, has proved adequate and sufficiently sensitive to record any significant alteration in the composition of the riverine fauna. Results have indicated, as expected, a certain diminution in the overall quantity of non-target invertebrate organisms in those rivers under continual control. This generally amounts to approximately 30% but there is no indication of a similar effect on the fish population.

20. The initial impact of the insecticide on the aquatic fauna appears to be more drastic during the first treatments of a river but, without interruption of the weekly schedule, the riverine fauna is able to recover gradually to a level comparable with other rivers in the area.

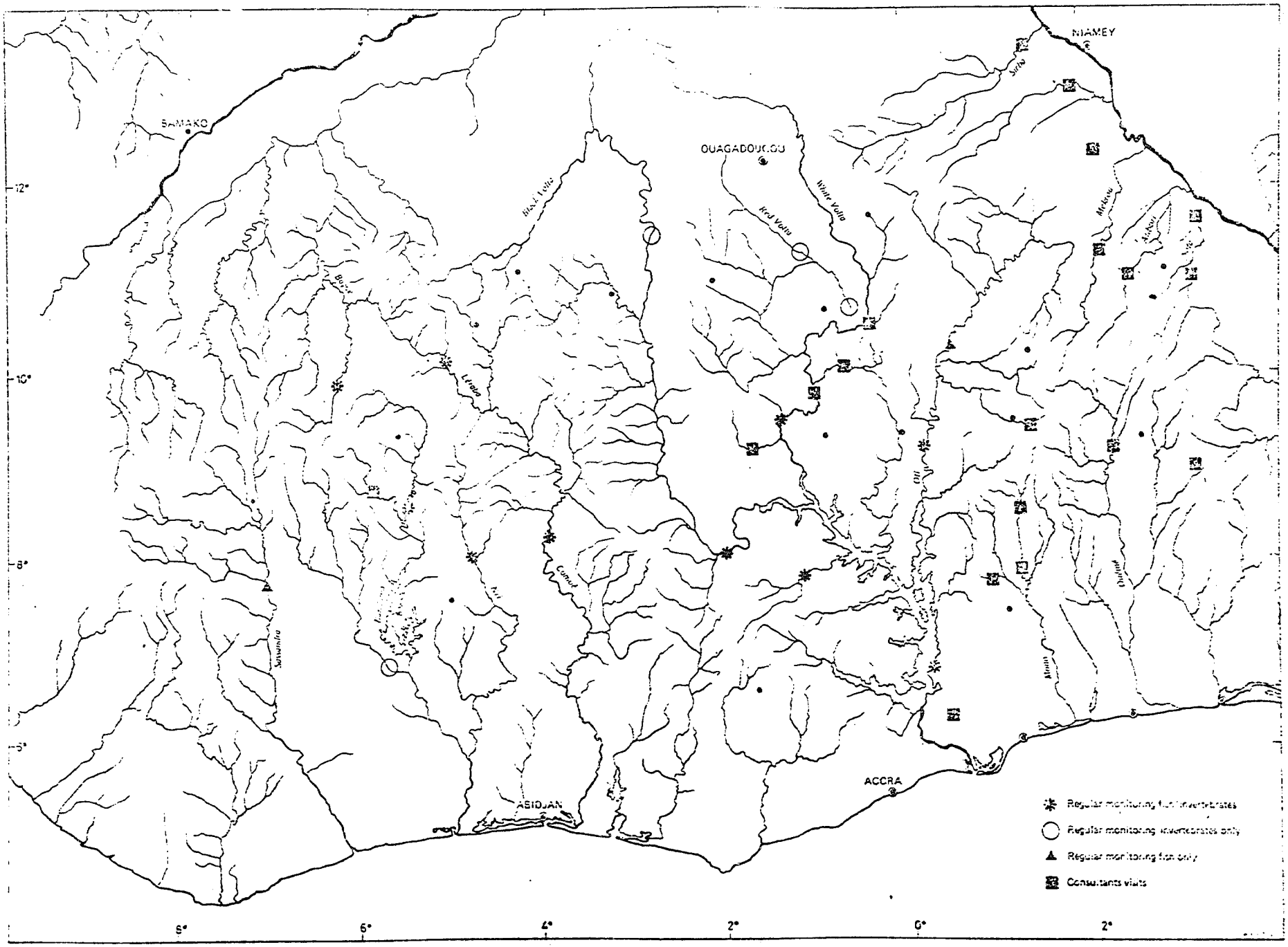
21. Studies on the fish population have not revealed the disappearance of any species under the regular application of larvicide, and the number of alvelings remains high, suggesting that breeding is unaffected.

22. Data collected is recorded on specially designed forms and fed into a computer for subsequent analysis. Because of the tremendous differences in the rivers, not only seasonal but annual on account of the varying rainfall affecting flow and discharge, several years study will be necessary before firm conclusions can be drawn. However, a certain consistency in results has already been noted permitting a reduction in monitoring frequency from monthly to quarterly intervals. This has enabled other rivers, particularly in the extension area, to be added to the monitoring circuit at no additional cost.

23. This environmental study has benefitted from a back-up research programme which is contributing significantly to a greater understanding of the natural balance that exists in the rivers and the inter-relationships of the different organisms. Identification keys for the various groups of invertebrate fauna are also being developed.

24. In addition to the regular monitoring programme, two consultant hydrobiologist and an ichtyologist made survey visits to the Phase III area to fill in gaps in our knowledge. The locations of these various studies are shown on fig ..... Regular meetings are held to coordinate the monitoring programme, which may be expected to continue for the duration of the Onchocerciasis Control Programme and which is sufficiently comprehensive and resilient to cover other larvicides that might be introduced.

AQUATIC MONITORING SITES



CHAPTER VI

TRAINING

1. After adoption of the PAG Mission Report in 1973, the rapid implementation of the Onchocerciasis Control Programme and launching of operations required a large number of personnel of varied disciplines and levels. The main thrust of OCP being entomological the greatest need was, of course, for entomologists and technicians. The demands of the Programme were greater than the available supply and a contract was concluded with the Organisation de Coordination et de Coopération pour la Lutte contre les grandes Endémies (OCCGE) for the training of these categories of personnel at the Institut de Recherches sur l'Onchocercose (IRO) at Bouaké. Under this contract 4 entomologists, 1 assistant entomologist and 26 technicians were trained between 1974 and 1977, sufficient, in fact, to fill all the posts in OCP authorized in the budget. With funds provided for fellowships, one medical officer received training in ophthalmology and another followed a course in public health.

2. As the Programme developed, the need for in-service or more advanced training of its personnel became evident. Training appropriate to the specialized needs of the different sections of the Programme was organized, for example, two technicians received specialized instruction in rearing single generations of flies for taxonomic identification, and several entomologists were introduced to the new techniques developed for identifying the different species of the S. damnosum complex. The opportunity was given to an assistant entomologist to receive academic training to qualify as an entomologist.

3. On the epidemiological side requirements were much smaller and in-service training was possible: technicians were taught to take skin snips and examine them for microfilariae, and census clerks to collate essential information on the population in villages surveyed by the epidemiological teams.

4. In the field of administration, emphasis was given to providing instruction, either in Ouagadougou or in WHO Headquarters, Geneva, in stores management, book-keeping, cost accounting, and preparation and execution of the budget. Attention was also paid to the training of mechanics, on whom much of the success of the operations depends. English and French language courses were arranged and continuous in-service-training in secretarial duties was provided.

5. The methods and techniques which OCP has developed to survey, control and evaluate the vector and the disease are models of value to entomologists, parasitologists and ophthalmologists tudying onchocerciasis elsewhere. Accordingly, doctors and scientists participate in Programme activities for varying periods including, so far, an entomologist from Sudan, two physicians from Mali and Brazil and an ophthalmologist and health superintendent from Nigeria. The Mali physician is now employed in the Programme Epidemiological Evaluation Unit. At the request of the Ghana Government, two national entomologists were attached to the Tamale sector for 4 months practical training prior to their subsequent assignment by the Government to assist with preliminary studies in the proposed extension area. The Programme has also been included in the reorientation training course for WHO entomologists which had 11 participants in 1976 and 10 in 1977.

6. At its fourth session held in December 1977 in Kuwait, the JCC confirmed its special interest in the question of training. The participating countries strongly emphasized that they wished to avail themselves of all the possibilities that the Programme could offer in this regard. During 1978, the Programme Director visited each of the countries for an exchange of views with the authorities. The action taken so far was reviewed and the problem of training

in onchocerciasis was considered within the context of the overall training programme of WHO. The assistance that the Programme can provide to the countries in this field was more clearly defined. As a result of these discussions, a number of fellowships have been awarded and others are being processed. (Table 1).

7. During 1978 the Programme also arranged training for 13 personnel from Guinea in entomology, parasitology and ophthalmology and 2 from Tanzania in entomology, at IRO, Bouaké, the Institut d'ophthalmologie tropicale d'Afrique de l'ouest (IOTA), Bamako, and in OCP itself, as appropriate.

8. The Programme constitutes an ideal framework for trainees of a certain level to transform their academic knowledge into operational practice by learning to work in the field.

9. The specific areas in which OCP can assist in training national personnel are:

- parasitology and ophthalmology as applied to the collection of base line data on onchocerciasis and to the epidemiological evaluation of a control campaign against the disease;
- ecology and control of the vectors of onchocerciasis as applied to the geographical surveillance of the breeding sites, to the organization of detailed entomological investigations, and to the planning and establishment of an entomological evaluation network;
- ecology and control of the vectors of onchocerciasis as applied to the planning, costing and implementation of vector control operations (aerial logistics, equipment and ground support networks);
- cytotaxonomy of the S. damnosum complex in West Africa;
- techniques for the collection, classification and presentation of data on economic development projects in the Programme area;
- planning of the infrastructure, and financial and administrative management for an onchocerciasis control campaign.

10. Basic training in parasitology, ophthalmology and epidemiology as applied to onchocerciasis, as well as the biology and control of the vectors of onchocerciasis and the cytotaxonomy of vectors in general, can be undertaken only by Universities or other specialized institutions.

11. In order to assist the countries to attract candidates, OCP will organize seminars on onchocerciasis, on the model of that arranged in 1977 with the West African College of Physicians, in Ghana, and intended for medical students and research workers. Information Weeks similar to that initiated by Benin will also be arranged. It is clear, however, that the certainty of future employment in the discipline of choice, and the existence of a national structure within which there are promotional possibilities based on performance and effort is essential if students and young research workers are to be attracted to work in this field. Unfortunately, few ministries of health have structures for medical entomologists, although it is a speciality which merits strong encouragement considering the problems posed by vector-borne diseases in many countries. Taking into account the fact that it will take time to establish and finance new structures in the countries, the United Nations Development Programme has agreed that part of the funds allocated for training could be utilized to pay trainees who could be employed by the Programme for a pre-determined duration, pending their integration into the services of their countries of origin.

12. It is necessary for each country to determine whether onchocerciasis is sufficiently important to be treated separately, or whether it can be tackled within extended basic health services. Currently, few of the countries have direct involvement in the control or surveillance of onchocer-

ciasis. Accordingly, the creation of new structures, as described below, will be necessary, particularly for the entomological aspect; the number of units required will depend on the area and affected population to be covered.

(a) A standard entomological unit would normally be staffed by one entomologist and about four technicians. The entomologist must have a University degree in medical entomology, or in zoology with specialization in medical entomology. A wide basic training before specializing in the biology and control of vectors of onchocerciasis would enable him to deal also with the vectors of other diseases. Specific training relating to *Simulium* species could be provided by the IRO, Bouaké, Ivory Coast, after which the entomologist could receive practical on-the-job training with the Programme in surveillance, control and evaluation techniques. The entomological technicians, who must be secondary school graduates, could be given six months training at IRO. If necessary, this could be followed by a short period in the Programme. It would be useful to include in this unit a hydrologist to install the gauges in the watercourses and measure the discharge, although, generally this type of work could be undertaken by a department outside the health services. The extent of the area covered by an entomological unit is determined by the local geography and the network of rivers. The unit's task would be, first, to collect base-line data on the distribution and density of the vectors and the identification of the species of the *S. damnosum* complex, and then, to undertake control and/or evaluation measures.

(b) Every vector control programme applying insecticide regularly to the watercourses, should comprise an aquatic monitoring unit composed of a hydrobiologist (entomologist), an ichthyologist and two technicians. The practical training of these specialists could be obtained at ORSTOM,[1] Bouaké, in a six-

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[1] Office de la Recherche Scientifique et technique Outre-mer

month course in ecology, sampling techniques and the identification of specimens. To benefit from complementary disciplinary input which it might require from time to time, the unit should preferably be installed within a specialized institution. Both the hydrobiologist and the ichthyologist should have a university diploma in zoology.

(c) As acceptable chemotherapy is not currently available, specific medical intervention is not called for immediately. However, in anticipation of the development of a suitable drug, medical units should be established in each country. Initially the main task of each unit would be to identify those areas most severely affected and collect from a certain number of key villages base-line data allowing the evolution of the disease to be followed after control. In this respect, doctors, parasitologists, ophthalmologists and their assistants should be trained in established methods for the diagnosis of the disease and its effects, and learn how to determine its endemicity. In most of the participating countries such an activity could be considered within the basic health services: specialized training could be given by means of a six-week seminar organized by the Programme. Personnel eligible for these seminars could be recruited from amongst those working in health centres and hospitals, particularly in endemic zones. Thus all data collected would be comparable, and a core of ad hoc personnel would be available to undertake detailed evaluations and deliver treatment when the time comes.

(d) This overall medical and entomological structure would require a coordinator operating at a central level. The qualifications of the coordinator would depend on the area to be covered, the number of entomological units required in the countries, the importance of the problem and the type of work to be performed. The success of every control project will depend to a large extent on the enthusiasm of the coordinator and his managerial capability.

TABLE I

Country/Name	Current Occupation Title	Field of Training
Bénin		
Gilbert MENSAH	Hydrobiologiste Chargé de Recherche Ministère de la Santé Pub. Cotonou	6 months hydrobiology Training ORSTOM/Bouake Started August 1978
Germain OUSSA	Chef des Services de Médecine et de Pédiatrie Hôpital, Parakou	3 years Ophthalmology Special. at Dakar Univ. Starting 15 October 1978
Djokodjo Clément GLELE	Médecin-Chef Circonscription médicale Djougou	Ophthalmology - 3 years Special. at Dakar Univ. Starting possibly Oct. 15, 1978
Martin CODJO AKOGBETO	Professeur de Biologie-Géologie à Porto-Novo, au Lycée Behanzin	Entomology training at ORSTOM/Paris - 15 months Starting possibly Oct. 1978
Ghana		
James SAMMAN	Assistant Research Officer Institute Aquatic Biology Achimota	3 years course in Hydrobiology at Salford Univ. (U.K.) with field work in Ghana initially
Joseph Somma AMAKYE	Research Officer at Council for Scientific and Industrial Research Accra	3 years course in Hydrobiology. Field Work in Ghana first.
Léonard Abraham Kwame ANTWI	Research Officer at Council for scientific and Industrial Research Accra	On the job training in Pesticide residue analysis insecticide at Univ. of Miami, Florida (USA), starting Sept.1978, 6 months-Miami, and 1 month-Atlanta.
Samuel Zanya BUGRI	Medical Officer in charge of communicable Disease Control and Public Health Hospital Tamale	Postgraduate public health Training course with special emphasis on parasitology IN Tehran.
Michael D. WILSON	Entomologist	1 year course medical Parasitology at London School of Hygiene and Tropical Medecine, commencing 25 Sept. 1978
Guinea		
Arsène SAGNO	Biologiste chargé des Enquêtes paludométriques au Service de Prévention Projet Paludisme Conakry	4 months training in Entomology at IRO/Bouake Starting mid-September 1978 Subsequently 1 month training WITH OCP
Roger Tŏpkŏ LAMA	Professeur de Biologie Faculté des Sciences de la Nature, I.P.K. Conakry	4 months entomology training at IRO/Bouake commencing mid-September 1978 Subsequently 1 month with OCP
Kabine KABA	Assistant auprès de l'Expert Entomologiste OMS pour projet pilote Onch-Guinée	- do -
Raymond Koho KONE	Chef d'Equipe Parasitologie Service de Prévention Projet Paludisme	- do -

.../...

