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The Chief of the Malaria Section has the honour to communicate hereunder the following note

COMBINED MALARIA AND BILHARZIASIS CONTROL IN SOUTHERN RHODESIA

by

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Introduction

In areas where malaria is only a seasonal problem and where for months of the year, for climatic reasons, vector anophelines disappear and malaria transmission ceases, it has always been difficult to arrange for the suitable employment of technicians, labour and equipment during the malaria off-season. In highly organized urban areas it was possible to arrange that staff and equipment no longer required for anti-malaria oiling, etc., could be employed in the off-season in the construction and maintenance of permanent anti-malaria works, drainage, marsh clearance, borrow pit filling and the like. In rural areas, and particularly in Africa, it has always been a problem to know how to make effective use of men and equipment when the control of malaria ceased. In many instances, labour forces were paid off and dispersed, equipment put to other uses, causing serious difficulties in the need to reassemble, often in the face of serious objections, transport and equipment, and the need to recruit de novo a new labour force which had to be trained before it was of value.

In Southern Rhodesia, before the 1939-45 war when it was decided that an organized effort should be made to deal with rural malaria, consideration had to be given to the best means of employing the resources during the dry, cold winter months in Southern Rhodesia when no malaria transmission is taking place.

In Southern Rhodesia at the relevant time, 1938-39, there was no doubt that bilharziasis and malaria were the two chief disease problems and for this reason a malaria and bilharziasis research organization was set up to study how best such a programme could be implemented.

The 1939-45 war quickly followed and practically no work was done until 1945 other than some studies on the distribution of the molluscan vectors of bilharziasis in the Colony.

The work done during the war in the development of the chlorinated hydrocarbon residual insecticides quite altered the outlook and prospects for rural malaria control and the plans were altered to make use of this new development. Some small-scale experiments with various formulations of DDT showed that it was possible to give adequate protection by residual insecticide spraying to small isolated communities in malarious areas. Starting in October 1949 an experimental area comprising the Mazoe Valley was protected against malaria by residual spraying applied in the months October to March inclusive to cover the malaria transmission period. The teams carrying out this work turned their energies from April to September inclusive to an effort to exercise some control of bilharziasis by the application of copper sulfate as a molluscicide to all rivers, streams and dams. April to September is the ideal time of the year to undertake such a task because the rivers are no longer flushed with heavy storms; the volume of water flowing is greatly diminished and the country drying up makes access of the spraying teams to river banks easier. The Mazoe Valley experiment covered an area of 1,900 square miles and a population of 2,600 Europeans and 117,000 Africans. It represented a fair cross-section of Southern Rhodesian rural environment and population. The whole cost of this two year experiment amounting to £45,000 was met by the State Lottery Trustees.

During the winter months April to September inclusive, the control teams devoted their attention to the application of copper sulfate to surface waters. In the first winter (1950), all rivers and streams in the upper part of the catchment were treated and in the following year, the lower reaches of the Mazoe River west of Shamva, the lower tributaries and a re-treatment of places in the upper catchment where vector snails were still to be found. It must be admitted that, although a very great reduction of snails was achieved, reinfestation soon occurred. There is no doubt that at this experimental stage the judging of the amount of copper sulfate to be applied to natural streams with irregular beds, a great variety of depths, reed banks and other vegetation was very difficult indeed. A system of checking of snail population three days after treatment showed that the most efficient and economical application was when snails of Physopsis and Planorbis spp. were killed but larger specimens of Lymnaea natalensis were not affected. Despite the greatest care, public relations with the fresh water fisherman were not improved when in some cases numbers of fish were destroyed. It might be fairer to say that the fish were temporarily disabled by the copper sulfate and tended to lie near the surface where they were an easy prey to Africans anxious to collect the fish for food.

The hope that it would be possible to time malaria and bilharziasis control over the same area in the same year was frustrated and it was obvious that in well-watered country malaria control could cope with a much larger area (at about 50 - 60 persons per square mile) than could be hoped for with bilharziasis control. It was decided at the end of the two years' experimental period that instead of trying to treat all surface water in a given area, more practical results would be achieved by treating specific areas and sites.

The sites selected were - (a) few hundred yards up and down stream from road bridge and foot path crossings; (b) stretches of stream near to villages, and (c) places where domestic water supplies were drawn. This policy was put into effect during 1952 and continued in the winter of 1953.

