CEER – 13
February 1979

# REPORT ON A CONSULTATION ON BILHARZIA CONTROL IN SWAZILAND

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
UNIVERSITY OF PUERTO RICO — U.S. DEPARTMENT OF ENERGY

# REPORT OF A CONSULTATION ON BILHARZIA CONTROL IN SWAZILAND

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February 1979.

## Acknowledgments

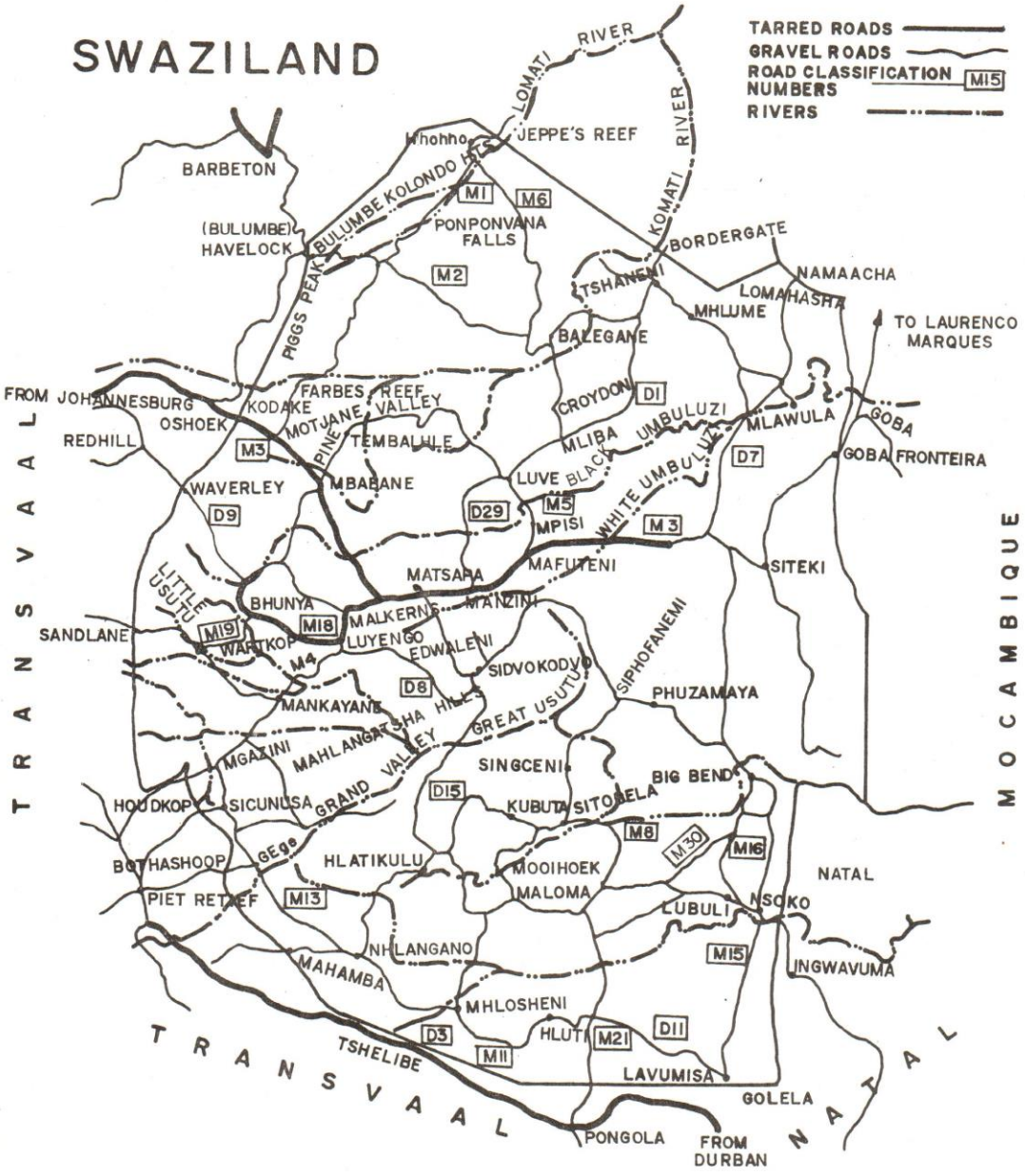
This report was prepared by Dr. Cen R. Jones, Epidemiologist of the World Health Organization, and Dr. William R. Jobin of CEER. The cost of the study was supported by the World Health Organization, the U.S. Agency for International Development and the U.S. Department of Energy under contract No. EY-76-C-05-1833.