.../... TABLE 1

Country/Name	Current Occupation Title	Field of Training
Guinea (Cont'd)		
Mamadou Sarifou BALDE	Chef d'Equipe Entomologie - do -	- do -
Souleymane KOUROUNA	Chef d'Equipe Parasitologie Projet pilote Oncho-Guinée	4 months Entomology Training IRO/Bouake plus 1 month OCP: starting Jan. 1979
Thoue OULARE	Assistant auprès Expert Entomol. OMS Projet pilote Onch-Guinée	- do -
Sékou Yalani CAMARA	Médecin à l'Inspection Médicale des Ecoles Conakry	Prior attending IRO/Bouake will undergo 6 weeks training Parasitology OCP/EPI): Starting October 1978
Yaya KASSE	Médecin Ophthalmologiste et Directeur du Project Onchocercose, Kankan	12 months training at IOTA Bamako commencing September Subsequently 2 months with OCP
Lah DORE	Chef d'Equipe dépistage Lésions oculaires, projet pilote Onchocercose	- do -
madou DIALLO	Chef Section Parasitologie Laboratoire nationale Projet Paludisme	8 weeks Parasitology training with OCP/EPI, starting October 1978
Siba GBAMOU	Technicien Parasitologie Projet pilote Onchocercose	- do -
Niger		
Hamadi ADAMOU	Laborantin Direction de l'Hygiène et de la Médecine Niamey	Practical field training within Program Area prior to his attending IRO/Bouake commencing mid-September 1978 in Entomology
Rahiou LABO	Adjoint Chef Section Parasitologie-Laboratoire d'Elevage, Niamey	- do -
Nigeria		
Candidate's name not yet known	Ophthalmologue	Ophthalmologist training with OCP
Tanzania		
Nicholas John MASAOE	District Health Officer at Regional Development Director Arusha	4 month Entomology training at IRO/ Bouake, starting Jan. 1979
Aguel Justin LUGOI	District Health Officer at Principal Secretary Ministry of Health, Dar-es-Salaam	- do -
Togo		
Katevi KOUMOUVI	Assistant d'Entomologie auprès du Service Grandes Eudémies et Paludisme, Lomé	4 months entomology training at IRO/Bouake, starting end September 1978
Dr. Ayité Folly ABOUSSA	Médecin Chef, Subdiv. Sanit. Aneho	3 years. Spécialisation in Ophthalm. at Univ. of Dakar Started November 1976

CHAPTER VII

IMPLEMENTATION AND COSTS

Budget execution 1974-1979

1. As of May 1978, expenditures for the 1974-1979 period are expected to be $55,359,597[1], representing savings of $7,200,403, that is 12% over the PAG estimates which were $62,560,000[2].

2. A comparison between the PAG Mission estimates by activity for 1974-1979 and total expenditure currently estimated as of May 1978 for the same period, gives the following breakdown:

ACTIVITY	PAG	% of Total	CURRENT ESTIMATES	% of Total	SAVINGS (overrun)
Vector Control	35,033,000	56	35,175,000	64	(92,000)
Epidemiological Evaluation	3,406,000	5	2,979,000	5	427,000
Economic Development	1,399,000	2	827,000	1	572,000
Director's Office, AFMIS, WHO Support, Meetings	13,390,000	22	11,583,000	21	1,807,000
Research/Training	9,232,000	15	4,317,000	8	4,915,000
JCC	-	-	479,000	1	(479,000)[3]
TOTAL.....	62,560,000	100	55,360,000	100	7,200,000

3. A comparison between the PAG Mission estimates by category of expenditure for 1974-1979 and anticipated expenditure for the same period, is as follows:

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1 actual expenditures for 1974-1977 amount to 29,299,147

2 adjusted to include 15% contingencies and 8% inflation per year compounded annually.

3 there was no provision for the JCC in the PAG report.

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CATEGORY	PAG	% of Total	CURRENT ESTIMATES	% of Total	SAVINGS (Overrun)
Personnel	$20,566,000	33	$20,099,000	36	467,000
Aerial contract	11,236,000	18	10,509,000	19	727,000
Insecticide	7,712,000	12	5,818,000	11	1894,000
Research/Training	9,282,000	15	4,317,000	8	4965,000
Operations/Maint/Travel	4,611,000	7	8,067,000	15	(3456,000)
Capital Items	9,153,000	15	4,616,000	8	4537,000
Other (JCC, Meetings, Consultants)	-	-	1,934,000	5	(1934,000)[1]
Total	$62,560,000	100	$55,360,000	100	$7200,000

4. By the above comparisons, actual expenditures are expected to be 25% less on insecticide, 53% less on Research/Training, and 50% less on capital acquisitions. Over the 1975-1977 period, programme total costs per kilometer of river have decreased 32% from $31,48 in 1975 to $21,52 in 1977. Projections through 1979 also suggest decreases in total cost per kilometer beyond the 1977 rate. These reductions have occurred as a result of maintaining administrative overheads relatively constant and by carefully monitoring the most important variable items in vector control such as insecticides and evaluation teams.

5. From 1975-1977, minimum guaranteed flight hours were exceeded by 7,2% for fixed wing and 3,6% for helicopter. 1977 insecticide applications in Phase I and Phase II represented decreases of 5% and 46% in litres per km of river protected compared to 1975 and 1976.

6. As of May 1978, the number of entomological surveillance teams per km of river protected in Phases I, II and III had been reduced by 16%, 28% and 11%, respectively compared to the first year of operation (1975, 1976, 1977, respectively).

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[1] no provision was made for this in the PAG report

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7. Excepting dramatic reversal of the climatic conditions experienced during the last 3 years, the satisfactory cost-effectiveness ratio of our operations should continue during the 1980-1985 period since the optimal use of Programme financial resources reflects better knowledge of field conditions and improved efficiency.

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CHAPTER VIII

PLAN OF ACTION AND BUDGET 1980-1985

A. PLAN OF ACTION

1. During the subject period, the objective of the OCP will remain essentially as originally planned by the PAG Mission, that is to reduce the impact of onchocerciasis to a sufficiently low level so that it no longer represents either a public health problem or an obstacle to socio-economic development and also to maintain and adjust control activities so as to stabilize the disease at a tolerable level. Methods of endemiological evaluation of the control operations will continue unchanged; other activities of this Unit will include applied research, chemotherapeutic trials, and training of personnel. The Economic Development Unit will continue its primary function of information-gathering and liaison. The present administrative infrastructure of the OCP should remain substantially unchanged with 48 professional posts, 643 general services posts, 2 aerial bases and about 6 sectors and 22 subsectors.

Vector Control Operations

2. The Plan of Action for vector control over the period 1980-1985 calls for the protection of 3 552 438 kms of river compared to 2 095 207 kms during the period 1974-1979, or an increase of 70%. This is due to the gradual bui d-up of activities during the period 1974-1979 (with, in fact, no treatments at all during 1974) as compared to the period 1980-1985, which is projected to maintain the same level every year as that anticipated by end 1979.

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RIVER DISTANCES PROTECTED
BY PHASE BY YEAR IN KMS[1]

	1974	1975	1976	1977	1978	1979	TOTAL 1974-1979	PER YEAR 1980-1985	TOTAL 1980-1985
Phase I	-	191,143	191,143	191,143	191,143	191,143	955,715	191,143	1146,858
" II	-		59,894	59,894	59,894	59,894	239,576	59,894	359,364
" III	-			258,908	258,908	258,908	776,724	258,908	1553,448
Ivory Coast extension	-				41,064	82,128	123,192	82,128	492,768
TOTAL	-	191,143	251,037	509,945	551,009	592,073	2095,207	592,073	3552,438

[1] Calculated by multiplying estimated wet season river lengths by 17,5 weekly treatment circuits and estimated dry season river lengths by 34,5 weekly treatment circuits.

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3. In terms of inputs per kilometer of river protected helicopter hours will decrease from 112 to 109 per 10,000 km (-3%)m and vector collecting teams will decrease from 15 to 13 per 100,000 km (-13%). See Annex 1 and 2 at the end of this narrative.

4. The rate of fixed-wing hours will, however, increase from 23 to 27 per 10,000 km of river protected (17%) and the amount of insecticide used per 100km of river treated will increase from 39 to 42 litres (8%). This is due to anticipated higher-than-average rates of consumption for these two inputs in the Ivory Coast extension area, larger rivers in the south necessitating more fixed-wing aircraft use and more insecticide than smaller rivers further north. The impact of these increases on total unit inputs for the period 1980-1985 compared to the period 1974-1979 is great since they affect every year of the former, and only 2 years of the latter. Present estimates for the Ivory Coast extension zone are based on extremely limited experience and may be modified as time goes on.

5. The conduct of programme activities during the period 1980-1985, will require annually a total of 6,430 helicopter flying hours and 1583 fixed wing flying hours. The grand total will be 38,580 and 9,498 hours for helicopter and fixed wing, respectively. Compared to 1979, this represents no increase in aircraft or in aircraft hours per km of river protected.

6. These hours are distributed annually as follows:

	HELICOPTER	FIXED WING
Phase I	1800	367
Phase II	898	200
Phase III	2582	516
Ivory Coast extension	1150	500
TOTAL	6430	1583

7. Since it has been possible to extend operations into Ivory Coast without increasing the size of the aerial fleet but only the number of flight hours, the Programme will be in a better position to negotiate an increased

number of hours with no increase in the number of aircraft under the next aerial contract for the period 1980-1985.

8. The aerial contract projections account for 27% of the total budget. To attract bidders, the Programme is obliged to guarantee a certain number of hours for the contract period. The establishment of the number of guaranteed hours is directly tied to the number of aircraft required as well as anticipated minimum flight time requirements of the Programme. Also, once the minimum guaranteed hours are fixed by contract, economy to the Programme through reduced flight time below the guaranteed level is not possible.

9. Two hundred and fifty thousand litres of insecticide will be required annually. Although the trend for insecticide use in Phase I and in Phase II reflects decreasing amounts per kilometer of river protected, uncertainty exists with regard to consumption in Phase III, as well as to the effect that treatment of the Ivory Coast extension zones will have on insecticide use in the interior, northern zones of Phases I and II. For this reason, we are projecting the same quantity of insecticide per kilometer of river covered as that planned for 1979.

10. A total of 270 capture points will be serviced by 78 teams operating from 22 subsectors and 6 sectors during the period 1980-1985. The distribution of these teams is as follows:

	CAPTURE POINTS	NO. TEAMS	NO. SECTORS	NO. SUB-SECTORS
Phases I, II, III	245	70	6	20
Ivory Coast extension	25	8	-	2
	270	78	6	22

10. This represents no increase in the number of vector collecting teams, sectors, and sub-sectors respectively per km of river protected compared to the status quo as anticipated at end 1979.

HELICOPTER HOURS BY YEAR AND PHASE ABSOLUTE AMOUNT (Q)
AND RATE (R) 10,000 KM OF RIVER PROTECTED

	A		B		C		D		E		F		G		H		I	
	1974		1975		1976		1977		1978		1979		Total for year treated 1974-1979		By year 1980-1985		Total 1980-1985	
	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R
Phase I	-		1912	100	2420	127	1907	100	1800	94	1800	94	9839	102	1800	94	10800	94
" II	-		-		1410	235	859	143	898	149	898	149	4065	170	898	149	5388	149
" III	-		-		-		2369	91	2582	100	2582	100	7533	97	2582	100	15492	100
Ivory Coast extension	-		-		-		-		860	209	1150	140	2010	163	1150	140	6900	140
TOTAL	-		1912	100	3830	153	5135	101	6140	111	6430	109	23447	112	6430	109	38580	109

FIXED-WING HOURS BY YEAR AND PHASE ABSOLUTE AMOUNT (Q)
AND RATE (R) PER 10,000 KM OF RIVER PROTECTED

Phase I	-		366	19	352	18	367	19	367	19	367	19	1819	19	367	19	2202	19
" II	-		-		224	37	200	33	200	33	200	33	824	34	200	33	1200	33
" III	-		-		-		415	16	516	20	516	20	1447	19	516	20	3096	20
Ivory Coast extension	-		-		-		-		280	68	500	61	780	63	500	61	3000	61
TOTAL	-		366	19	576	23	982	19	1363	25	1583	27	4870	23	1583	27	9498	27

INSECTICIDE BY YEAR AND PHASE ABSOLUTE AMOUNT (Q)
AND RATE (R) PER 100 KM OF RIVER PROTECTED

	A		B		C		D		E		F		G		H		I	
	1974		1975		1976		1977		1978		1979		Total for year treated 1974-1979		By year 1980-1985		Total 1980-1985	
	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R	Q	R
Phase I	-		75631	40	88243	46	72116	38	75000	39	75000	39	385990	40	75000	39	450000	39
" II	-		-		33611	54	17523	29	20000	33	20000	33	91134	37	20000	33	120000	33
" III	-		-		-		57968	22	80000	31	80000	31	217968	28	80000	31	480000	31
Ivory Coast extension	-		-		-		-		38000	93	75000	92	113000	93	75000	92	450000	92
TOTAL	-		75631	40	121854	49	147607	29	213000	39	250000	42	808092	39	250000	42	1500000	42

VECTOR COLLECTOR TEAMS BY YEAR AND PHASE ABSOLUTE No (Q)
AND RATE PER 100,000 KM OF RIVER PROTECTED

Phase I	-		31	16	31	16	31	16	24	16	24	14	141	15	24	14	144	14
" II	-		-		19	32	19	32	14	23	14	23	64	27	14	23	84	23
" III	-		-		-		36	14	32	12	32	12	100	13	32	12	192	12
Ivory Coast extension	-		-		-		-		8	19	8	10	16	13	8	10	48	10
TOTAL	-		31	16	50	20	86	17	78	14	78	13	321	15	78	13	468	13

Epidemiological Evaluation

11. Field evaluation: The total number of villages included in the first evaluation of the Programme area was 313, of which 45 were detailed evaluation villages (DE). Not all these 300 villages will be included in future follow-up for reasons such as change of population and very low endemicity of onchocerciasis. About 50% of the total number of simple evaluation villages (SE) will be regularly re-examined, whereas nearly all the 45 detailed evaluation villages will be included in the follow-up.

12. The sample for the future longitudinal study will therefore be approximately 150 villages SE and 45 villages DE, in principle equally distributed within the three phases of the Programme area.

13. In some of the DE-villages a stratification of the sample may be used to confirm the absence of transmission in certain areas, for instance, examination only of children born since the beginning of the vector control programme. For the same reason non-infected populations resettling onchofreed areas may also be included.

14. Follow-up intervals: The selected villages will be re-examined every third year. Areas of very stable and successful vector control will be controlled every fifth year by simple evaluation, to confirm the absence of transmission, whereas it may be necessary to make more frequent passages in areas of doubtful transmission control.

	Phase I	Phase II	Phase III
1st passage	1975	1976	1977
2nd passage	1978	1979	1980
3rd passage	1981	1982	1983
4th passage	1984	1985	

15. The criteria for selection of villages to be included in the future follow-up will be based mainly upon:

- the duration of vector control;
- level of on-going transmission, if any.

16. A third factor to take into consideration will be the statistical background, i.e. a sufficient number of carefully selected villages must be examined to enable reliable conclusions.

17. The follow-up villages will therefore be grouped together, according to the above criteria, and taking into account geographical and epidemiological characteristics, such as endemicity levels.

18. The research activities undertaken by the Unit are described in paragraphs 26-31.

Economic development

19. It is already clear that whatever development takes place in the oncho zone must contribute to the total development of each country. A regional orientation has therefore to be given to the information and liaison functions of the Unit.

20. Another input into the information function of the Economic Development Unit will consist of the conduct of studies on specific development problems. Thus some applied socio-economic research is envisaged. A list of such studies and topics of interest was given in the annual socio-economic report for 1977, in which it was also envisaged that special seminars on such topics would serve to clarify issues.

21. Finally there is clearly now a need for additional activities by the Unit.[1]

Training

22. The training programme will continue to aim at three objectives:

(a) to improve the skills of personnel already employed;
(b) to prepare new personnel as may be required;
(c) to instruct personnel from other African countries in the procedure of survey, control and evaluation of onchocerciasis and its vectors.

[1] Please refer to Chapter IV paras. 8 and 9

Research

23. The research activities undertaken or sponsored by the Programme during 1980-1985 will continue to be closely related to its changing requirements.