When the Mazoe Valley Scheme ceased, the Southern Rhodesia Government accepted the value of the measures, particularly in regard to malaria control and the units were re-organized as a Government service within the Department of Health. Malaria control was now confined to native reserves in Northern Mashonaland, 13 in number, an area of 2,940 square miles with an estimated population of 203,000.

The details of the work carried out in this period have been discussed by Alves (1951) and Alves & Blair (1953).

During the malaria season 1953-54, the operations of the units were extended to additional native reserves and in 1954-55 a further increase of the area treated was possible particularly in the south-eastern areas of the Colony bounding on the Sabi Valley.

During this work a further important advance in technique was made. In the first spraying in the Mazoe Valley, DDT wettable powder was used but in view of the reports of Muirhead Thompson's work it was decided to switch to BHC wettable powder which was used on the second spraying in the 1949-50 season and exclusively thereafter. During the 1952-53 season it was impossible, on account of very heavy rains and a disruption of communications, to give certain remote parts of native reserves their second treatment for the season. Despite this no outbreak of malaria occurred although the disease was occurring in large areas of similar reserves which were not being sprayed. The expense of transporting units to cover the same population twice in one season, firstly in October to December and again approximately three months after the first treatment, in January to March, accounts for a big proportion of the total cost of the operations. It was finally decided to apply a very heavy dose of BHC to all places, generally those in lower lying and more inaccessible areas, in October to December. Then, instead of re-visiting the same areas from January to March, the units were free to treat other areas with a lesser dose of BHC in more accessible areas at a higher altitude where malaria transmission is not effective until the autumn. The development of this technique and the change in tactics is illustrated in Table I. It will be noted that the costs per head directly protected have come down most satisfactorily. It must be made clear here that much of this lowering in cost has been due to a fall in the price of BHC wettable powder.

The proposal for the current malaria year, 1955-56, is to devote the energies and resources of the ten control teams now available to creating a barrier ring of native reserves protecting the interior plateau area where the bulk of the population lives, and which is the area of the greatest economic importance. In order to undertake this work, certain native reserves within the "barrier" will no longer be sprayed by the Government residual control teams but left to undertake any residual spraying they care to do by their own efforts with the technical advice and supervision of officers of the Health Department.

The "barrier" sparying will be done on the same plan, a double strength application (70-80 mg gamma isomer BHC per sq. foot) to the more remote and low-lying areas in October to December and a normal application (30-40 mg gamma isomer BHC per sq. foot) to other areas in the "barrier" January to March. This proposal is more fully discussed by Alves & Blair (1955).

During the winter months of 1954, bilharziasis control has again concentrated on one area (the southern portion of the Mtoko Reserve) in an effort to settle whether it was possible completely to eradicate snails by re-treating all rivers and streams on a second occasion 4-6 weeks after the first treatment in an effort to destroy young snails which might have hatched out from eggs unharmed by the first application of copper sulfate. In all, an area of 500 sq. miles and an estimated 400 miles of rivers and streams were treated. The results of this work were not very encouraging considering the labour, energy and molluscicide expended. In the latter half of the 1954 winter season, some of the control units were withdrawn from Mtoko Reserve and employed on Lake McIlwaine. This is an artificial lake, 40 sq. miles in extent with a shore-line of 42 miles which has been created on the Hunyani River 17 miles south of Salisbury. The dam filled in the first wet season after its construction and so it was not possible to clear trees and other obstructions from the lake bed and shore line. Despite the fact that this particular stretch of the Hunyani River was not heavily infested by vector molluscs, the lake when established with fairly dense marginal vegetation soon had an enormous population of snails. The shore line most accessible to the public was treated first and some preliminary work with sodium pentachlorphenate was started. During the 1955 winter all teams were concentrated on the lake and enormous numbers of snails were killed not only by spray teams using stirrup pumps operating from the shore, but by teams in boats powered by outboard motors.