## Summary

From a brief survey in February 1976 it was found that bilharzia is wide spread in Swaziland and it is estimated that approximately 150,000 individuals are infected with one or both forms of bilharzia. The more common form of infection is due to S. haematobium. The intermediate snail hosts of both types of bilharzia are found throughout the Middleveld and Lowveld but have only a scanty distribution in the Highveld. The sugar and rice irrigation schemes favour the distribution of these snails.

The conservation dams in the Middleveld appear to be sites of intense bilharzia transmission as are the sugar, rice and citrus irrigation farms.

The present control programme of the Ministry of Health would appear to have reduced the prevalence of bilharzia in the Manzini area and in the sugar estates around Big Bend. The snails control efforts in the conservation dams is not effective.


SWAZILAND
TARRED ROADS
GRAVEL ROADS
ROAD CLASSIFICATION NUMBERS M15
RIVERS
LOMATI RIVER
KOMATI RIVER
Nhohho
JEPPE'S REEF
BARBETON
(BULUMBE) HAVELOCK
BULUMBE
KOLONDO
M1
M6
PONPONVANA FALLS
BORDERGATE
PIGGS PEAK
M2
TSHANENI
NAMAACHA
LOMAHASHA
MHLUME
TO LAURENCO MARQUES
BALEGANE
FROM JOHANNESBURG
KODAKE
FARBES REEF
MOTJANE
VALLEY
PINE
CROYDON
D1
OSHOEK
REDHILL
M3
TEMBALHLE
MLIBA
UMBULUZI
MLAWULA
GOBA
GOBA FRONTEIRA
D7
LUVE
BLACK
WHITE UMBULUZI
WAVERLEY
MBABANE
D9
D29
M5
MPISI
M3
SITEKI
MATSAPA
MAFUTENI
LITTLE USUTU
BHUNYA
MANZINI
SANDLANE
M19
M18
MALKERNS
WARTKOP
LUYENGO
M4
EDWALENI
SIPHOFANEMI
SIDVOKODVO
D8
PHUZAMAYA
MANKAYANE
GREAT USUTU
MAHLANGATSHA HILL
MGAZINI
MAHLANGATSHA VALLEY
SINGCENI
BIG BEND
HOUDKOP
SICUNUSA
GRAND
D15
KUBUTA
SITOBELA
M8
M30
M16
BOTHASHOOP
GEGE
HLATIKULU
MOOIHOEK
NATAL
PIET RETIEF
M13
MALOMA
LUBULI
NSOKO
NHLANGANO
M15
INGWAVUMA
MAHAMBA
MHLOSHENI
D3
HLUTI
M21
D11
TSHELIBE
M11
LAVUMISA
GOLELA
TRANSVAAL
PONGOLA
FROM DURBAN
NATAL
MOCAMBIQUE

## BACKGROUND INFORMATION

### Geophysical features

Swaziland is a land locked country of 17,400 sq. km. situated between Mozambique and the Republic of South Africa. The country is divided into four topographical regions each of which runs from North to South in roughly parallel belts. These are from West to East, the Highveld, Middleveld, Lowveld and the Lubombo Plateau. Their main characteristics are summarized:

| Zone | Mean altitude in metres | Mean annual rainfall in cms. | Estimated population by mid 1976 (in thousands) |
|---|---|---|---|
| Highveld | 1,200 | 130 | 183,2 |
| Middleveld | 700 | 90 | 237,4 |
| Lowveld | 225 | 70 | 110,0 |
| Lubombo plateau | 600 | 80 | 29,3 |
| | | TOTAL | 559,9 |

### Population

The population is estimated to be around 559,900 (mid 1976) and has an annual growth rate of about 3%. Settlement patterns make delivery of both preventive and curative health care difficult as the Swazis do not live in villages but in widely dispersed homesteads. Based on the arbitrary assumption that communities having populations of 1,000 or over can be classified as urban, less than 16% is urban and a quarter of this urban population resides in company operated towns located in freehold lands whilst the remainder is under the control of Town Councils or Central Government.