24. The principal objectives of future entomological research are as follows:

i) to find a series of alternative larvicides and formulations to replace Abate;

ii) to locate the resting sites of the adults in order to determine the feasibility of employing adulticides to strengthen control measures;

iii) to prepare suitable keys for the identification of the adult females and males, pupae and larvae of the different species of S. damnosum common to the Programme area;

iv) to study the movements of S. damnosum s.l. and the factors influencing migration; this would enable the Programme to predict when reinvasion would take place and from where, and to take appropriate action before, rather than after, the event.

v) to develop appropriate technologies which will facilitate the control of the vector; this will involve seeking alternative methods of control, including environmental manipulation, to reduce the sources of the vector.

25. The aquatic monitoring operations will be pursued. Trials will be undertaken to determine the efficacy of environmental manipulation e.g. modification of some breeding sites which should lead to a corresponding reduction in the quantity of insecticide applied to the watercourses. Following these experiments an SAP Working Group will be convened to consider the possible wider application of the technique, especially in those areas where development and intensive settlement is taking place.

26. Medical research will continue to emphasize studies involving the epidemiology of the disease and the search for a safe and efficient therapeutic agent.

27. The preparation of a document on the research policy of the Programme is planned for early 1979.

28. The role of EPI during 1980-1985 will consist primarily of the evaluation of drug trials and their eventual application on selected populations, as well as applied research to define cases at risk of blindness and in need of treatment. Another important aspect of research will be the investigation of more refined evaluation techniques that may become available in the future, and which may improve the diagnosis or treatment of onchocerciasis.

29. In addition contracts will be established with a certain number of specialized institutions or research workers for the execution of studies which have priority for the operational objectives of the Programme, and which cannot be undertaken by Programme personnel.

30. Basic research oriented towards greater understanding of the disease will be carried out under the WHO Special Programme for Research and Training in Tropical Diseases, which maintains close liaison with OCP.

31. Particular importance will be given to research on chemotherapy. The justification for such research as well as a broad outline of our plan of action in this field are given in annex

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TABLE I. - OCP 1980-1985 BY PROGRAMME ACTIVITY

	1980	1981	1982	1983	1984	1985	TOTAL 1980-1985
Vector Control Operations	12,405,600	13,090,500	13,851,500	16,239,700	17,154,600	18,207,000	90,948,900
Epidemiological Evaluation	850,300	936,200	1,029,600	1,133,700	1,250,600	1,359,100	6,559,500
Economic Development	413,000	458,000	507,600	562,700	624,300	692,200	3,257,8[illegible]
Applied Research, Environmental Protection and Training	1,188,000	1,283,000	1,385,600	1,496,200	1,616,000	1,745,200	8,714,000
Programme Director and Administrative Support Ouaga	2,420,300	2,641,800	2,918,300	3,226,400	3,569,700	3,919,700	18,696,200
Meetings	163,300	176,300	190,400	205,600	222,000	239,800	1,197,[illegible]
Administrative Support-Geneva	208,700	231,500	256,800	284,900	316,100	350,700	1,648,7[illegible]
Technical Support FAO/ROME	24,100	26,000	28,100	30,300	32,800	35,400	176,700
Regional Liaison - Brazzaville	60,700	67,600	75,400	84,100	93,700	104,500	486,000
Independent Chairman and JCC	124,400	137,000	150,700	165,700	182,400	200,900	961,100
GRAND TOTAL.....	17,858,400	19,047,900	20,394,000	23,429,300	25,062,200	26,854,500	132,646,300

8.9.3.8.

I.B.

COMPARISON BETWEEN 1974-1979 AND 1980-1985

BY PROGRAMME ACTIVITY

	1974-1979	1980-1985	Increase(Decrease)	%
Vector Control Operations	35,174,873	90,948,900	55,774,027	158,5
Epidemiological Evaluation	2,978,987	6,559,500	3,580,513	120.2
Economic Development	713,048	3,257,800	2,544,752	356.9
Applied Research, Environmental Protection and Training	4,316,937	8,714,000	4,397,063	101.9
Programme Director and Administrative Support Ouaga	8,506,031	18,696,200	10,190,169	119.8
Meetings	530,594	1,197,400	666,806	125.7
Administrative Support/Geneva	2,421,876	1,648,700	(773,176)	(31.9)
Technical Support/Rome	113,748	176,700	62,952	55.3
Technical and Administrative Support/ Brazzaville	124,146	486,000	361,854	291.5
Office of the Independent Chairman & JCC meetings	479,357	961,100	481,743	100.5
TOTAL.....	55,359,597	132,646,300	77,286,703	139.6

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TABLE I.C

ONCHOCERCIASIS CONTROL PROGRAMME
1980-1985
BY PROGRAMME ACTIVITY

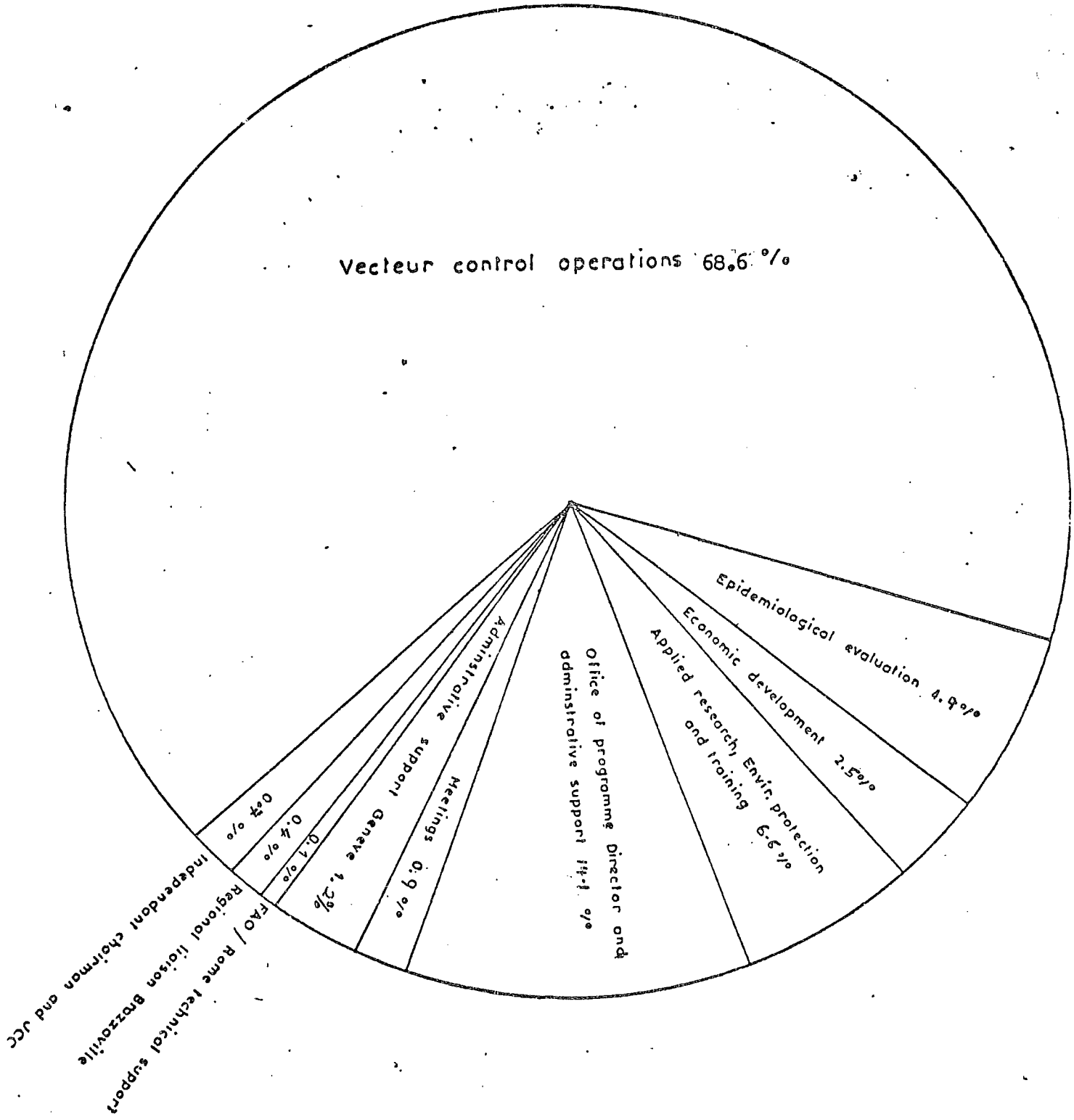

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TABLE II - OCP 1980-1985 BY CATEGORY OF EXPENDITURE

	1980	1981	1982	1983	1984	1985	TOTAL
ANNUAL COSTS							
Personal services	6,273,600	6,995,100	7,799,500	8,696,400	9,696,400	10,811,400	50,272,400
Aerial operations	5,177,700	5,177,700	5,177,700	6,732,500	6,732,500	6,732,500	35,730,600
Insecticide	1,675,400	1,809,400	1,954,200	2,110,500	2,279,300	2,461,600	12,290,400
Research and Training	1,188,000	1,283,000	1,385,600	1,496,200	1,616,000	1,745,200	8,714,000
Rent, Supplies, Operations and Maintenance	1,477,900	1,596,100	1,723,700	1,861,500	2,010,300	2,171,000	10,840,500
Operational travel	624,900	675,000	728,800	787,000	850,100	918,100	4,583,900
Consultants	207,700	224,300	242,200	261,500	282,500	305,000	1,523,200
Meeting	163,300	176,300	190,400	205,600	222,000	239,800	1,197,400
Independent Chairman and JCC	124,400	137,000	150,700	165,700	182,400	200,900	961,100
TOTAL ANNUAL COSTS.....	16,912,900	18,073,900	19,352,800	22,316,900	23,871,500	25,585,500	126,113,500
CAPITAL ITEMS							
Buildings	80,000	50,000	50,000	50,000	50,000	50,000	330,000
Furniture	5,000	5,000	5,000	5,000	5,000	5,000	30,000
Vehicles	785,500	844,000	911,200	982,400	1,060,700	1,139,000	5,722,800
Equipment	75,000	75,000	75,000	75,000	75,000	75,000	450,000
TOTAL CAPITAL ITEMS.....	945,500	974,000	1,041,200	1,112,400	1,190,700	1,269,000	6,532,800
GRAND TOTAL.....	17,858,400	19,047,900	20,394,000	23,429,300	25,062,200	26,854,500	132,646,300

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TABLE II.B

ONCHOCERCIASIS CONTROL PROGRAMME 1980 1985
BY CATEGORY OF EXPENDITURE

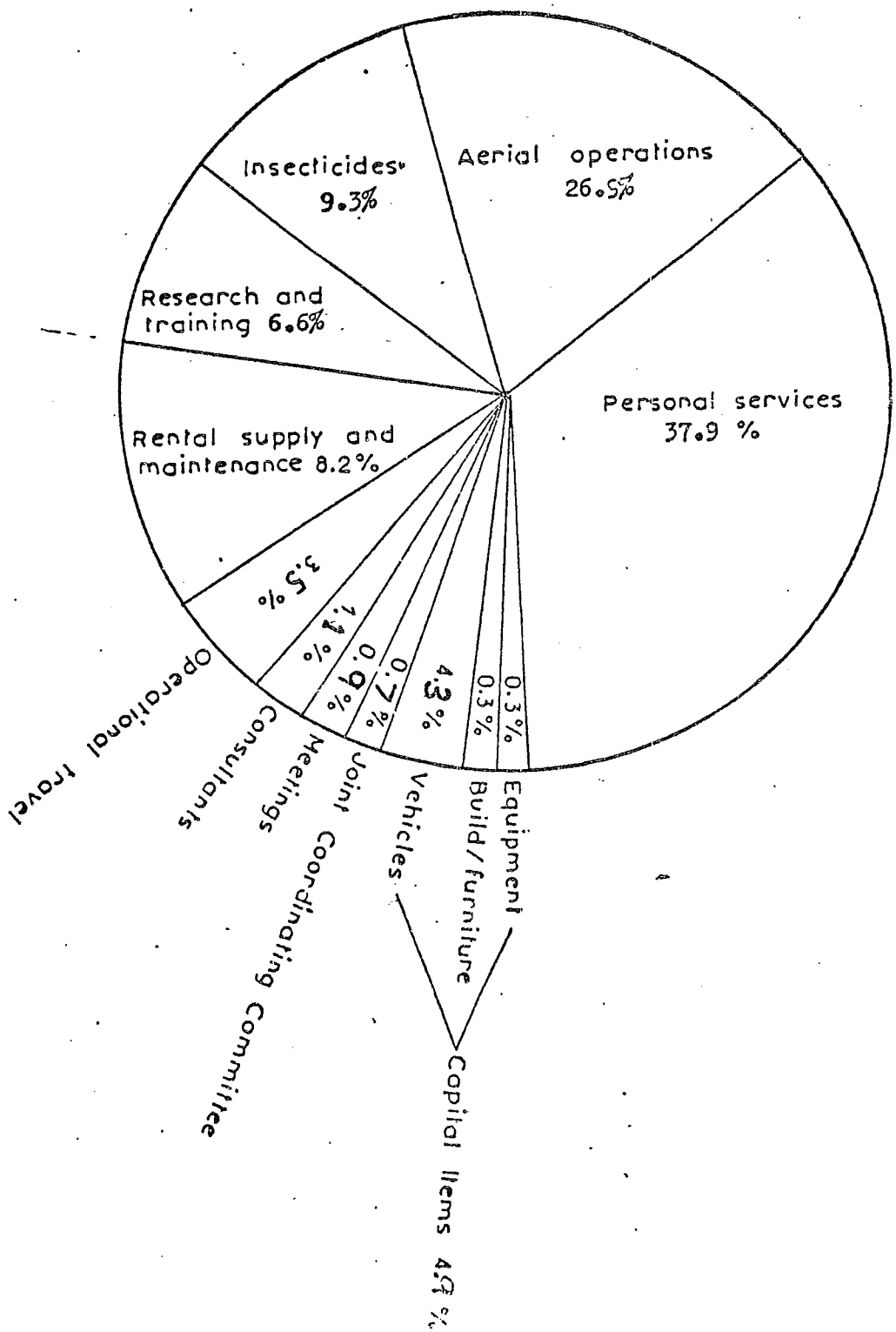

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TABLE III - VECTOR CONTROL OPERATIONS UNIT 1980-1985
BY CATEGORY OF EXPENDITURE

	1980	1981	1982	1983	1984	1985	TOTAL
ANNUAL COSTS							
Personal services	3,391,800	3,781,900	4,216,800	4,701,700	5,242,400	5,845,300	27,179,900
Aerial operations	5,177,700	5,177,700	5,177,700	6,732,500	6,732,500	6,732,500	35,730,600
Insecticide	1,675,400	1,809,400	1,954,200	2,110,500	2,279,300	2,461,600	12,290,400
Research and Training	-	-	-	-	-	-	-
Supplies	36,600	39,500	42,700	46,100	49,800	53,800	268,500
Accomodation and Utilities	52,500	56,700	61,200	66,100	71,400	77,100	385,000
Operations and maintenance	879,200	949,500	1,025,500	1,107,500	1,196,100	1,291,800	6,449,600
Operational travel	415,200	448,500	484,300	523,000	564,900	610,100	3,046,000
Consultants	77,400	83,600	90,300	97,500	105,300	113,700	567,800
Meetings	-	-	-	-	-	-	-
Independent Chairman and JCC	-	-	-	-	-	-	-
TOTAL ANNUAL COSTS.....	11,705,800	12,346,800	13,052,700	15,384,900	16,241,700	17,185,900	85,917,800
CAPITAL ITEMS							
Buildings	30,000	30,000	30,000	30,000	30,000	30,000	180,000
Furniture	2,000	2,000	2,000	2,000	2,000	2,000	12,000
Vehicles	617,800	661,700	716,800	772,800	830,900	939,100	4,539,100
Equipment	50,000	50,000	50,000	50,000	50,000	50,000	300,000
TOTAL CAPITAL ITEMS.....	699,800	743,700	798,800	854,800	912,900	1,021,100	5,031,100
GRAND TOTAL.....	12,405,600	13,090,500	13,851,500	16,239,700	17,154,600	18,207,000	90,948,900

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TABLE IV - EPIDEMIOLOGICAL EVALUATION UNIT 1980-1985
BY CATEGORY OF EXPENDITURE