To compare the experience of malaria control with bilharziasis control, malaria control has proceeded very satisfactorily and with the experience gained the operations become more and more economic especially with the fall in price of BHC wettable powder. Bilharziasis control is still in an unsettled state, there is not any great confidence in the efficiency of copper sulfate as a molluscacide and the tendency has been for the price to rise rather than fall. The prices per ton (2,000 lbs) have ranged as follows:

1949	£44.0.0
1950	£64.0.0
1951	£76.10.0
1952	£85.10.0
1953	£74.0.0
1954	£106.0.0
1955	£88.9.0

In view of the various types of experimental approach which have been attempted in the application of copper sulfate, it has not been possible to work out the cost of bilharziasis control on a per capita of population protected basis. The quantities of copper sulfate used have been as follows, the amount shown as "by other agencies" being application by Government Health Inspectors, farmers' associations and local authorities, the copper sulfate being provided free of charge by the Government:

Year	Copper sulfate used - short tons		
	By control units	By other agencies	Total
1948	-	5.00	5.00
1949	-	5.50	5.50
1950	25.25	3.25	28.50
1951	9.75	6.85	16.60
1952	22.52	3.66	26.18
1953	26.25	6.25	32.50
1954	27.00	7.25	34.25
1955 (to September)	42.22	1.55	43.77

During 1954 and 1955 experimental work with sodium pentachlorphenate was pursued and about 2,000 lbs expended. This molluscacide promises to compete with copper sulfate in price, shows promise of some residual action and, of course, is lethal to snail eggs and thus is more likely to secure a better final kill than copper sulfate.

Organization of control units

(a) The Supervisors

Each unit is self-contained and in the charge of a European supervisor. The supervisors are young Europeans who like the open air life; they spend about 11 months of the year in the rural areas. Each is provided with a two-wheel caravan for accommodation and this is towed by the 30-cwt truck provided from one field headquarters to the next. It was expected that there might be a big turnover in staff but this has not proved so.

Of the 10 teams approved on budget for 1955-56, one supervisor has completed four years' service, one supervisor has completed three years' service, two supervisors have completed two years' service and one supervisor has completed one year's service.

The new recruits are attached for training to one of the experienced men, learn the techniques and how to handle the spray operators and all the details of the administration of rations, pay, transport and supplies. When they have been trained in such matters, taking generally a month or six weeks, they take over their own spraying teams and operate independently.

(b) The Labourers

The basic labour force of each control unit is 10 African labourers, permitting each unit to operate four stirrup pumps at a time leaving two labourers in reserve for measuring and carrying BHC wettable powder and relieving the men in the teams. This forms the standard unit for malaria and bilharziasis control.

During the malaria season, however, it is the practice to build up the strength of a malaria control unit under an experienced European supervisor to 30 labourers and it is then possible to residual spray from 600 to 1,000 huts or rooms per day with such a reinforced unit. In the large unit the supervisor uses his transport to establish "sub-bases" and moves units of 10 to new areas as soon as they have finished an area, each sub-unit being under the immediate supervision of an experienced African, subject to frequent and usually surprise checks by the European supervisor.

In bilharziasis control working on irregular streams with poor access to the banks a unit of 10 labourers is as much as a supervisor can tackle. The result of this policy is that the labour force tends to be grouped into two, one of which forms the senior cadres and works throughout the year, the other, a more casual type of labourer who works during the malaria control season only.

(c) The Transport

The success or failure of operations in a rural area such as have been described hinges on the state of the communications and the reliability of the transport. In Southern Rhodesia we are fortunate to have a system of roads, "drifts" (causeways) and bridges which make practically all areas approachable except at times of very heavy rain. This system of communications is continually being improved and certainly renders the task of control much easier. The reliability of transport is, in my opinion, even more vital and this factor far above any other has been the greatest cause of anxiety. In fact in the 1953-54 season when an attempt was made to residual spray native reserves to the west of Bulawayo, the number of days of useful work done was seriously reduced by transport breakdown. It has been found that the ideal vehicle for Southern Rhodesian conditions is a 30 cwt truck equipped with a canvas canopy and fitted with a tow-bar. This vehicle is capable of towing a two-wheeled caravan when base camp is being changed and for the daily duties can carry the labourers, stirrup pumps and stocks of BHC wettable powder.

To cover all the operations a three-ton truck is used for the conveyance of stores, chemicals and rations to base camps.