Water resources

Water resources are substantial, represented mainly by streams an to a lesser extent by springs and marginally by ground water. In the Lowve and Lubombo plateau water resources are mainly confined to the four major rivers which traverse the area. Only streams in the higher elevation appea to be free of bilharzial infestation.

A feature of Swaziland is the large numbers of conservation reservoirs or dams which have been constructed in the main by the Ministry of Agriculture.

## REVIEW OF BILHARZIA IN SWAZILAND

### Prevalence

Bilharzia is a matter of concern to the Government of Swaziland as so much of the country's agricultural development depends on irrigation schemes.

As far back as the early 1950's the medical department collected data on prevalence and the related epidemiological factors concerning the establishment and spread of bilharzia. Prevalence patterns were established by workers such as Batchelor and Gaudie and the latter estimated that a third of the population of Swaziland was infected with S. haematobium and perhaps 5% with S. mansoni. The intermediate snail hosts responsible for transmission of the disease appear to be Bulinus (Physopsis) globsus and Biomphalaria pfeifferi. Species identification of the snails was made at Potchefstroom University.

The highest rate of infections are to be found in the Middleveld and Lowveld near irrigation schemes and conservation dams. In the Highveld

cases are found to have originated from areas of lower altitude.

It was unfortunate that the bulk of the records relating to past surveys could not be located. However the survey data available at the Bilharzia/ Malaria Unit at Manzini was analysed by age and sex and for topographical zones and river basins and is contained in appendix A. Considerable variations in the prevalence rates are to be found amongst school children and it is mi leading to give an overall prevalence rate as the statistics are derived from a sample of just over 20 schools out of a total of more than 400 primary schools throughout the country. If the prevalence figures for the Middleveld and Lowveld are subdivided into those obtained from irrigated areas and those from none irrigated areas, then the country can be considered to comprise six epidemiological zones each with characteristic prevalence rates.

AVERAGE APPROXIMATE PREVALENCE RATES FOR SCHOOL CHILDREN

| Topographical zone | | S. haematobium | S. mansoni |
|---|---|---|---|
| Highveld | | <10% | <1% |
| Middleveld | Irrigated areas | >75% | 50-75% |
| | Non irrigated areas | 25-50% | <10% |
| Lowveld | Irrigated areas | 25-50% | ab 75% |
| | Non irrigated areas | <25% | <25% |
| Lubombo | | ab 25% | ab 5% |

Those prevalence estimates are made from existing data and the figures quoted in Gaudie's publication.

A figure which will feature in future discussions is the infection rate of school entrants i.e. the prevalence amongst the 6-7 year age-group. For urinary bilharzia this figure averages 20% whilst for rectal bilharzia the rate may approximate to 15%.

## The reservoir of infection

If the population of Swaziland is assumed to be 500,000 then using the most approximate prevalence rates, it is estimated that there are about 140,000 people infected with one or both forms of bilharzia. This estimation can be calculated in the following way:

| Age group | % of total population | Number at risk | S. haematobium | | S. mansoni | |
|---|---|---|---|---|---|---|
| | | | Assumed prevalence | Est. no. of individuals infected | Assumed prevalence | Est. no. of individuals infected |
| 5 | 19% | 95,000 | 5% | 4,750 | 3% | 2,850 |
| 5-14 | 27% | 135,000 | 35% | 47,250 | 20% | 27,000 |
| >14 | 54% | 270,000 | 20% | 54,000 | 10% | 27,000 |
| All age groups | 100% | 500,000 | - | 106,000 | - | 56,850 |

If the double infection rate is assumed to be 15%, then approximatel 140,000 individuals in Swaziland can be considered as infected with bilharzia.

## Previous control activities

Concurrently with the survey work already described, several small pilot control projects were established in selected areas of the country. The first large scale attempts at control were started in the second half of 1970. The Manzini scheme financed mainly by the Manzini Town Council, was by focal snail control along water courses where the absence of stepping stones obliged people to wade through the water and also where the streams were used for ablutions. This resulted in an appreciable reduction in the number of the intermediate snail hosts and was followed up by mass treatment with hycanthone, of the infected school children attending the Manzini schools.