	1980	1981	1982	1983	1984	1985	TOTAL
ANNUAL COSTS							
Personal services	553,000	616,600	687,500	766,600	854,800	953,100	4,431,600
Aerial operations	-	-	-	-	-	-	-
Insecticide	-	-	-	-	-	-	-
Research and Training	-	-	-	-	-	-	-
Rent & Utilities	13,900	15,000	16,200	17,500	18,900	20,400	101,900
Supplies	26,700	28,900	31,200	33,700	36,400	39,300	196,200
Operation & Maintenance	86,300	93,200	100,600	108,600	117,300	126,700	632,700
Operational travel	62,900	68,000	73,400	79,200	85,600	92,400	461,500
Consultants	18,700	20,200	21,800	23,500	25,400	27,400	137,000
Meetings	-	-	-	-	-	-	-
Independent Chairman and JCC	-	-	-	-	-	-	-
TOTAL ANNUAL COSTS	761,500	841,900	930,700	1,029,100	1,138,400	1,259,300	5,960,900
CAPITAL ITEMS							
Buildings	-	-	-	-	-	-	-
Furniture	1,000	1,000	1,000	1,000	1,000	1,000	6,000
Vehicles	62,800	68,300	72,900	78,600	86,200	73,800	442.600
Equipment	25,000	25,000	25,000	25,000	25,000	25,000	150,000
TOTAL CAPITAL ITEMS	88,800	94,300	98,900	104,600	112,200	99,800	598,600
TOTAL	850,300	936,200	1,029,600	1,133,700	1,250,600	1,359,100	6,559,500

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TABLE V - ECONOMIC DEVELOPMENT UNIT 1980-1985
BY CATEGORY OF EXPENDITURE

	1980	1981	1982	1983	1984	1985	TOTAL
ANNUAL COSTS							
Personal services	337,200	376,000	419,200	467,400	521,100	581,000	2,701,900
Aerial operations	-	-	-	-	-	-	-
Insecticide	-	-	-	-	-	-	-
Research & training	-	-	-	-	-	-	-
Supplies	5,800	6,300	6,800	7,300	7,900	8,500	42,600
Accomodations & Utilities	-	-	-	-	-	-	-
Operation & Maintenance	24,500	26,500	28,600	30,900	33,300	36,000	179,800
Operational travel	35,000	37,800	40,800	44,000	47,600	51,400	256,600
Consultants	-	-	-	-	-	-	-
Meetings	-	-	-	-	-	-	-
Independent Chairman and JCC	-	-	-	-	-	-	-
TOTAL ANNUAL COSTS.....	402,500	446,600	495,400	549,600	609,900	676,900	3,180,900
CAPITAL ITEMS							
Furniture	-	-	-	-	-	-	-
Vehicles	10,500	11,400	12,200	13,100	14,400	15,300	76,900
Equipment	-	-	-	-	-	-	-
TOTAL CAPITAL ITEMS.....	10,500	11,400	12,200	13,100	14,400	15,300	76,900
GRAND TOTAL	413,000	458,000	507,600	562,700	624,300	692,200	3,257,800

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1984	1985	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	229,[illegible]	257,900	1,[illegible]
[illegible]	216,[illegible]	233,[illegible]	251,900	272,000	293,800	317,300	1,504,[illegible]
[illegible]	109,[illegible]	116,600	125,[illegible]	136,[illegible]	146,900	158,600	792,[illegible]
[illegible]	193,[illegible]	215,800	233,800	251,600	271,800	293,500	1,[illegible],500
[illegible]	[illegible]	560,[illegible]	610,500	659,[illegible]	712,500	769,400	3,8[illegible]
[illegible]	431,[illegible]	[illegible]	431,500	530,600	575,300	612,000	[illegible]
[illegible]	1,307,[illegible]	1,[illegible]	1,391,100	1,394,250	1,505,[illegible]	1,[illegible],300	[illegible]
[illegible]	[illegible]	[illegible]	94,500	102,[illegible]	110,[illegible]	118,[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1,[illegible]	1,4[illegible]	1,6[illegible]	[illegible]	[illegible]

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TABLE VII - OFFICE OF THE DIRECTOR AND ADMINISTRATIVE SUPPORT OUAGADOUGOU 1980-1985
BY CATEGORY OF EXPENDITURE

	1980	1981	1982	1983	1984	1985	TOTAL
ANNUAL COSTS							
Personal services	1,757,200	1,959,300	2,184,600	2,435,800	2,715,900	3,028,200	14,081,000
Aerial operations	-	-	-	-	-	-	-
Insecticide	-	-	-	-	-	-	-
Research and Training	-	-	-	-	-	-	-
Supplies	59,400	64,100	69,200	74,800	80,700	87,100	435,300
Accomodation and utilities	18,900	20,400	22,000	23,700	25,600	27,600	138,200
Operation and maintenance	239,100	258,200	278,900	301,200	325,300	351,300	1,754,000
Operational travel	111,800	120,700	130,300	140,800	152,000	164,200	819,800
Consultants	87,500	94,500	102,000	110,200	119,000	128,500	641,700
Meeting	-	-	-	-	-	-	-
Dependent Chairman and JCC	-	-	-	-	-	-	-
TOTAL ANNUAL COSTS	2,273,900	2,517,200	2,787,000	3,086,500	3,418,500	3,786,900	17,870,000
CAPITAL ITEMS							
Buildings	50,000	20,000	20,000	20,000	20,000	20,000	150,000
Furniture	2,000	2,000	2,000	2,000	2,000	2,000	12,000
Vehicles	94,400	102,600	109,300	117,900	129,200	110,800	664,200
Equipment	-	-	-	-	-	-	-
TOTAL CAPITAL ITEMS	146,400	124,600	131,300	139,900	151,200	132,800	826,200
GRAND TOTAL	2,420,300	2,641,800	2,918,300	3,226,400	3,569,700	3,919,700	18,696,200

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TABLE VIII - ADMINISTRATIVE SUPPORT 1980-1985

BY CATEGORY OF EXPENDITURE : GENEVA, ROME & BRAZZAVILLE

	1980	1981	1982	1983	1984	1985	TOTAL
GENEVA HQ.							
ANNUAL COSTS							
Personal services	173,700	193,700	216,000	240,800	268,500	299,300	1,392,000
Operation and Maintenance (Data processing)	35,000	37,800	40,800	44,100	47,600	51,400	256,700
TOTAL.....	208,700	231,500	256,800	284,900	316,100	350,700	1,648,700
FAO/SUPPORT/ROME							
Consultant services	24,100	26,000	28,100	30,300	32,800	35,400	176,700
BRAZZAVILLE/AFRO							
Personal services	60,700	67,600	75,400	84,100	93,700	104,500	486,000

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TABLE IX - MEETINGS 1980-1985

Meetings	163,300	176,300	190,400	205,600	222,000	239,800	1,197,400

TABLE X - JOINT CORDINATING COMMITTEE 1980-1985
BY CATEGORY OF EXPENDITURE

	1980	1981	1982	1983	1984	1985	TOTAL
ANNUAL COSTS							
Personal services	70,900	79,100	88,200	98,300	109,600	122,200	568,300
Supplies	4,400	4,800	5,200	5,600	6,000	6,500	32,500
Operational travel	14,100	15,300	16,500	17,800	19,200	20,800	103,700
J.C.C. Meeting	35,000	37,800	40,800	44,000	47,600	51,400	256,600
TOTAL.....	124,400	137,000	150,700	165,700	182,400	200,900	961,100

TABLE XI - TOTAL EXPENDITURE 1974-1985

EMPHASIZING TRANSITION PERIOD 1980-1981

	1974-1978	1979	1980	1981	1982-1985	TOTAL 1974-1985
Vector Control Operations	26,084,473	9,090,400	12,405,600	13,090,500	65,452,800	126,123,773
Epidemiological Evaluation	2,279,787	699,200	850,300	936,200	4,773,000	9,538,487
Economic Development	343,148	369,900	413,000	458,000	2,386,800	3,970,848
Applied Research & Environmental Protection & Training	3,216,937	1,100,000	1,188,000	1,283,000	6,243,000	13,030,937
Programme Director & Administrative Support Ouagadougou	6,399,631	2,106,400	2,420,300	2,641,800	13,634,100	27,202,231
Meetings	379,394	151,200	163,300	176,300	857,800	1,727,994
Administrative Support/Geneva	2,233,676	188,200	208,700	231,500	1,208,500	4,070,576
Technical Support/FAO/Rome	91,448	22,300	24,100	26,000	126,600	290,448
Technical Support/Brazzaville	69,746	54,400	60,700	67,600	357,700	610,146
Independent Chairman and W.H.C.	366,157	113,200	124,400	137,000	699,700	1,440,457
TOTAL	41,464,397	13,895,200	17,858,400	19,047,900	95,740,000	188,005,897

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CHEMOTHERAPY

The prospects for chemotherapy and human therapy in general in the Programme area in the next few years can be considered from two angles:

(i) To substantially reduce the human parasite reservoir in support of the blackfly control campaign, no great assistance from the therapeutic methods currently available can be expected.

- Nodulectomy is not very effective for this purpose and it is virtually impossible to carry it out on a large scale.
- Because of its contraindications and the difficulties in administering it, suramin could affect only a part of the human parasite reservoir (at most half).
- DEC has only a very limited effect on the overall prevalence of the disease. The microfilaria counts that it leaves in the human body, when administered at normal doses, are quite enough to ensure continued transmission.
- This situation could only be changed by the discovery - not foreseeable at present - of an alternative effective, non-toxic microfilaricide that is easy to administer.

(ii) If, on the other hand, the aim is simply to avoid the onset of severe ocular complications in onchocerciasis patients at risk of blindness (adolescents and adults with high parasite counts) some hope

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can be placed in the currently available therapeutic methods :

- Surgical removal of head nodules might be useful in children and adolescents with high parasite counts. It is hoped that the trials in progress in the Programme area will provide more information on this point.
- DEC, administered with extreme caution at first and subsequently prescribed ad infinitum, would undoubtedly reduce the ocular microfilaria count in very cooperative subjects to a sufficient extent to prevent the onset of severe lesions.
- Suramin, in tolerable doses (for example, with a very gradually increasing regimen) could remove the majority of macrofilariae once and for all from the patients with the highest parasite counts and protect them from severe ocular complications if reinfestation did not occur.

Need for an accelerated programme in chemotherapy

While, therefore, the ongoing research effort in chemotherapy is not negligible, there is, at this stage of the Programme, a clear need to consider whether an accelerated research programme could be undertaken to rapidly develop an efficient and non toxic drug which could be used in mass treatment of onchocerciasis. The advantages of developing such a drug would be as follows :

(i) It would provide rapid relief to those persons already suffering from the disease, especially those under threat of blindness. At present, even with complete interruption of disease transmission following thorough Simulium damnosum control, sufferers are obliged to wait 10-15 years for their

onchocerciasis infections to disappear as the adult Onchocerca volvulus worms slowly die off from old age.

(ii) It would provide an insurance against any possible future development of insecticide resistance on the part of S. damnosum in the Programme area - an occurrence which could otherwise throw the whole control scheme into jeopardy.

(iii) Even when, as is hoped, the presently accepted tolerable level of onchocerciasis is achieved throughout the Programme area, and when serious eye lesions and blindness are things of the past, the demand may arise for more critical standards of tolerability. At that time, when residual transmission is light, there is likely to be a greatly increased demand for treatment of lightly-infected persons suffering from the severe itching skin lesions of onchocerciasis. For them also improved drug treatment will be needed.

(iv) It would provide a reasonably good chance of reducing the amount of financing for vector control which, taking into account the costs of additional extensions within the present countries and to new countries, could reach more than $ 400 million over a 10-year period.

(v) Finally, it should be noted that the increase in development costs of all drugs and the uncertainty of return on investment for drugs to control O. volvulus has so far limited research investment by the pharmaceutical industry in this area. Return on investment is determined by amortization of research and development expenditures and the costs of production against a potential market at a stable price for a specific period of time. Expanded demands for efficacy and safety testing and the expense of maintaining permanent screening facilities for compounds of potential interest are other

major reasons for the low rate of introduction of new products to control the tropical diseases. The lack of adequate facilities and competent clinical investigations in endemic countries has also hampered the development of new drugs for these diseases. It would seem therefore that where potential benefits are more social than economic in nature, there is a need for support to the pharmaceutical industry with grant money to ensure the availability of unprofitable drugs.

Immediate research involving presently available drugs

(a) General Strategy

We already know that among the drugs which are at present available for use in human medicine, and which are known to have a filaricidal action, there is no single one, and no combination thereof, which can be used as an alternative to vector control in order to control onchocerciasis.

On the other hand, given an accelerated drug research programme, there is real hope that present-day filaricides could be used effectively and widely within the Programme area in order to supplement the effects of vector control. To this end, they would need to serve two purposes, the first of which is the more pressing :

(i) to prevent the onset of blindness in those persons who are still at special risk thereof, despite the nearly complete interruption of transmission;

(ii) to reduce the microfilarial reservoir, by means of mild, acceptable, and intermittently continued suppressive therapy with microfilaricides, thereby perhaps accelerating the drop in the level of the reservoir that is expected to follow the near interruption of transmission resulting from vector control.

Accelerated research on these lines may be expected to yield whatever practical results are likely to be forthcoming, within 5 years ; and the cost of such research by means of expansion and extension of the existing OCP research programme and that of the WHO Special Programme for Research and Training in Tropical Diseases (TDR) would be relatively modest when compared with one year's budget of vector control.

The cost of putting into action the results of such research cannot be estimated until the methods to be used are decided upon, but in all probability use would have to be made of national health programmes and personnel.

It must be emphasized, however, that chemotherapy on these lines cannot be expected to supplant entirely the need for vector control. It may succeed in lowering the continuing incidence of blindness in the Programme area, and it may possibly help to bring forward the day when sustained vector control produces a satisfactorily low prevalence and intensity of *O. volvulus* infection in the area.

(b) Lines of research

The main lines of "immediate" chemotherapeutic research that should be pursued more energetically, given increased funds, are as follows :

(i) study the pharmacodynamics, pharmacokinetics and toxicity of suramin and diethylcarbamazine (DEC) ;

(ii) investigate and develop optimal schedules of DEC with betamethazone coverage, by the use of which the heavy microfilarial loads in patients at high risk of blindness may be reduced without unacceptable reactions ;

(iii) investigate and develop low-total-dose (and/or slow build-up) schedules of suramin (4-5G total) to be used as a macrofilaricide in patients at high risk of blindness;

(iv) investigate further the macro- and microfilaricidal (suppressive) actions of (a) furazolidone, (b) Metrifonate, (c) Metrifonate and DEC, (d) levamisole and DEC, (e) Mebendazole and DEC, (f) Metrifonate and levamisole, (g) Mebendazole and levamisole and DEC, (h) Metrifonate and levamisole, (i) DEC transdermal lotions, (j) other drugs revealed by literature search recently commissioned by TDR;

(v) investigate the role of various drugs e.g. aspirin, antihistamines, disodium chromoglycate, indomethacine, colchicine, corticosteroids, in reducing the reactions to microfilaricides;

(vi) investigate, with the aid of fluoresceine angiography, the possible deleterious effect of filaricides on the optic nerve in cases with disease of the posterior segment of the eye.

106. In conjunction with the eventual application of the results obtained from the above investigation, further research is needed as follows:

(vii) refine the signs and symptoms by which patients at high risk of blindness can be recognized in time for treatment to be effective in preventing the onset of blindness;

(viii) investigate, at regular intervals after the near interruption of transmission in the Programme area, the viability of the adult worms in the nodules harboured by the human population.

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THE CHEMOTHERAPY RESEARCH PROGRAMME OF THE WHO SPECIAL PROGRAMME ON RESEARCH AND TRANING IN TROPICAL DISEASES
SCIENTIFIC WORKING GROUP ON FILARIASIS

A considerable amount of research has already been set in motion by the WHO Special Programme in the field of onchocerciasis chemotherapy.

Research on chemotherapy has so far been the number one priority of the Steering Committee of the Filariasis Scientific Working Group. There is no doubt that the main incentive for this drive has been the need for improved chemotherapy for onchocerciasis.

The goals of the chemotherapy programme are as follows :

(i) To determine the best methods of using the drugs currently available for treatment of onchocerciasis.

(ii) To discover and develop (a) new improved macrofilaricides; (b) new microfilaricides less violent than diethylcarbamazine citrate (DEC); and (c) a filarial chemoprophylactic - all effective against O. volvulus. In the context of OCP an effective non-toxic macro-filaricide is the number one requirement - a drug that will kill the adult worms wherever they are located, whether superficial or deep.