(d) Stirrup Pumps

Since the start of the operations in 1949 the spraying apparatus used has been standardized on the Nesthill Universal Stirrup Pump, Model number 2022, made in Sheffield, England. These cost, fitted with teh feet of rubber hose, about £4 each. The length of hose with which the pumps are normally sold is too short for residual spraying. The pumps are very robust and trouble-free in operation and have stood up to service for over one year on both malaria and bilharziasis control. It has been found that the packing of the pump is easily replaced by good quality string and the leather washers by strips of leather obtained from saddlers' off-cuts. All repairs are done in the field by the teams themselves.

Much play has been made of the advantages of knapsack and pressure sprayers carried on the back, but from our experience we are quite convinced that stirrup pumps are the most economical and efficient means of residual spraying in malaria control and for applying concentrated copper sulfate solutions to rivers. It is admitted that each pump requires two labourers, one to spray and one to pump but because the sprayer can concentrate on the application this is better done than by a knapsack sprayer whose attention is distracted by the need to pump. The sprayer and the pumper can change occupations frequently so reducing occupational fatigue. Another important advantage is that the pumper can keep the BHC wettable powder in suspension much better by a stirring stick in an open bucket than can be done in a closed container knapsack sprayer. Anyone who has tried to enter a traditional African hut with a knapsack sprayer on his back will appreciate the difficulty and awkwardness of the manoeuvre.

The containers used for the chemicals vary. In malaria control operations, any container of three to four gallons capacity is adequate, galvanized iron buckets, empty petrol tins, small oil drums and even the empty 25 lb BHC tins, which, however, have a short life for this work. In bilharziasis control containers are quite a problem as copper sulfate in strong solution rapidly corrodes iron and galvanized containers. Use is now made of plastic buckets which stand up to the chemical perfectly and are reasonably robust in construction. The plastic buckets nest well for transport and the bucket sides stand up well when the container is filled with water.

(e) BHC Wettable Powder

In the first treatment in the Mazoe Valley October to December 1949, DDT wettable powder and DDT in kerosene was used but since then BHC wettable powder has been used in all residual spraying work. Our material has been supplied by Klipfontein Organic Products in the Union of South Africa. Certain consignments have been of a gamma isomer content of 12-1/2 per cent. but the standard concentration now employed is 10 per cent.

The wettable powder is packed for us in 25 lb tins which are easy to handle in the field and are sturdy enough to withstand rough handling in transport.

The standard suspension used is one lb of the powder in 3 to 3-1/2 gallons of water.

3 to 3-1/2 gallons of the suspension of wettable powder will residual spray about two to four African huts or rooms.

The "double-strength" suspension is two lbs of the wettable powder in 3 to 3-1/2 gallons of water and when applied in the standard way results in an application of about 70-80 mg of the gamma isomer of BHC per square foot of surface.

All huts used for human habitation are treated in the programme, this includes treatment of the kitchen hut if the children of the family use it as a sleeping place. In some areas even empty grain stores are sprayed if children sleep in them at night.

(f) Copper Sulfate

All copper sulfate used is of commercial grade and we prefer that it be packed in 50 lb boxes.

The boxes are easily carried from the transport to the river bank. Packs in 56 and 112 lb kegs are more difficult to pack on vehicles and are unpopular as a porterage load.

Costs of malaria control

A breakdown of the costs of items in malaria control may be of interest. The figures given below are for the malaria season 1954-55 and are divided to show the effect of 70-80 mg gamma isomer per square foot during the period October to December 1954.

	Oct.- Dec.	Jan.- Apr.	Season
1. Reserves and other areas treated	16	27	43
2. Number of huts or rooms sprayed	116,556	112,469	229,025
3. Estimated population protected	407,946	395,641	801,587
4. Estimated insecticide in mg of gamma isomer per sq. ft	71	44.6	-
5. Lbs BHC wettable powder applied	84,046	51,407	135,453 (67.7 tons)
6. Total cost per hut or room treated in pence	24.7	19.4	22.4
7. Total cost per head at 3.5 persons per hut	7.1	5.5	6.4
8. Total expenditure in pounds sterling	12,004	9,375	21,379
(a) European salaries	1,258	1,284	2,542
(b) Labourers' wages	1,260	1,305	2,565
(c) Labourers' rations and sundries	800	781	1,581
(d) Transport hire charges including caravàn and special driver charges	2,458	2,779	5,237
(e) Insecticide	6,012	2,936	8,948
(f) Depreciation on equipment, particularly stirrup pumps	216	290	506

The season was rather unusual in that the volume of work done in the period January - April nearly equalled the work done October - December. Usually the heavy rains of the latter part of the wet season interfere seriously with the speed of operations. This is all the more surprising as the first three months of 1955 were exceptionally wet.