This control work was extended to the Lomahasha area and the irrigation systems of Ngonini and Big Bend in 1971. In areas of irrigation the

method of snail control was that of constant head application using drip feeds combined in certain areas with focal control.

In 1974 these efforts at control were expanded and applied to several rural areas throughout the Middleveld and the Lowveld near Nsoko.

## EXISTING PILOT CONTROL PROGRAMME

### Epidemiological methods

The Bilharzia Unit based in Manzini, has mobile teams engaged in snail collection, urine and stool examinations and molluscicide. Single examinations are carried out on both urine and stool specimens obtained from primary school children. Only spot prevalence rates are calculated and no attempts have been made to measure either incidence or intensity of infection. Indeed the present resources of the unit are insufficient to carry out these more sophisticated measurements.

The Ministry of Health in cooperation with the Ministry of Education has this year started a school health programme in which four mobile teams, one for each administrative district, examine all new school entrants. Each team comprises a public health nurse and two volunteers. It is hoped that the teams will be able to cover all the 400 odd primary schools in one year. The physical examination includes a test for urinary bilharzia and it is recommended that in addition, the stool is examined for S. mansoni infection. For the later examination it will be necessary to distribute containers to the pupils the day before the school is visited.

The average age of school entrants is seven years. It is thought that approximately 70% of children start primary school which means that there are some 10,000 new school entrants each year. Such a large sample would

provide invaluable epidemiological data from which a more realistic estimate of the national problem could be made. As the examination of stool specimens is an unpopular and time consuming procedure, a random sample of 5,000 new entrants for S. mansoni infection would be large enough to provide reliable information.

Snail control methods

Out ide the irrigation systems, snail control is a simple programme carried out by a six man crew with one vehicle. Chemicals are applied repeatedly to transmission sites between October and March which cover the bilharzia transmission season. Such a strategy of focal transmission control is widely accepted for use in similar areas in Southern Africa.

In the natural streams and water conservation reservoirs, known locally as small dams, the chemical used is Bayluscide, applied some five times per transmission season at roughly seven week intervals. At the dams the chemical is sprayed in a three metre band along the accessible parts of the shore which harbour snails. The back pack sprayers contain 30 litres of water and 100 to 200 gms. of Bayluscide. Each tankful is emptied along roughly 100 metres of shore line resulting in a concentration at the shore, of about 1 mgm per litre immediately after spraying. This is judged by the light yellow colour in the water within five minutes of application.

In the small streams of natural drainage systems near Manzini and in the rural area, Bayluscide is sprayed with the same techniques as in the dams, the efforts being concentrated at the obvious points of human contact with the snail infested portion of the streams.

In the natural drainage systems the snail control activities began with 29 areas around Manzini and Lomahasha which embraced eight small dams

and 23 small streams. Each area involves one day's work for the five man snail control team. At the beginning of molluscicide applications in 1970, virtually all the 29 areas contained Bulinus (Physopsis) globosus the intermediate snail host of S. haematobium although only two areas contained Biomphalaria pfeifferi the snail host of S. mansoni. By 1975 the snails had been eliminated from two thirds of the areas (Appendix B, Table 1). An analysis of the snail data for typical streams showed that after 2-3 years of repeated molluscicding the snails disappeared (Appendix C, Figure 1) and in those streams where they persisted they were greatly reduced in numbers. However in the small dams the control programme rarely led to any long term decreases in the number of snails (Appendix C, Figure 2). Although the strategy of focal control does not assume that the snails will be eliminated, it is a costly process if the number of snails is not significantly reduced so that chemical application too can be eventually reduced. This is especially true in dams which require large quantities of chemicals.

In 1974 molluscicicding activities in rural non irrigated areas was expanded to six areas and then in 1975 to an additional 14. These 20 areas contained 47 dams and 12 small streams. Again each area is of a size that one snail control team can carry out inspection and apply chemicals in one work day including travel time from Manzini. It is already apparent that there has been no impact on the number of snails in the dams(Appendix B, Table 2) although it is too soon to make a complete evaluation of the work. During field surveys in February 1976 the dams at Mbasheni and at Ngcina contained large numbers of adult Physopsis sp. and Biomphalaria sp. despite more than two years of repeated molluscicicding. In contrast to the streams, the dams often contained Biomphalaria as well as Physopsis. In streams the ratio of Physopsis to Biomphalaria was 10:1 whilst in dams it was 2:1 indicating that perhaps urinary

bilharzia would be more common along side the streams whilst mixed infections would be found in the vicinity of the dams.