The first step towards goal (i) involves finding centres in endemic areas where clinical trials can be done, initiating trials at these centres and, where necessary, providing radio-labelled drugs to assist with pharmacokinetrics and metaboloc studies Leading towards goal (ii) which is a much longer-term objective, it has been necessary to secure the cooperation of the pharmaceutical industry, to stimulate lead-directed synthesis for new filaricides, to set up and support filaricide screening centres, and to initiate work on the metabolism of filariae directed towards finding new chemotherapeutic pathways.

(a) Collaboration with the Pharmaceutical Industry

Good collaboration has been established with several sectors of the pharmaceutical industry. It has been based on personal contacts and mutual trust established as a result of personal visits, which have been made over the last two years to many companies in Europe USA and Japan, by various members of the Steering Committee, of the Secretariat and by other advisers (Dr L. G. Goodwin, Professor G. Lämmler, Professor M. Sasa, Dr H. Tanaka, Dr E. de Maar, Dr B. O. L. Duke).

These visits have included the following pharmaceutical companies, all of which have expressed interest in this field of chemotherapy.

B.A.S.F./Knoll A.G./Nordmark-Werke
Ciba-Geigy AG
Farbenfabriken Bayer AG
Hoechst AG
Hoffmann La Roche AG
Imperial Chemical Industries Ltd.
Janssens Pharmaceutica
May & Baker
Parke-Davis Ltd.
Pfizer Ltd.
S.A. Rhône-Poulenc
Sumitomo Chemical Co.
Tanabe Seiyaku Co.
Wellcome Foundation Ltd.

A number of these companies have promised to consider maintaining or extending their own screening activities for filaricides. Some of them have undertaken to supply selected compounds to the Filaricide Screening Centres which are being supported by the WHO Special Programme (see 3.2), and in most such cases it is the Principal Investigators who have established their own links with the industry for the supply of compounds to their screens. Again the relationship is one of mutual confidence.

It is particularly satisfactory that these contacts with the pharmaceutical industry have in several instances led to contractual agreements between the company concerned and WHO based on a carefully negotiated and mutually agreed "letter of intent" dealing with the problems of patents, profits and the further development of any potentially successful filaricides that may be found.

One such agreement has been signed with the Wellcome Foundation, Beckenham, Kent, U.K. enabling Dr J. Keeling, as Principal Investigator, to set up a filaricide screen for the testing annually of up to 400 selected compounds from the Wellcome Foundation compound library.

Another agreement has been signed with Hoechst AG, Frankfurt-am-Mainz, Federal Republic of Germany. This will enable Hoechst, with the aid of their Dr H. Loewe, to sponsor a programme of chemical synthesis around suramin as a lead compound, which will be carried out by Professor P. Nickel at the Department of Chemistry, Free University of Berlin. Any compounds developed will be tested first in the Hoechst filaricide screen and later in the other WHO-supported screens.

Parke-Davis Ltd., in the USA, is now showing a renewed interest in a possible collaborative venture with WHO for the synthesis of new filaricides; visits to several Japanese pharmaceutical companies have resulted in their increased awareness of the needs for drugs in tropical medicine, and hence to a more rational channelling of compounds to the screen maintained by Dr H. Tanaka at the Institute of Medical Science, University of Tokyo.

(b) Filaricide screening activities

(b)1. Primary and secondary screening in rodents, cats, etc.

Four academic centres for chemotherapeutic research and screening of filaricides have been supported by the Special Programme. These are Dr D. A. Denham, London School of Hygiene and Tropical Medicine, Department of Medical Helminthology; Professor G. Lämmler, Institut für Parasitologie, Justus-Liebig-Universität, Giessen, FRG; Dr J. W. McCall, University of Georgia, Department of Parasitology, Athens, Georgia, USA; Dr H. Tanaka, Institute of Medical Science, University of Tokyo.

The supply of selected compounds, from industry and elsewhere, to these centres is still slightly below saturation point, at least while results continue to be negative. Further sources of supply of new compounds are being sought, but it is always wise to have some screening capacity in hand since the further investigation of a positive compound, whenever one is found, can result in a lot of extra work which upsets the screening routine

Positive results are beginning to come from some of the primary and secondary screens Professor Lämmler at the University of Giessen, has reported that furazolidone, a nitrofuran derivative used in the treatment of diarrhoea, shows marked macrofilaricidal action against Litomosoides carinii. Arrangements are being made to pass this compound through other screens and, since it is already approved for use in human medicine, to plan tests of its possible action against O. volvulus and W. bancrofti in man.

Dr J. McCall of the University of Georgia, working in conjunction with Professor J. Jaffe, University of Vermont, has also revealed that chlofazimine, a drug used for the treatment of leprosy in man, has a causal prophylactic action against L. carinii and Dipetalonema viteae at relatively high dosage. Further experiments are now in progress to determine the minimum effective prophylactic regimen. If the results are still promising, further experiments will be planned in other animal filarial models, and later perhaps also in man for action against O. volvulus and W. bancrofti.

(b) 2. Development of a tertiary screen for Onchocerca in cattle

Pilot investigations into the use of O. gibsoni and O. gutturosa in cattle, as a tertiary screen for possible drug action against Onchocerca volvulus, have been successfully carried out by Dr B. Copeman at the Department of Veterinary Science, James Cook University, Townsville, Australia. His results using DEC, levamisole, mebendazole, suramin, etc. indicate that this screen can be used effectively to reveal potential micro- and macro-filaricidal action against O. volvulus. Prior to this, such screening could only be done, and that very rarely, in experimentally infected chimpanzees.

Large numbers of heavily infected cattle are available at very low prices in Australia and the Department has excellent facilities for handling, holding and autopsying these animal The macrofilaricidal action of a drug can readily be assessed in every detail by histological examination of the 10-30 nodules which are found in each animal, and the similarity of O. gibsoni to O. volvulus, both in regard to the nodules produced and in their response to known filaricides, is remarkable This screen, therefore, provides an excellent intermediat step between the filarial infections of small rodents and O. volvulus in man

Dr. Copeman has now received further support to extend his work and will endeavour to investigate ethidium bromide; melarsaronyl potassium; oral melarsoprol; furazolidone; metrifonate; praziquantel; Ciba-Geigy 4540, etc.; combinations of metrifonate, mebendazole and levamisole; other drugs revealed by the Stanford Research Institute literature search (see below); other drugs stemming from the WHO-supported filaricide screening centres; and tetracycline (to see whether it is absorbed by the adult worms).

The cattle Onchocerca model in Australia also offers a means of field-testing drugs for prophylactic action. Almost 100% of calves bred and held in the area become naturally infected with O. gibsoni by the age of seven months, and there are sufficient holding facilities for experiments on these lines to be carried out.

(b).3. Future plans

In order to increase the collaboration and exchange of compounds between screening centres, to plan for an increased supply of compounds, and to compare methods, problems and new leads, it is planned to organize a working group meeting for the Principal Investigators of the various WHO-supported filaricide screening centres late in 1978.

(c) Radio-labelled DEC and suramin

In order to assist with the planned investigation into the pharmacokinetics and metabolism of the current filaricides, DEC and suramin, the Steering Committee undertook to obtain radio-labelled preparations of these two drugs. They will be made available for trials in patients at the OCP Chemotherapeutic Centre at Tamale in northern Ghana, originally started by OCP but now under the auspices of TDR, and part of the already close cooperation established between the Special Programme and OCP.

Contracts have been signed, and work has begun, on the synthesis of both these compounds, labelled with C^{14} in the ring structure. Stanford Research Institute (Dr DeGraw) will provide 5 grammes labelled DEC; and Farbenfabriken Bayer AG (Dr D. Wegner) has agreed to provide 1 gramme of labelled suramin, of which 800 mgs, will be available for work on onchocerciasis and 200 mgs for work on trypanosomiasis.

(d) Investigations into methods of use, toxicity, pharmacodynamics and pharmacokinetics of metrifonate, DEC and suramin, and other potential filaricides

Experiments on these lines with metrifonate are already under way, and protocols for the similar careful investigation of DEC and suramin, when used in the treatment of onchocerciasis, are being prepared by the team from the Liverpool School of Tropical Medicine in northern Ghana. They will make use of the radio-labelled compounds mentioned above.

Support has also been given to Dr O.O. Kale at the Department of Preventive and Social Medicine, Ibadan, Nigeria, to undertake trials of drugs against O. volvulus. The development of other centres, where work on the chemotherapy of onchocerciasis can be done, is being explored. Possibilities exist in Sudan, Tanzania and Liberia to mention but some. Particular efforts are being made to interest ophthalmologists in the preventive therapy of ocular onchocerciasis.

The Committee has also given much thought to the toxic reactions sometimes associated with the use of suramin. It has arranged for investigations to be made into the stability of suramin under conditions of tropical storage. About 20 samples, comprising different brands of suramin, which had been stored for varying periods at ambient temperature in the tropics, were collected and sent for isotachyphoretic analysis by D I. Flynn of the Department of Biochemistry, University of Edinburgh Medical School, U.K. In none of them was any impurity or decomposition product detected.

Also, to make further investigations into the pathogenesis of the terminal toxicity of high suramin dosage, attempts are being made to obtain a chimpanzee (an animal which reacts to the drug in a manner similar to man) for an experiment along these lines.

(e) Search of the literature of approved drugs for new filaricide leads

The Committee has now received the report which was commissioned on this subject from the Stanford Research Institute (Dr Cory). The report provides information on a number of compounds, already in use in human medicine, which would repay testing for filaricidal action in animals or man. It also provides leads as to groups of compounds which could profitably be selected either for

further screening or as points of departure for programmes of synthetic chemistry. Plans for the research follow-up of this report will be laid at the forthcoming SWG meeting.

(f) Recruitment of postgraduate biochemists to work on folate metabolism of filarial worms in relation to the action of filaricides

Two postgraduate students have now been selected and will shortly start work for two years under Professor J. Jaffe at the University of Vermont, USA. They will be working on the folate metabolism of filarial worms in an attempt to find metabolic pathways that could be blocked by new filaricides. Possibly this research may be extended to include a study of purine metabolism. The successful candidates, out of eight applicants found after circulating all departments of biochemistry in tropical Africa, are Mr R.A. Acquaah, Dept. of Biochemistry, University of Ghana, and Dr M.M. Iba, a Nigerian presently at the Medical School of the University of Minnesota, USA. Professor Jaffe's programme is funded in part by the United States National Institutes of Health, and already includes one other post-graduate student from Zaire, whose final year will be funded by the Special Programme.

(g) Informal workshop meeting on "Methods to be used in chemotherapeutic trials in onchocerciasis"

This meeting, sponsored by the Special Programme on the advice of the Filariasis Steering Committee, took place at the University of Ibadan from 5-9 December 1977. It was highly successful in promoting friendly contacts between workers from many parts of the world in stimulating interest in drug trials for onchocerciasis, in persuading some new workers to enter this field in Africa, in disseminating information on methods, and in laying down guidelines for drug trials. The ethical aspects of such trials received much attention, and the group's considered opinions on them should be of assistance in planning future trials. The report of the meeting will shortly be available from WHO.

(h) Workshop meetings of the Scientific Working Group

Largely to meet the anticipated needs of OCP in an intensified programme of chemotherapeutic research, the Filariasis Scientific Working Group meeting, timed

for July 1978, will devote two days exclusively to small workshop-type meetings on the following subjects.

(I) Chemical leads for the synthesis of new filaricides.

(II) The pathogenesis of the inflammatory lesions produced by microfilariae of O. volvulus, especially in the eye and in relation to treatment with filaricides; and means of preventing such lesions.

It is hoped that the deliberations of these groups of experts will point the way for further research on these two subjects, which are vital to onchocerciasis chemotherapy; and that they will identify places where such research can be done and persons who can carry it out.

(I) Budget

The Filariasis Scientific Working Group is currently funding research into chemotherapy (largely aimed at onchocerciasis) at the rate of about $900,000 p.a. It is very probable that this rate of spending will be increased in the near future if full advantage is to be taken of all the available avenues of research now opening up for new drugs and for more effective schedules with old drugs.

(J) Conclusions

For the time being the limiting factors are not only financial but also the difficulty of finding the right people to do the work. However, if and when we are lucky enough to reach the stage of having a promising compound which needs further development as a new macrofilaricidal drug for use against O. volvulus in man, then very much larger funding (measured in millions of dollars) will be necessary to put such a compound through all the necessary safety trials.

It is regrettable that successful new drugs cannot be turned out to order on a fixed time schedule, or even in direct proportion to the amount of money invested in the search. In the German pharmaceutical industry they say that four "G" factors must be combined to make the search successful: Gehirn, Gehuld, Geld and Gluck*; and one has only to leek at the stories behind many of the other successful drugs used against parasitic diseases to be sure that the greatest of these is luck.

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In the present circumstances, if an accelerated drug development programme is undertaken with funds provided to the Onchocerciasis Control Programme, it must be coordinated with TDR through the Filariasis SWG. This is particularly so when it comes to making approaches to pharmaceutical companies which, understandably, get very tired of WHO making endless different advances each time wearing a different hat.

To achieve the goal of more effective therapy for onchocericasis it would seem that we must in the short-term:

(I) improve the use of existing filaricides;

and, in the long term and in order to provide an effective, practical non-toxic macrofilaricide:

(II) increase lead-directed chemical synthesis activities;

(III) maintain adequate screening facilities;

(IV) stand financially prepared to develop promising new candidate compounds.

It is in the last of these activities (IV) that the closest collaboration with the pharmaceutical industry will be needed. The negotiation of the financial terms under which any such drug development shall proceed will depend very much on who owns the patent rughts of the promising compound(s) for development, when they appear. Each company will seek to drive a different bargain.

In most onchoceriasis zones the sufferers from the disease cannot afford to purchase any drug such as a macrofilaricide solely effective against O. volvulus, which carries the full commercial costs of development in its sale price. The negotiable options for financing the development of such a drug would seem therefore to range between (a) the sponsors of the OCP and of the Special Programme paying the industry to develop the drug on quantity and at a sufficient price to refund the industry for its dedelopment costs. In either case account will have to be taken of any other potential commercial applications (especially in the veterinary field) that the compound may have.

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*Brains, patience, money and luck.