The difference between the total expenditure for each period practically represented the increased cost of the insecticide used in October - December when a 70 mg gamma isomer per square foot application was being made.

If the year's operations are taken as a whole, the expenditure falls into three classes - staff 31 per cent.; transport and equipment 27 per cent. and insecticide 42 per cent.

Summary of main points

1. In Southern Rhodesia since 1949 malaria and bilharziasis control is attempted by one organization. Teams of one European supervisor and 10-30 African labourers carry out residual spraying from October to March or April, the period of malaria transmission. The same team with 10 labourers devotes itself to bilharziasis control using copper sulfate as a molluscacide from April to September, the dry winter season when the volume of water to be treated is at its lowest and the snails are most vulnerable.

2. The field work is carried out by a series of units carrying out one task using a single piece of apparatus, a stirrup pump applying either BHC wettable powder in suspension to the interior surfaces of African huts or rooms or copper sulfate to streams and rivers.

3. Malaria control has in practice been strikingly successful and in the 1955-56 season an attempt is being made to protect the majority of the population and the areas of greatest economic and agricultural importance by residual spraying of all habitations in a "barrier" ring of African reserves. By residual spraying the habitations of less than 700,000 Africans living in the barrier zone, it is hoped to be able to give a reasonable protection against malaria to two million of the 2-1/2 million inhabitants of the Colony.

Geographically this is made easier as the whole of the centre of the country is a broad plateau subjected to an annual epidemic invasion of malaria vectors from the Zambesi Valley to the north and west and the Sabi and Limpopo Valleys to the east and south.

4. No other antimalaria measure has been widely used other than residual spraying. Malaria prophylactic drugs are used by some Europeans but only to a very minor degree by the African population.

5. At an all-in cost of about 6-1/2d per head malaria control of a satisfactory level is achieved in populations of a density of about 45 per square mile. This, it is maintained, is a reasonable charge if account is taken of the very large population indirectly protected by living behind the sprayed areas.

6. Bilharziasis control using copper sulfate as a molluscacide has not been successful. Great reductions in vector snail population have been achieved but the numbers have not been depressed enough or for long enough to achieve any great reduction in the rate of infestation in the population. The introduction of sodium pentachlorphenate as a molluscacide, with its effect on snail egg masses and its residual effect in slow-moving streams, offers hope that a more effective break in the schistosome life cycle may be possible.

7. Bilharziasis control has not yet reached a stage when any one method of attack or any one molluscacidal agent can be accepted as standard practice.

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TABLE I

MALARIA CONTROL: SOUTHERN RHODESIA: 1949-56

Year	No. of Units	No. of Res.	Area in Square Miles	Pop. of Areas	Pop. per Sq. Mile	Total Costs in £.	BHC Wettable Powder per Short ton	Prop. of Total Cost %	Cost per Head in pence	Remarks
1949-50	4	Mazoe Valley	1,900	2,600 E 116,746 A	63	12,640	£275.0.0	59.8	25.4	First spraying DDT Second spraying BHC
1950-51	4	Mazoe Valley	1,900	2,600 E 119,664 A	64	10,545	£275.0.0	52.6	20.7	BHC exclusively
1951-52	6	13	2,940	203,125	69	12,695	£231.5.0	38.2	15.0	BHC 2 sprayings North Mashonaland Reserves
1952-53	5	13	2,940	208,203	71	10,670	£187.10.0	38.7	12.3	ditto
1953-54	7	19	6,355	354,879	56	14,934	£170.0.0	44.3	10.1	
1954-55	7	43	11,712	801,587	68	21,379	£132.0.0	41.8	6.4	Double strength spray Oct-Dec. Single strength other areas Jan-Apr.
1955-56	10	45	18,918	667,375	35		£113.10.0			Double strength spray Oct/Nov/Dec. Single strength Jan/Feb/Mar/Apr.