An estimate of operational costs was made for the snail control crew at several dams during February 1976. Some four dams were treated per day, applying about 200 gms. of Bayluscide at each dam. The typical dam contains 100,000 cu. metres of water although only about 1,000 cu. metres of snail habitat were actually treated. In each dam spraying was usually limited to about 300 metres of shore line in a three metre wide band with a mean depth of slightly over one metre. These dams were usually surrounded by scattered households averaging around 200 people within a reasonable walking distance in a circular area of roughly 10 sq. kilometres.

At 1976 prices wages for the men were about E 1.50 per day, the chemical costs E 5.00 per 200 gms. and the average trip of around 50 miles at E 0.30 per mile - E 15.00 per day.

| | |
|---|---|
| Labour, 6 x E 1.50 | = E 9.00 |
| Chemicals, 4 dams x 0.5 kgm. x E 10 per kgm. | = E 20.00 |
| Transport, 50 miles x E 0.30 | = E 15.00 |
| Supervision and overhead of 100% | = E 44.00 |
| Total daily cost per crew for four days | = E 88.00 |
| Average cost per dam | = E 22.00 |

For estimating purposes, cost of snail control is often expressed in annual cost per 100 cu metres of snail habitat controlled. Thus the annual cost for five treatments to a dam with 1000 $m^3$ of snail habitat, is E 110.00 or E 12.00/100 cu metres, which is well within the usual range which varies between E 1.00 to E 100 per year in other parts of the world. For assessing

the public health cost of snail control this method costs annually E 110.00 per 200 people or E 0.55 per year for each person protected from transmission, a fairly high cost if this method is to be continued for more than a few years.

In the small stream systems it is less expensive initially in terms of cost per 100 cu metres of snail habitat treated, since the amount of chemical used is roughly half that sprayed on the dams in the same period. The estimated cost for streams, treating about 2000 cu metres of habitat in one day with 0.4 kgm of chemical is:

| | |
|---|---|
| Labour 6 men x E 1.50 | = E 9.00 |
| Chemical 0.4 kgm x E 10.00/kgm | = E 4.00 |
| Transport 50 miles x E 0.30/mile | = E 15.00 |
| Supervision and overheads of 100% | = E 28.00 |
| Total cost per day | = E 56.00 |

or E 5.60 per 100 cu metres of habitat.

Thus the initial per capita cost is also probably lower, at E 0.30 per year. Furthermore the expenses decrease after 2 years to about one half the initial figure and after five years to about one fifth of the initial cost. In comparison with treatment of snails in the dams, the present programme in streams is much less expensive especially in terms of a long range programme.

Snail control in existing irrigation schemes

The strategy of the control of snails in the irrigation schemes near Big Bend and Ngonini which began in late 1970 using Frescon, was system wide transmission control in which all snail habitats were treated every seven weeks during the transmission season. The object was to reduce infected

snails without attempting their elimination. At the present the following irrigation systems have had snail control programmes operating since 1970.

| Irrigation system | Crops | Area in hectares | Population at risk 1976 |
|---|---|---|---|
| Ngonini | Citrus | 600 | 1,000 |
| Tambuti | Citrus | ... | ... |
| Ubombo Ranches )..... Pootzeigt " ) | Sugar | 12,000 | 4,200 |
| Bar J | Sugar | 1,200 | 800 |
| Crooks | Sugar and citrus | 1,200 | 800 |
| Sivunga | Sugar | 2,600 | 1,000 |
| Big Bend Sugar Estate | Sugar | 3,000 | 6,000 |