ANNEX 2

RESEARCH AGREEMENTS

I. ENTOMOLOGY - VECTOR ECOLOGY

Institution	Research proposed	Progress and/or results	Period	Amount US
ORSTOM, France Institut de Recherches sur l'Onchocercose (IRO), Ivory Coast	To study methods of sampling adult and aquatic stages of species of S.damnosum complex; to develop suitable adult trapping device and artificial substrate for larvae; to observe behaviour of adults and feeding habits of the larvae; to carry out research on the resting sites of the adults.	Two adult traps developed. The aluminium sheet trap which shows most promise is being extensively tried in OCP area in 1977; concurrently many useful observations made on behaviour of the adults. An artificial substrate of plastic strips tested satisfactorily and its limitations noted. The vertical distribution of the larvae in the water has been recorded. The range of particles ingested and their rate of passage through the larval gut was studied.	Sept. 1974-75 Oct. 1975-76 1977 1978	64,700 45,100 50,400 50,000
Institut de Médecine Tropicale Prinz Léopold, Belgium			Dec. 1975 1976-77	10,000 10,000
OCCGE, Upper Volta IRO, Ivory Coast	To study the distribution of the different species of the S.damnosum complex inside and outside the OCP area; to observe and record morphological and ecological differences between the species; to determine the vectorial capacity of each species.	By cytotaxonomic means the distribution of the different species of the S.damnosum complex have been plotted in Phase I and Phase III west of the OCP area and the area surrounding it. Morphological differences have been recorded in the West African species of the complex and a classification key prepared for field workers to identify the adult females. Studies continue on the epidemiological importance of each of the species.	Sept. 1974-75 Oct. 1975-76 1977 1978	54,200 45,000 43,000 38,000

I. ENTOMOLOGY - VECTOR ECOLOGY (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US$
Biosystematics Research Institute, Ottawa, Canada	To study in detail the morphological characteristics of all stages of the species of the S.damnosum complex associated with OCP and prepare classification keys.	By conventional means and the use of a Scanning Electron microscope and computer a comprehensive range of morphological characters is being studied in the different species of the S.damnosum complex. The methods were refined in 1976 and with a freer flow of typed specimens from OCP and Bouaké substantial progress was made in 1977 with the development of a key to identify the adults. This is being refined in 1978.	Nov. 1975-77 1978	55,000 24,000
Bernhard-Nocht-Institut, Hamburg, Federal Republic of Germany	To determine whether the filarial larvae developing in Simulium vectors can be differentiated histochemically.	Using enzymatic and histochemical techniques clear differences have been shown in microfilariae of O.volvulus strains from Guatemala, the forest region of Liberia and the OCP savanna area. The same techniques are being used to see if the developing stages in the S.damnosum adults can be similarly differentiated. This study is being continued in 1978 by a consultant work-in close association with the institution.	1977 1978	14,700 3,500
Liverpool School of Tropical Medicine, UK	To study enzyme polymorphisms in species of the S.damnosum complex and determine whether a method could be developed whereby the adults of the various species could be differentiated.	Fifteen enzymes have been examined in the adult S.damnosum s.l. Using phosphoglucomutase it has been possible to differentiate S.yahense from other species of the complex at sites studied. There is evidence to support consideration of S.squamosum and S.yahense as separate species. The method has so far permitted the identification of flies biting man at a site in Ghana as S.yahense.	Oct. 1975-76 1977	14,500 11,000

I. ENTOMOLOGY - VECTOR ECOLOGY (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US $
Bennett Analytical X-Ray Ltd., Vancouver, Canada	To relate migrating adult S.damnosum s.l. to their breeding sources by X-ray Energy Dispersive Spectroscopy (XES) analysis.	Using XES analysis it proved possible to "fingerprint" individual flies and relate them to the riverine site from which they emerged. Each river presented a different and specific pattern. In this way it was possible to trace flies caught reinvading the controlled area back to their source rivers, thereby incriminating the Marahoué and Bagoé rivers.	1976 1977	12,500 2,500
CDC, Atlanta, United States of America	To study the possibility of establishing a colony of S.damnosum s.l.	Following success with a rearing chamber in developing S.decorum and S.vittatum from eggs to adults and getting the adults of S.decorum to blood-feed and mate, similar experiments were planned with S.damnosum species. Due to the difficulty of transporting material in good condition from West Africa to the United States of America only one egg batch was successfully reared to adults.	Aug. 1975-76	4,000
Tropenmedizinisches Institut der Universität, Tübingen, Federal Republic of Germany	To study the possibility of establishing a colony of S.damnosum s.l.	The Principal Investigator had experience with rearing Simulium species in East Africa. It being more satisfactory to send eggs from West Africa to Germany several trials of his rearing system were possible. It was found necessary to maintain the chemical composition of the water within strict limits. Larvae reaching second instar would normally develop to adults. A blood feeding mechanism was developed.	Aug. 1975-76	1,800

I. ENTOMOLOGY - VECTOR ECOLOGY (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US $
University of Ghana, Legon, Ghana	To determine whether electrophoretic methods would be sufficiently sensitive to separate species of the S.damnosum complex.	Following application of the metnod to the study of Anopheles mosquitos, some preliminary trials were undertaken with Simulium species but results were inconclusive.	Aug. 1975-76	1,800
Centre for Overseas Pest Research, London, UK	To carry out biogeographical studies to determine whether changes in distribution of S.damnosum can be associated with concurrent weather features and the direction of movement be inferred from the windfield.	Two biogeographers have been involved in the Programme area and in London analysing data on the distribution of S.damnosum adults and trying to relate their movements to the major wind currents and, in particular to the Intertropical Zone. There is evidence of flies appearing at certain sites in relation to line squalls but the final conclusions are still awaited.	Feb. 1975-76	11,000

II. ENTOMOLOGY - VECTOR CONTROL

Institution	Research proposed	Progress and/or results	Period	Amount US $
OCCGE, Upper Volta IRO, Ivory Coast	To evaluate new insecticides and formulations in artificial channels and in rivers, for controlling S.damnosum s.l.	After many trials and modifications to the system a floating cage method for testing insecticides has now been perfected to the extent that results obtained from it are comparable with tests carried out in the river. A series of candidate insecticides and formulations have been tested following which chlorphoxim was selected for large-scale trials. Much information has been collected on the most appropriate type of formulation. These trials continue as alternative products are made available.	Sept. 1974-75 Oct. 1975-76 1977 1978	36,500 29,500 33,000 28,300
ORSTOM, France Hydrobiological Unit, Bouaké, Ivory Coast	To survey the aquatic environment and collect information relative to the effect of chlorphoxim on non-target organisms during large-scale trials.	With the assistance of a consultant, data has been collected on the N'zi river prior to the treatment of the river on a weekly basis from the beginning of the rainy season. The results will indicate whether chlorphoxim could be introduced as an alternative insecticide to Abate.	1977	16,500
University of Kiel, Kiel, Federal Republic of Germany		Some funds were provided to Kiel University to assist the consultant in the sorting of material and finalization of the report due in July 1978.	1978	1,350
University of Alberta, Edmonton, Canada	To study the detachment, reattachment and mortality of Simulium larvae after larvicide treatment and determine the parameters relating to detachment and reattachment in laboratory and riverine conditions.	Using artificial flumes with pumped stream-water, detachment rates, mortality of detached and non-detached Simulium larvae were determined with Abate and methoxychlor. Larvae detach within 15 minutes after treatment with methoxychlor but take up to four hours with Abate. Larvae reattaching after insecticide treatment pupate and produce apparently normal adults. Non-reattaching larvae die.	1975-76 1977	8,100 6,000

II. ENTOMOLOGY - VECTOR CONTROL (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US $
Center for Disease Control (CDC), Atlanta, United States of America	To carry out research on the chemical analysis, the physical properties and the specifications of Simulium larvicides.	Methods for analysing the active ingredient have been developed for Abate and methoxychlor and are under study for other insecticides. A method for extraction of water, mud and organisms and analysis of residues has been described for Abate, methoxychlor and chlorphoxim and is being developed for other larvicides. Interim specifications have been issued for 20% Abate EC. The physical-chemical properties of formulations have been studied including half-life, absorption on particles and biological uptake in living organisms.	1977	5,000
Institute for Medical Research, Zagreb, Yugoslavia	To investigate the simultaneous exposure of experimental animals to different organophosphorus compounds.	Trials were carried out with rats fed with the larvicide Abate and the drug, metrifonate, used against schistosomiasis, to determine whether there was any potentiating effect when these two organophosphorus compounds were used together. The answer was negative.	Aug. 1975-76	5,000
ORSTOM, France IRO, Ivory Coast	To develop a suitable method for testing the susceptibility of S.damnosum larvae to different insecticides and collect baseline data throughout the Programme area.	A satisfactory method for testing susceptibility levels in field conditions by exposing larvae to different concentrations of insecticide for three hours was developed. Using this method a range of data has been collected from rivers in the OCP area.	Sept. 1974-75	25,000
University of Reading, UK	To study the acute toxicity of insecticides against Simulium and agricultural pests, which might be employed in the Programme area, on non-target invertebrate organisms.	A continuous flow and simulated stream technique was developed to establish basic tolerance levels of representative stream invertebrates to Simulium larvicides. The results obtained by this method, though consistent, did not correspond to what is observed in field applications.	July 1974-75	4,000

III. GENERAL EPIDEMIOLOGY, MEDICAL AND PARASITOLOGICAL RESEARCH

Institution	Research proposed	Progress and/or results	Period	Amount US $
Medical Research Council, London, UK	To carry out longitudinal parasitological and ophthalmological studies in hyper-, meso- and hypo-endemic villages of northern Cameroon savanna; to continue studies to correlate the clinical and ocular findings in onchocerciasis with immunopathological findings; to conduct studies on DEC and Suramin and certain new drugs; to study the prognostic value of head nodules and outer canthus skin biopsies as risk factors for blindness.	Data have been collected from a number of villages of different endemicity on the prevalence of microfilariae in the cornea and in the anterior chamber of the eye as well as the prevalence of eye lesions by age and village. Correlated with entomological data, preliminary results indicate little transmission can be associated with quite a high prevalence of positive skin snips in that area. Depigmentation, common in the forest area, is rare in the savanna and this may be associated with biting density of the flies in each area. Head nodules were removed from 55 patients who are still being followed up. Optic nerve disease has been found to be very common in onchocerciasis. Patients have been treated with DEC followed by Suramin to determine whether Suramin is better tolerated after microfilariae have been killed. It has been found that heavily infected patients cannot be treated with DEC without corticosteroid cover. Lampit may have a macrofilaricidal effect. These studies were concluded at the end of 1977.	Nov. 1975-76 1977	43,000 44,000
Tropenmedizinisches Institut der Universität, Tübingen, Federal Republic of Germany	To carry out longitudinal parasitological and entomological studies in hyper-, meso- and hypo-endemic villages of northern Cameroon savanna to complement the studies of the MRC team (above). The completion of both sets of data will be used for the construction and testing of a mathematical model.	During the first year the villages were selected, catching points established, the distribution of breeding sites plotted, and flies collected on a routine basis and dissected. At the end of one year it was possible to calculate the annual transmission potential at villages with different levels of endemicity, related to the conditions, hydrological and climatic, pertaining throughout that year. These studies are continuing through 1978 to provide three years' consecutive data.	Mar. 1976-77 1978	88,600 33,600

III. GENERAL EPIDEMIOLOGY, MEDICAL AND PARASITOLOGICAL RESEARCH (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US $
Bernhard-Nocht-Institut, Hamburg, Federal Republic of Germany	To study the effect of nodulectomy in onchocerciasis patients living in areas where transmission has been interrupted.	In 1977 the nodules were removed from a number of patients in villages in Upper Volta. This study is being followed up in 1978 in cooperation with the Epidemiological Evaluation Unit.	1977-78	5,000
Istituto di Anatomia e Istologia Patologica, Rome, Italy	To carry out histological examinations of skin biopsies taken from selected patients in the OCP area to assist in the identification and classification of skin lesions due to onchocerciasis.	More than 500 histological examinations were carried out in 1976 on material submitted by OCP. A further 500 examinations are being done with colour pictures being made of the most significant specimens. Final results will be considered for publication in a monographic document.	1976 1977	400 5,000
Museum National d'Histoire Naturelle, Paris, France	To attempt to prepare an inventory of Onchocerca species found in domestic and wild animals in the OCP area, to determine which are transmitted by S.damnosum and to identify morphological characteristics of the infective stages.	The Gomba cow in Togo is parasitized by O.gutterosa, O.armillata, O.dukei and O.ochenzi. The vectors are unknown but the distribution of the microfilariae in the skin is being studied which may give indication of potential vectors. S.damnosum bites cattle in the area but it has not been incriminated as yet as a vector of any of the above Onchocerca species. This work is continuing in 1978 with the assistance of a consultant recruited directly by the Programme.	July 1976-77	37,700
The Johns Hopkins University, Baltimore, United States of America	To study the in vitro culture of Onchocerca volvulus microfilariae.	O.volvulus larvae in blackflies collected in Guatemala were cryopreserved and still viable 259 days after freezing. These larvae exhibited normal characteristics during subsequent cultivation in vitro. Microfilariae of O.volvulus remain viable at least 17 months in vitro after cryopreservation.	Feb. 1976-77	10,000

III. GENERAL EPIDEMIOLOGY, MEDICAL AND PARASITOLOGICAL RESEARCH (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US $
Royal Commonwealth Society for the Blind, UK	To collect data on the density of the parasite and the clinical symptoms of onchocerciasis in certain villages in northern Ghana; to establish the prevalence and clinical severity of the disease by examination of the population of first-line villages; to carry out trials with DEC.	Detailed ophthalmological and parasitological examinations were carried out at Zongoiri in 1974 and 1975 and at Awrigu in 1975. In trials with DEC it was found that its effect is most pronounced the first two to three weeks after treatment. There was a marked improvement in subjective eye symptoms after seven weeks; the low dose of 12.5 mg/kg in subjects up to 40kg can be given without clinical supervision and is effective.	Oct. 1974-75 1975-76	31,000 10,000
Institut für Parasitologie, Giessen, Federal Republic of Germany	To finalize a reference list on Suramin.	A bibliography on Suramin 1970-1975 was published.	Feb. 1976	850
CDC, Atlanta, United States of America	To determine the extent to which the equine parasite O. cervicalis will develop in the jird, Meriones unguiculatus using Culicoides variipennis as a source of infective larvae.	Many of the technical problems associated with producing third stage larvae in C.variipennis were worked out. Only 11 male jirds were exposed, nine of these to low levels. The final report on this study should be available towards the end of 1977.	March 1976	3,950

IV. CHEMOTHERAPY

Institution	Research proposed	Progress and/or results	Period	Amount US
Ministry of Health, Accra, Ghana (Chemotherapeutic Research Centre, Tamale)	To establish a Chemotherapeutic Research Centre at Tamale and undertake studies on the chemotherapy of onchocerciasis. DEC and Suramin will be used to increase the understanding of their mode of action and trials will be carried out with other old and new drugs alone or in combination.	The Centre was established and equipped and some preliminary trials undertaken with metrifonate in three dosage schedules. It has been shown to be an effective microfilaricidal drug. Trials continue in 1978 with other drugs separately and in combination and attempts made to alleviate the mazzotti reaction.	1977 1978	50,000 (56,500)
Liverpool School of Tropical Medicine, UK	To provide technical and professional assistance to the Ghana Government for special investigations to be conducted at the Chemotherapeutic Research Centre (above).	As above.	1977 1978	12,000 (79,000)
Unité d'enseignement et de recherche de médecine et de santé tropicale, Hôpital Michel-Lévy, Marseille, France	To develop a protocol for treatment of onchocerciasis using Suramin either by modifying the weekly dose or prolonging the interval between injections so as to reduce the secondary effects of the drug; five regimens of treatment to be tried on medium to heavily infected patients.	This work is being undertaken in Mali and in 1977 some trials were undertaken to determine the protocols of treatment to be adopted. A number of patients were treated according to three different protocols and these will be followed-up in 1978.	July 1976 1977	10,000 10,000

IV. CHEMOTHERAPY (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US
OCCGE, Upper Volta Centre Muraz, Bobo-Dioulasso	To carry out chemotherapeutic trials on onchocerciasis in infected patients with DEC, levamisole and Nifurtimox according to established protocols.	Three protocols are being followed (a) trials with DEC and with levamisole; (b) trials with DEC and levamisole together and (c) trials with Nifurtimox. Progress is being made with (a) and (b) although final results will not be available until the end of the evaluation period. With DEC, six months after treatment the microfilarial density remained low. With levamisole the microfilarial density reduced perceptibly one month after treatment. A combination of DEC and levamisole at half the prescribed dose also shows a reduction in microfilarial count immediately after a 21 days' treatment.	Feb. 1976	13,500

V. ENVIRONMENTAL PROTECTION

ORSTOM, France Hydrobiological Unit, Bouaké, Ivory Coast	To carry out the aquatic monitoring programme on rivers in Ivory Coast, Upper Volta and Mali and undertake research on the quality and quantity of fish and invertebrate fauna in the rivers treated and untreated.	The effect of weekly applications of Abate on fish and nontarget invertebrate fauna was studied on a monthly basis following an approved protocol. Data so far collected reveal that although Abate has an impact on the aquatic environment, the quality and the quantity of fauna remains at a very high level and fish are apparently unaffected. Considerable advances have been made in the classification of the insect fauna. In 1978 the frequency of monitoring was reduced to four times a year and additional sites in the proposed extension area selected for routine surveillance.	Jan. 1975-76 Mar. 1976-77 1977 1978	103,300 61,500 54,500 85,700

V. ENVIRONMENTAL PROTECTION (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US $
Institute of Aquatic Biology, Achimota, Ghana	To carry out the aquatic monitoring programme on four rivers in Ghana.	Data collected monthly from the Black Volta, White Volta and Daka have shown the effect of the weekly treatment of Abate to be at an acceptable level. Base-line data was collected on the Oti River for 18 months prior to the commence-ment of treatment. In 1978 the frequency of monitoring was reduced to four times per year and additional points in the proposed extension area incor-porated in the surveillance programme.	Mar. 1975-76 1977 1978	35,000 46,000 54,000
University of Waterloo, Ontario, Canada	To sample the aquatic fauna in rivers in the OCP area not covered in the routine monitoring programme.	This study was carried out by a consultant and additional funds were provided to the institute to assist with the sorting out of the samples. A report with all data collected was submitted in 1978.	1978	1,200
Mrs B. Walsh, Ouagadougou, Upper Volta	To study the effects of the regular treatment by Abate of the Red Volta, a seasonally flowing river in Upper Volta and Ghana, following the established protocol.	This study was completed at the end of 1977 and a report submitted comparing the situation on the river pre- and post-control. The initial impact of the treatment was marked but a measurable recovery in the fauna is apparent as control continues.	1977	5,000
Dr B. Roman, Ouagadougou, Upper Volta	To study the fish population in rivers before and after treatment and to make a cata-logue of the species and composition present.	The results to date show that most of the rivers have a very healthy and varied population of fish. None of the species appears to have been affected by the Abate and the presence of alvelings indicates that breeding is proceeding normally.	July 1975-76 1977	15,000 6,000

V. ENVIRONMENTAL PROTECTION (continued)

Institution	Research proposed	Progress and/or results	Period	Amount US
University of Salford, UK	To study and make a qualitative assessment of the invertebrate aquatic fauna in a number of seasonal rivers prior to treatment.	This study showed the proportional variation of taxa present amongst different rivers in West Africa with particular reference to the fauna found in S.dammosum breeding sites.	Jan. 1975	1,000

EPIDEMIOLOGICAL EVALUATION

DATA RECORDED UP TO 30 JUNE 1978

	In the OCP area	Outside the present OCP area	Total
Villages evaluated by EPI	306	30	336
Villages evaluated by other teams	26	5	31
Total	332	35	367

Note: Unless a decision is made to extend the Programme it is not planned to re-examine the villages outside the OCP area.