AREAS WHERE SNAIL CONTROL IS EXPECTED TO START IN 1976

| Irrigation system | Crops | Area in hectares | Population at risk 1976 |
|---|---|---|---|
| S.I.S. Tshaneni | Sugar and rice | 7,650 | 3,300 |
| Mhlume | Sugar | 12,000 | 6,200 |
| Vuvulane | Sugar, cotton, maize, veg. | 4,950 | 3,000 |
| Tambirkulu | Sugar, citrus | 1,600 | 4,800 |
| Mamc | | 800 | 750 |
| River Bank Sugar Estate | Sugar | 600 | 400 |
| Marshall Campbell | Sugar | 500 | 400 |
| Matlock Estate | Sugar | 200 | 200 |

These control measures have been a joint effort of the irrigation estates and the Ministry of Health. This year on the advice of their own consultants, the Commonwealth Development Corporation irrigation group has agreed to take on complete responsibility for control of bilharzia within their system, which includes S.I.S. Tshaneni, Mhlume, Vuvulane and Tambimkulu.

Existing water supply programmes

The provision of adequate safe water to houses has been proven to be as effective as snail control for interruption of bilharzia transmission and the extent of domestic piped water is a major determinant of the level of transmission.

Water supplies are provided through three Government departments whilst the irrigation authorities are responsible for the domestic supplies to their employees.

| | |
|---|---|
| Water and Sewerage Board | - Urban Supplies |
| Ministry of Agriculture | - Rural Development Areas |
| Ministry of Health | - Rural Spring Protection |
| Irrigation farms etc. | - to employees. |

The Water and Sewerage Board provides water to 14 townships and have plans to extend their activities to a 100 rural areas in the next 10 years which will provide safe water to 25,000 people. The Ministry of Health with a budget of around E 30,000 per year hope to protect 45 existing springs each year and this programme continued for the next 10 years will provide a relatively safe source of water to another 22,000 people. If the Ministry of Agriculture were to supply domestic water to the four existing Rural Development Areas approximately 24,000 people would be reached. They have plans for developing two more R.D.A.'s in the next two years which will take in another 20,000 people. In another 10 years the Ministry aim to double that number and if priority is given to domestic water supply then almost 90,000 people in the rural areas would benefit from an adequate water supply. If all the Ministries were to implement their plans then around 126,000 people would receive a domestic water supply in 10 years.

However none of these authorities have finalized their plans and at present at least 300,000 rural inhabitants are without piped water. Thus the present goal for 10 years development if implemented, will mean that only a third of the rural population will have a safe water supply.

The cost of rural water supply systems for bilharzia control varies with the extent of the system but in rural Middleveld communities this will vary from E 10 to E 20.00 per capita for initial construction and perhaps E 2.00 per capita per year for maintenance. These estimates are based on experience with very simple rural supplies to prevent bilharzia in St. Lucia, Eastern Caribbean.

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ACKNOWLEDGEMENTS

The writers wish to express their appreciation for the kind assistance and full cooperation which they received from all the Staff of the Ministry of Health, the Ministries of Agriculture and Education and the officials of the Commonwealth Development Corporation.

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# APPENDICES

| | |
|---|---|
| Appendix A | Tables of prevalence |
| Appendix B | Summary of snail control programme |
| Appendix C | Snail and molluscicide data |

APPENDIX A

LE 1: PREVALENCE OF S. HAEMATOBIUM INFECTION IN CHILDREN 5–14 YEARS BY TOPOGRAPHICAL ZONES AND RIVER BASINS (SWAZILAND)