Data not collected by EPI

For 31 villages, data from surveys conducted according to the OCP methodology by OCCGE (Centre Muraz, African Institute of Tropical Ophthalmology). the Mobile Ophthalmology Group (GOM) in Upper Volta, and the RCSB team in Ghana were recorded. These are the only data available.

In 24 villages similar data were recorded and verified during a later visit by EPI.

Visits

A number of villages have been visited several times by EPI since 1975:

1 visit	312 villages
2 visits	21 villages
3 visits	2 villages
4 visits	1 village

Type of evaluation

Simple evaluation	273 villages
Detailed evaluation	63 villages

TABLE 1. COMPOSITION OF SAMPLE: SITUATION BY COUNTRY ON 30 JUNE 1978

Level of endemicity	PAG estimates		Actual EPI figures	
	No. of clusters	No. of People	No. of clusters	o. of people
1. NIGER				
Sporadic	1	300	1	444
Hypoendemic	1	300	3	548
Mesoendemic	2	600	4	752
Hyperendemic	2	600	6	1,176
Total	6	1,800	14	2,920
2. TOGO				
Sporadic	1	300	-	-
Hypoendemic	1	300	-	-
Mesoendemic	2	600	5	2,911
Hyperendemic	2	600	12	5,049
Total	6	1,800	17	7,960
3. GHANA				
Sporadic	2	600	1	334
Hypoendemic	3	900	1	197
Mesoendemic	5	1,500	11	3,309
Hyperendemic	6	1,800	31	11,962
Total	16	4,800	44	15,802

Level of endemicity	P.G estimates		Actual EPI figures	
	No. of clusters	No. of people	No. of clusters	No. of people
4. UPPER VOLTA				
Sporadic	8	2,400	3	1,106
Hypoendemic	8	2,400	12	3,331
Mesoendemic	17	5,100	33	9,679
Hyperendemic	17	5,100	64	14,919
Total	50	15,000	112	29,035
Immigration zones			6	3,681
5. MALI				
Sporadic	2	600	3	957
Hypoendemic	2	600	8	2,561
Mesoendemic	5	1,500	17	5,289
Hyperendemic	5	1,500	37	7,911
Total	14	4,200	65	16,718
6. IVORY COAST				
Sporadic	2	600	-	-
Hypoendemic	2	600	1	187
Mesoendemic	[illegible]	1,200	4	1,457
Hyperendemic	4	1,200	45	11,209
Total	12	3,600	50	12,853

including the 1978 extension area (Sassandra and Marahoué basins)

Level of endemicity	PAG estimates		Actual EPI figures	
	No. of clusters	No. of people	No. of clusters	No. of people
3. BENIN				
Sporadic	1	300	-	-
Hypoendemic	1	300	1	519
Mesoendemic	2	600	8	2,506
Hyperendemic	2	600	15	5,093
Total	6	1,800	24	8,118

Percentage share of each country in the sample (OCP area)

	Niger	Upper Volta	Mali	Ivory Coast	Ghana	Togo	Benin
According to PAG	5.5%	45.5%	12.5%	11%	14.5%	5.5%	5.5%
Actual OCP figures	3%	33.5%	17%	13.5%	16.5%	8%	8.5%

Extension phase and areas outside the present programme boundaries

	Niger		Ivory Coast		Ghana		Togo		Benin	
	No. of villages	Population examined	No. of villages	Population examined	No. of villages	Population examined	No. of villages	Population examined	No. of villages	Population examined
Sporadic	1	195	-	-	-	-	-	-	-	-
Hypoendemic	1	193	-	-	1	321	-	-	-	-
Mesoendemic	1	131	1	312	2	587	1	616	2	554
Hyperendemic	-	-	6	1,252	9	3,740	9	2,181	1	297
Total	3	519	7	1,564	12	4,648	10	2,797	3	851

Total sample

	No. of villages	Population concerned
Programme area, 1978	332	97,087
Areas outside present CCP boundaries	35	10,379
Total	367	107,466

REINVASION

1. Insecticide treatment of the rivers of Phase I, which began in February 1975, was followed within three weeks by a general reduction in S. damnosum s.l. biting densities over the whole area treated. At the end of April 1975 however, disturbing numbers of biting flies began to appear along the River Bandama and on the River Léraba at Pont Léraba.

2. At first it was considered that control might be breaking down with the increase in discharge caused by the onset of the wet season, and the supervision of the treatments was intensified. In spite of this, biting rates increased through June, July and August (Fig.). At the same time intensive ground and helicopter prospections on the affected and nearby rivers failed to produce any but the very occasional larva.

3. The flies were characterized by parous rates approaching 100% and heavy infections with filaria larvae indistinguishable from O. volvulus. This last factor was believed to indicate that the flies might originate from the forest where such infections are usual.

4. In April 1976 OCP staff and members of the Institut de Recherches sur l'Onchocercose (IRO), Bouaké, met in Bobo-Dioulasso to plan the field research to be undertaken to investigate the nature and origin of the reinvasion, should it recur. The study utilized as many methods of catching and observing the flies as was feasible, and included cytotaxonomic determinations of adults and larvae reared from eggs obtained from biting adults. Other reinvading flies were fed on onchocercal carriers to determine whether they could transmit O. volvulus. Adults caught in the affected areas were compared with larvae and pupae from suspect source rivers outside the Programme area, by Fluorescent X-ray Spectroscopy to see if they could be traced to specific rivers. Fly

catches were made daily at 8 stations and extra vector collectors and chauffeurs were specially recruited for this purpose.

5. The results of the studies undertaken between April and October can be summarized as follows:

(i) The increase of biting flies recurred in April and continued through September not only along the River Bandama and at Pont Léraba, but also to a much lesser extent at points in the Black Volta river basin. No local breeding could be found that could account for the adult populations.

(ii) Daily catches at strategic points revealed that flies were only to be caught close to the river banks, and appeared in successive waves with peaks which were synchronous at well separated points (e.g. Pont Léraba and Niaka), suggesting the influence of meteorological factors. Over 97% of females were parous, of which 5 to 15% carried infective larvae similar to O. volvulus. Comparatively few flies had developing stages of O. volvulus. Since some of the arrival zones were uninhabited this suggested that the infections were obtained some distance away and at least 7 days prior to capture.

(iii) Flies from Pont Léraba developed infective O. volvulus larvae after feeding on an infected capturer. Eggs were obtained from other engorged flies and the larvae eventually reared from them were identified as belonging to the savanna cytospecies S. damnosum s.s. and S. sirbanum. Later in the season the techniques of adult identification had progressed sufficiently for captured adults to be identified directly. These confirmed that the great majority were of the two savanna cytospecies named above with the occasional occurrence of a few S. soubrense.

(iv) The fluorescent X-ray spectroscopy studies indicated that, in general, there was a reasonable correlation between the "fingerprints" of larvae and adults from the same source area. Applied to flies caught in the reinvasion area it indicated that those caught at Pont Léraba along the Bandama river were similar, suggesting a common origin. They appeared to originate from areas to the south-west of Phase I in April and May with a shift to the west and north-west in June. This last area included the untreated rivers of Phase III W of the OCP area.

(v) Once it became evident that reinvasion was occurring, and in the belief that flies might be of forest origin, the Lower-Bandama River was experimentally treated with insecticide from Lake Kossou to Tiassale.

Between 4 June and 7 July 1976 six treatment cycles were carried out, and had the effect of reducing the biting density at Tiassale from about 1000 per day to less than 10 per day. There was no equivalent effect on the biting densities along the Bandama or at Pont Léraba (Fig.) although slight reductions were observed on some of the Bandama/Bou stations such as Marabadiassa.

6. The lower Bandama treatments began before results of the cytotaxonomic studies were available, and confirmed that the reinvading flies were generally not of forest origin.

7. From these results it was concluded that:

(i) the biting S. damnosum were not of local origin and with few exceptions consisted of savanna cytospecies;

(ii) they were parous, therefore had taken a blood-meal prior to their arrival, and were importing and transmitting O. volvulus;

(iii) they must have originated from breeding sites of savanna species and therefore may have come from either the south-west, west or north of Phase I;

(iv) the exact origin of the flies was not known.

8. As 1977 was the first year in which Phase III W, part of the suspect source area for reinvasion, was routinely treated, studies on the reinvasion problem were extended to include this area. Sixteen daily catching stations were set up and manned with additional vector collectors. Studies on female flies caught in source and invaded areas included cytotaxonomic determination, dissection to determine age, infection rates and morphological characteristics. Specimens were also collected for XFS "fingerprinting". Collecting methods were extended to include Bellec plate traps sited at Pont Léraba to catch arriving adults, and Johnson suction traps located at Korhogo, Banfora, Sikasso and Bougouni to monitor air-borne insects. Figure . compares the techniques used in 1975-1977.

9. Potential source areas on the Marahoue and Upper Sassandra river systems were prospected by helicopter. Once it became obvious that the routine treatments of Phase III W did not prevent the reinvasion of the Bandama and Léraba rivers, the Upper Marahoue (22 June to 10 August) and Upper Sassandra systems (5 July to 10 August) were experimentally treated with insecticide.

10. The results of the 1977 studies showed that:

(i) The reinvasion of the Bandama and Léraba rivers occurred as usual despite the routine treatments of the Phase III W rivers.

(ii) The 1976 observations on the cytotaxonomic status and physiological conditions of the invading flies were confirmed.

(iii) Fly collections on Bellec plates at Pont Léraba showed peaks one or two days before those on vector collectors and most flies were gravid. There was an increase in humidity on the day the plates caught their first S. damnosum.

(iv) At the beginning of the rainy season savanna cytospecies were breeding on the Marahoue and Upper Sassandra systems.

(v) Flies caught biting on the Léraba, Bandama and Bou rivers tended to have longer wings than those biting at the Jagoé, Baoule and Ouassoulou rivers, suggesting different origins.

(vi) Following the second cycle of experimental treatments on the Marahoué an immediate drop in fly densities was observed at Pont Léraba and along the Bandama (Fig.). It could not be decided whether the extension to the Upper Sassandra river system materially reduced densities any further although local fly densities (e.g. at Massadougou) were dramatically reduced.

11. After consideration of the results of three years' studies, the Scientific and Technical Advisory Committee, at its sixth meeting in November 1977, endorsed the following conclusions:

(i) The Programme area is invaded by S. damnosum s.l. females from outside sources and this phenomenon can be expected to occur each year. The reinvading populations were composed of savanna cytospecies. The south-west to north-east direction of the reinvasion corresponds to the direction of the prevailing winds, confirming that migration is wind-assisted. Large numbers of females travel 200-250 kms, smaller numbers may travel up to 300 or 400 kms from source areas. The large majority arrive after a blood meal and oviposit within the OCP area before taking a further blood meal. A high

proportion of parous biting flies is therefore indicative of ongoing reinvasion. The studies indicated that the invading flies can carry O. volvulus from the source area. The experimental treatment of the Marahoué significantly reduced the fly population in the invaded areas. It is not yet known whether forest cytospecies have the same pattern of migration.

(ii) Any area situated 250 kms downwind from major breeding sites is open to reinvasion by, possibly, infective flies. Therefore, successful local vector control may not necessarily result in an entirely satisfactory epidemiological situation.

Strategy for 1978:

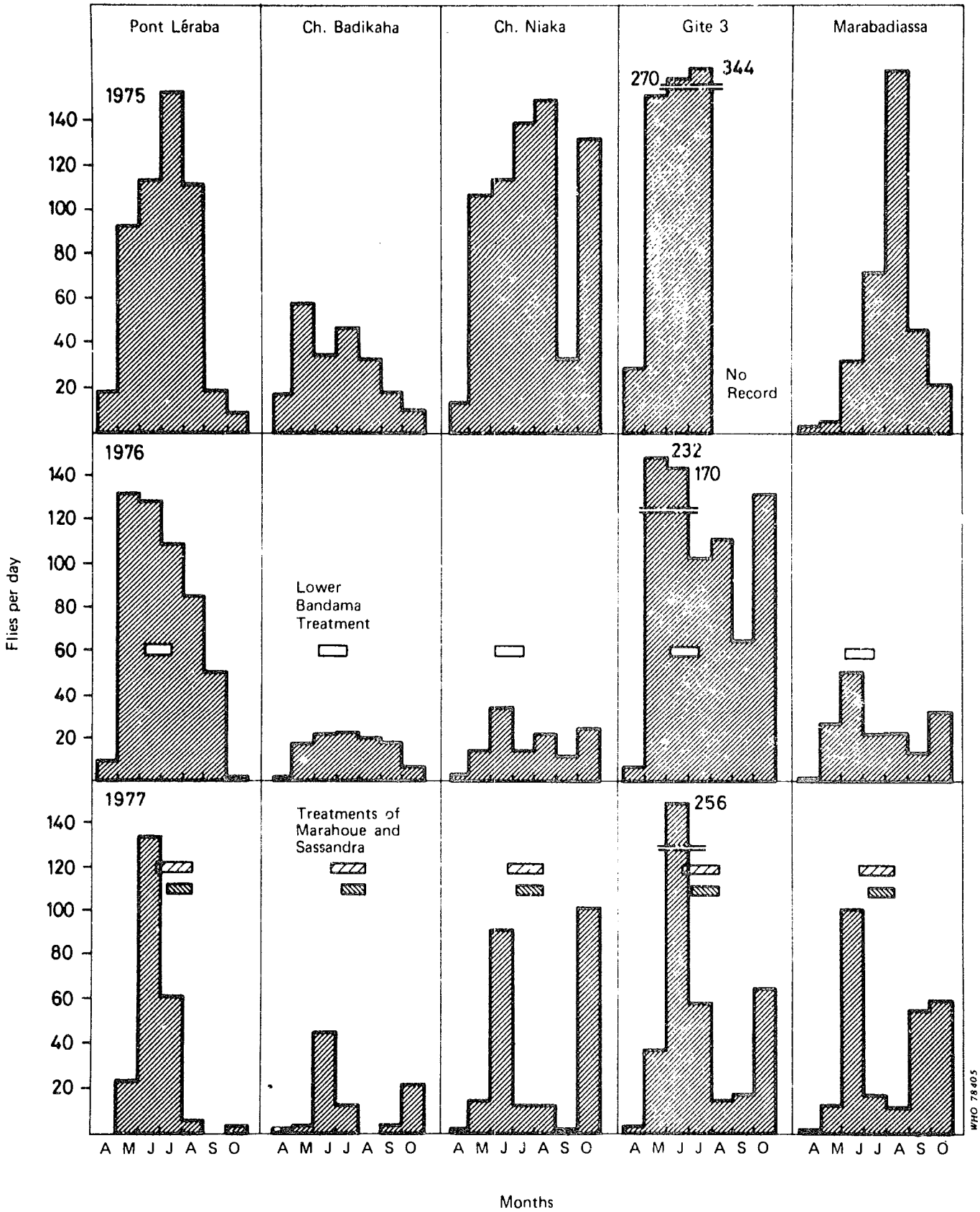
With the beginning of the Ivory Coast extension activities a new sub-sector was opened at Seguela in early March 1978. This became the centre of the reinvasion studies for 1978. Fourteen every-day catching stations were set up in both source and arrival areas.

Following the results of the experimental insecticide application of 1977 it was decided to treat the River Marahoue as soon as it began flowing, and to observe the effect on the Bandama and Leraba catches. After a reasonable interval, the River Sassandra would be treated to see if further reductions might follow.

Observations to date show that flies began to arrive at Pont Leraba and along the River Bandama before the Marahoue started to flow. Treatments began on 25 April when flow began and have resulted in lower fly densities in the reinvasion zone than in previous years. It is at present too early to comment on the effect of the Sassandra treatments which commenced on 7 June 1978.

7.9.78

MEAN DAILY CATCHES OF S. DAMNOSUM AT STRATEGIC REINVADED SITES



ACTIVITIES UNDERTAKEN IN THE REINVASION STUDIES

Year	1	1975	1976	1977
Normal Catches	2	+	+	+
Daily catches: Inside OCP Area	3	-	+	+
Daily catches: Outside OCP Area	4	-	-	+
Larval species Determination	5	+	+	+
Female species Determination	6	-	+	+
Check on possibility of local transmission	7	-	+	+
Site survey inside treated area	8	+	+	+
Survey outside treated area	9	+	+	+
Treatment - Phase III West	10	-	-	+
Treatment of potential sources outside area	11	-	Bandama down-stream	Sassandra up-stream
Aircraft trapping and meteorological studies (Rainey)	12	-	+	+
Fluorescent X-ray Spectroscopy (Bennett)	13	-	+	+
Suction traps (Johnson)	14	-	-	+
Plate traps (Bellec)	15	+	+	+
Synoptic weather studies	16	+	+	+
Local meteorological data Leraba	17	+	+	+

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September 22, 1978

9/25

What Proj. is this?
Onchocerciasis (698-0399)

Mr. E. Dennis Conroy
Director
Office of Regional Affairs
Bureau for Africa
Room 3327 A
USAID
Washington, D.C. 20523

Dear Dennis,

Further to our conversation, I am enclosing two copies of the draft OCP evaluation report and the report of the STAC meeting in Brazzaville.

I would hope that we could discuss these papers in a preliminary way in the first week of October.

With kind regards.

Sincerely,

Stephen Denning

Enclosures

DRAFT
SDenning/sn
April 12, 1978

PRELIMINARY COMMENTS ON DRAFT OCP EVALUATION REPORT
DATED 3.31.1978

CHAPTER I

Paras 1-2: Repeat of the story of the deserted fertile valleys; a more sophisticated formulation of the economic argument is required.

Para 3: Worse, but how much worse?

Para 17: Did the Steering Committee establish EDAP?

Chapter I: Some discussion of phasing might be appropriate i.e. first phase was six years and total program was seen as 20 years (based on certain assumptions about life of parasite, reinvasion, etc.)

CHAPTER II

Para 14: What does the last sentence mean?

Para 15: 60% of population: which population is this? How many people? How does this compare to para 3 of Chapter I?

Para 16: Is there direct evidence that oncho is the primary cause of blindness? This leads on to a more general point about the structure of Chapter II. Normally an appraisal report (for example) starts by a review of the country, then the sector, then the particular project under review. By proceeding in this way from the general to the particular, one gets a feel as to how the project fits into the environment. Chapter II of the draft report however proceeds in another way by examining the particular disease (II.1), the vector (II.2), epidemology (II.3) and only in section II.4 does the report turn to the overall health sector. Even then, one does not get a very clear idea as to the overall disease pattern in the countries or as to the significance of onchocerciasis relative to other diseases. It then digresses on a

primary health care system and returns to onchocerciasis with chemotherapy (II.5 and II.6). It might be more logical to deal with the general health situation (including, possibly, existing government policies and budgets and future strategies such as primary health care) and then turn to riverblindness (including its significance relative to other diseases). The object of this chapter should be to show that onchocerciasis is an important disease (relative to other diseases) and that it deserves the kind of expenditure being proposed (both in absolute terms and relative to expenditure on other diseases). I realize that the answers to these questions are not easy but we should not forget that several donors were raising these questions last year, including the Germans and Canadians. The alternative approach, adopted in the PAG Report, of zero-ing in on onchercias and dazzling the reader with clinical and entomological details of our chosen disease is a risky one, since it begs the main question: why are we focussing so much on this disease? One answer is that onchocerciasis is an important disease, even if not the most important, and that it happens to be one we can do something about, quickly cleanly and neatly. For the other diseases, technology has provided no simple answer. For the other diseases, improvement in health will be a long slow process of institutional and behavioural change.

Para 21: There is a not an adequate "lead-in" to the "fundamental differences" between forest and savanna fly. What are these?

Words like "caryogenetic" may be clear enough to the specialist, but they do not appear in my Webster's Dictionary. Perhaps a glossary would be helpful?

Para 23: What exactly are the differences in transmission potential?

Para 29: I thought the last STAC had concluded that occasional 400 km. flights were possible. (500 km in Chapter IV, para 12.)

Para 36: There is no "lead-in" to the "Programme objectives". This para might be eliminated or expanded.

Para 63: The statement about the correlation between presence of oncho and the absence of settlements is not entirely correct, since where there are no settlements there is by definition no oncho. In any event, a correlation does not prove causality.

What then is the evidence that "oncho is one of the main causes for the underpopulation"? What are the other causes? We should be careful here.

Para 64: Again we should be careful about generalizations of the sort contained in the first sentence, which have limited applicability since not all the deserted land is good nor is all the other land poor and exhausted. Is there clear evidence to show that as population decreases, biting rates increase? It sounds superficially plausible, but what is the evidence? An alternative hypothesis is that the fly population may decrease as human population decreases in an area.

Para 65: Is there evidence that oncho encourages coastal migration? Comparisons, e.g. with national averages in Ghana, do not prove this since they are weighted by the coastal population.

Para 66: What is this paragraph trying to say? Under-population is synonomous with maldistribution so that the first clause is tantologous. Maldistribution is a handicap, but this is not saying too much. Why should maldistribution be a bigger problem when population is increasing? Maldistribution in any event is not a problem everywhere in the OCP area.

Para 67: What is the evidence for the first sentence? A more cautious formulation may be preferable. I cannot understand the second sentence.

Para 68: This is the first discussion of the general health situation? But instead of a general review of the overall situation it switches to trypanosomiasis, then schistosomiasis, then a whole list of other diseases, without any attempt to evaluate the importance of any of them. What would be desirable would be indications of death rates, life expectancy rates for different age groups, and the distribution, by cause, of mortality and morbidity. While all details may not be known, the broad pattern should be available in WHO.

Para 72: Second sentence should be deleted or expanded.
If the report is to deal with health delivery systems, it should explain what exists in each country. What are the programs, levels of expenditure, numbers and types of employees, etc?
The Bank has supported the health component approach. But are we on solid ground when we propose this as the universal solution?

Para 73: It is true that irrigation projects pose particular problems. But this paragraph is not too helpful in suggesting "paying more attention".

Para 74: How much will this cost? Will it work, given considerable evidence that provision of sanitation, safe water, etc. only affects health if it is accompanied by behavioural changes which are very slow in coming?

Paras 75-82: The conditions in the countries vary enormously e.g. compare Ivory Coast with Benin. Are we on solid ground when we propose uniform solution for all countries. Surely the priorities for each country will differ and the pace, scale size and nature of the plans to improve health

services will vary a good deal. I am concerned that these paras imply instant health care for everyone, when we all know that this is not feasible. We should be careful to establish realistic expectations. Thus the training and managerial requirements of the kind of pyramidal structure proposed are staggering, even if the money for it could be found.

Para 87: This section seems to move too quickly into the details of particular drugs without giving an overall perspective on what is known about drugs generally.

Paras 87-92: On the drugs, a less descriptive and more analytical treatment would be helpful. What is the overall significance of the work? Para 98 starts to deal with this, and much of the earlier material in paras 87-97 could be condensed or put in an annex, or subsumed under the general framework of para 98 ff.

Para 99 (iv): Is this cost estimate of $400 million firm?

Para 99 (v): Is the idea of a guaranteed market a plausible alternative to research grants?

Para 101: What is the basis of this "real hope" of supplementary vector control? Why is there no hope of replacing it? What are "present day filaricides"?

Para 103: Why would one have to use national health programs?

Para 107 (ii): Para 102 said that whatever results will be got will be achieved in five years. So why worry about the fate of Tamale after five years? Para 86 said that results elsewhere in Africa cannot be applied unchanged in the area. How does this square with the proposal for a research station in Sudan? How will it help the Volta Valleys problem, if further testing is then required?

How would setting up a research station in Sudan stimulate vector control there?

Para 111: This is very tentatively worded and not calculated to convince the reader that the $2 million is a carefully prepared proposal.

Page 43: Where is the justification for the $8.5 million? How would it be spent? What is the relation to TDR financing?

The Bank's tentative position is that TDR should finance basic research while the OCP should cover applied research relevant to the Volta Valleys.

Overall on research, there are some interesting ideas here, but they could be presented more coherently and convincingly.

CHAPTER III

Para 3: Will all these dams be built in the relevant time frame? Dams, especially irrigation, also create new and different health hazards.

Para 5: This leaves one up in the air. What is being done about this?

Para 14: Is 7 days still fixed as the only period?

The last sub-paragraph is fairly critical to the costs of the program and deserves considerable expansion. One might start from the objectives of the program and reach this subparagraph as a conclusion.

Para 18: Make clear that the first sentence only applies to land-transport teams.

How does $2000 a week compare with OCP costs for a similar area? A quick calculation seems to imply that it is quite cheap

Thus 25,000 km2 = $100,000 p.a.

Therefore 700,000 km2 = $2.8 million p.a.

Perhaps the real argument is effectiveness, not cost.

Para 26: The total number of litres is less interesting than indices showing for instance litres per year, litres per treatment, litres per kilometer. The object would be to show that the OCP was becoming more efficient.

Paras 28 and 32: Same comment. How many flying hours per treatment, per year?

Para 30-31: What evidence is there these modifications improved effectiveness?

Para 33: Can you work out cost per liter, cost per drop, etc. to demonstrate the saving?

Para 35: What evidence is there that OCP is operating this large scale logistical exercise efficiently? Is it improving efficiency? What losses are there?

Para 36: I doubt whether this is appropriate in the report. It tends to imply that Viking will leave. It is of little interest to anyone except WHO.

Para 41: Is this material needed in the main text?

Para 43: This sounds like special pleading for WHO to take over rather than an objective discussion of costs and benefits of different alternatives. It also sounds like implicit criticism of Viking. Perhaps there should be an explicit evaluation of the experience to date, spelling out the problems and discussing alternative ways of dealing with them. For instance, can changeover problems be dealt with by longer term contracts? Can personnel continuity problems be dealt with by agreement with ~~by agreement~~ with the contractor? If not, would WHO be any more successful in this area? If a larger helicopter is desirable, why not include this in the contract specifications? Is WHO equipped to manage aircraft and aircraft personnel?

Para 47: Is the study to examine the possibility of WHO to operate the contract? (It does not say so in this paragraph). What other alternatives would be examined? Who would carry out the study?

Para 49: What are the costs of the entomological evaluation and how are they developing over time? Thus, what are the costs per year or per season or per month in prospection for breeding sites? How do these compare

in say 1976, 1978 with 1980 and 1985? The main issue is: how efficient is this operation. A sentence like "However only a tiny fraction of the potential breeding sites subjected to larvicidal treatment can be visited each week" conveys the impression of a group of entomologists visiting as many sites as possible, rather than as many sites as warranted by the objectives of the Program. In particular, have we learnt anything over the past four years that would enable us to reduce costs?

Para 51: Why do we need 400 catching points? Why not 300? Or 200? How about visiting once a fortnight? Should not the objective be to ensure that effective control is being maintained rather than in Phase I to find out whether control is being established? Would not this imply a lower level of activity?

Para 54: I did not follow the sentence about "the second or third passage of the Epidemiological Evaluation Teams".

Para 61: Discussion of reinvasion should start off with a general discussion of the phenomenon (including what was thought about it when the Programme was originally approved) before launching into the details of what happened in 1975 and so on. As I understand, reinvasion was always expected but the flight range was thought to be much less and the reinvading flies were expected to be "clean".

Para 71: What is the level of infected reinvading flies? How significant is this? Para (ii) is a bit vague on this: "may not necessarily result in an entirely satisfactory epidemiological situation". This may be what STAC said. But what is the practical significance of it for the donors? In particular, what implications does it have for the 20 year assumption? What is known about "major breeding sites" outside the area? What further studies are planned to know more about

this phenomenon? Some evaluation of the phenomenon is needed.

Para 72: This section is descriptive rather than analytical. Again, what is the practical significance of this work? What specifically is proposed in future?

Para 87: The objective is perhaps to determine the effectiveness of the vector control program not to undertake the (possibly academic) exercise confirming "the absence of transmission". How much has evaluation cost? How cost effective is it? Could it be reduced? Do we need 320 villages and 80,000 people in order to confirm the effectiveness of the Programme? One gets the impression of evaluation expanding to fill the time available of the evaluation staff -- which I am sure is not true. Can it be redrafted to show a more efficiency-conscious attitude?

Para 111: Did they have any reinvasion problems in Kenya?

Para 119: What might we expect in future? Do we have any clear objectives over time?

CHAPTER IV

Paras 5-22: This is an interesting account of the work that has been done. But what does it add up to in terms of practical results. How much did each project cost?

Para 23: How much money on each category?

Para 25: What are the practical implications of this? i.e. What efforts?

CHAPTER VI

Para 2: This is where indices would be useful to separate changes in scale of operation from changes due to inflation and to indicate efficiencies.

Para 4: Has the report discussed the reorganization earlier? What is it expected to achieve?

Paras 6-11: These paragraphs are thin on substance. I presume it will be backed up by a detailed annex. In its present form it is not reassuring. One would really like to see the relationship between numbers of treatments, flying hours, cost per hour, and inflation over time. Is it not the case that treatment has been suspended for extended periods in some areas already? How far will this be possible in the future? The report gives the impression of unthinkingly continuing what the PAG Report proposed, when I know this is not the case. The main questions in the donors' minds will be: why is this Programme costing so much? Can't costs be reduced now that control has been established? What efforts are being made to cut costs? The report should try to deal with these concerns.

Paras 18-29: Again, distressingly little evidence of cost consciousness here.

Paras 30-34: I suggest when we discuss when the Berg mission has formulated its findings.

Chapter VI: One general comment:

What will the objectives of the OCP be in terms of ATP and ABR for the next phase? I think it critical to have some measurable objectives.

CHAPTER VII

Para 13: It is difficult to discuss the future management structures when the report has given so little attention to the long term future of the control program. Is the 20 year assumption still valid? What will be the level of control needed (a) in the third phase and (b) after 20 years? What are the implications of reinvasion and of declining levels of the disease.

Paras 15-18: If these paragraphs are meant to imply that the solution to vector control is to resettle the valleys, I am afraid the argument is utopian. On the most wildly optimistic assumptions about resettlement, both spontaneous and organized, I suspect the change in population density in the OCP areas is not going to change sufficiently to affect transmission. In a number of the participating countries, there is no overpopulation and no economic justification for massive migration to the onchO areas (e.g. Ivory Coast). Even in countries where there is some need for resettlement, such as Upper Volta, there are other constraints to resettling the valleys such as heavy or poor soils, flooding, lack of drinking water, sleeping sickness and so on. As a result, I suspect it is unrealistic to think that resettlement is going to take place on a massive scale any time soon.

Para 18: What specifically do these circles mean in terms of rates of resettlement for specific countries and valleys?

Para 19: If the preceding comments are correct, resettlement will not solve the problem. Para 19 implicitly concludes that we should stop the vector control campaign. Do we really mean this?

Para 20: If para 20 is implying that the participating countries may not be adequately committed to resettlement it is unfair. There are very real questions as to the extent to which resettlement is justified. Even if there were not, there are very real practical difficulties in settlement programs which go far beyond government commitment.

Para 21: Such a committee could only make sense if it had the technical data on the implications of different alternatives -- certainly a great deal more than is in the draft report.

It may be premature and counterproductive to spell out the options in this amount of detail at this stage.

OTHER GENERAL COMMENTS

The report might benefit from:

(a) a more explicit evaluation of the risks of the Programme e.g. resistance, absence of funding say after another six years, etc.

(b) a fuller treatment of benefits and beneficiaries. One point to stress is that this is one program that helps the poorest of the poor. The number of people benefited over the 20 year period could also help.