I MIDDLEVELD

| RIVER BASIN | LOCALITY | DATE | MALES | | | | FEMALES | | | | OVERALL PREVALENCE RATES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5-9 years No. tested | % positive | 10-14 years No. tested | % positive | 5-9 years No. tested | % positive | 10-14 years No. tested | % positive | |
| LOMATI | Ngonini | 1972 | 29 | 58.6 | 22 | 68.0 | 16 | 50.0 | 24 | 66.7 | 59.3 |
| | Ndlalambi | 1973 | 45 | 60.0 | 42 | 54.8 | 40 | 52.5 | 48 | 54.2 | 55.4 |
| | Emvembili | 1973 | 43 | 62.8 | 33 | 78.8 | 42 | 59.5 | 26 | 100.0 | 72.2 |
| | Ngonini | Feb. 1976 | 21 | 42.9 | - | - | 18 | 72.4 | - | - | 56.4 |
| | AVERAGE | | 138 | 58.0 | 97 | 66.0 | 116 | 57.8 | 98 | 69.4 | 62.1 |
| MBULUZI | Luve | 1973 | 49 | 63.3 | 57 | 75.4 | 56 | 57.1 | 72 | 80.6 | 70.1 |
| | Berkinkosi | Mar. 1975 | 55 | 60.0 | 118 | 68.6 | 44 | 40.9 | 85 | 49.4 | 57.6 |
| | AVERAGE | | 104 | 61.5 | 175 | 70.9 | 100 | 50.0 | 157 | 63.7 | 63.1 |
| USUTU | Manzini (Elwandle) | 1971 | 17 | 76.5 | 15 | 86.7 | 10 | 60.0 | 20 | 70.0 | 74.2 |
| | Manzini (RFM) | 1971 | 116 | 37.9 | 140 | 60.0 | 136 | 42.6 | 170 | 61.8 | 51.8 |
| | Manzini (St. Paul's) | 1971/72 | 72 | 41.7 | 83 | 71.1 | 97 | 41.2 | 101 | 77.2 | 58.6 |
| | Tambuti | 1972 | 40 | 40.0 | 34 | 23.5 | - | - | - | - | 32.4 |
| | Manzini (St.Michaels) | 1972 | 86 | 12.8 | 51 | 27.5 | 76 | 5.3 | 133 | 17.3 | 14.5 |
| | Manzini (St.Teresa's) | 1971 | - | - | - | - | 126 | 50.8 | 191 | 61.8 | 57.4 |
| | Manzini (Salesian) | 1971 | 144 | 56.9 | 259 | 69.9 | - | - | - | - | 65.3 |
| | Manzini (SidneyWilliams) | 1972 | 101 | 2.0 | 56 | 7.1 | 116 | 0.0 | 58 | 0.0 | 1.8 |
| | Helehele | July 1973 | 61 | 14.8 | 100 | 31.0 | 62 | 21.0 | 110 | 40.0 | 29.1 |
| | Phonjwana | 1973 | 39 | 2.6 | 96 | 15.6 | 82 | 9.8 | 94 | 17.0 | 12.9 |
| | Manzini (St.Michaels) | April 1974 | 51 | 5.9 | 57 | 12.3 | 106 | 4.7 | 77 | 7.8 | 7.2 |
| | Manzini (Mthonjeni) | 1973 | 37 | 24.3 | 40 | 52.5 | 38 | 18.4 | 33 | 57.6 | 37.8 |
| | Manzini (Guava) | July 1975 | 37 | 43.2 | 26 | 53.8 | 71 | 38.0 | 25 | 40.0 | 42.1 |
| | Mbekelweni | April 1975 | 152 | 22.4 | 126 | 33.3 | 142 | 27.5 | 118 | 41.5 | 30.5 |
| | AVERAGE | | 918 | 27.9 | 1096 | 45.5 | 1070 | 25.5 | 1155 | 41.7 | 37.7* |

*This overall rate includes 518 individuals at Manzini and Tambuti who were not analysed by age and sex

APPENDIX A

TABLE 1: PREVALENCE OF S. HAEMATOBIUM INFECTION IN CHILDREN 5-14 YEARS BY TOPOGRAPHIC ZONES AND RIVER BASINS (SWAZILAND) (cont.)

II LOWVELD

| RIVER BASIN | LOCALITY | DATE | MALES | | | | FEMALES | | | | OVERALL PREVALENCE RATES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5-9 years No. tested | % positive | 10-14 years No. tested | % positive | 5-9 years No. tested | % positive | 10-14 years No. tested | % positive | |
| MBULUZI | Malinza | July 1975 | 9 | 11.1 | 8 | 12.5 | 12 | 0.0 | 3 | 0.0 | 6.5 |
| | Nakwane | Feb 1976 | 70 | 22.9 | 28 | 39.3 | 73 | 21.9 | 25 | 36.0 | 26.5 |
| | Vuvulane | Jan 1976 | 82 | 39.0 | 97 | 62.9 | 93 | 36.6 | 139 | 38.1 | 43.8 |
| | AVERAGE | | 161 | 30.4 | 133 | 54.9 | 178 | 28.1 | 167 | 37.1 | 36.6 |
| USUTU | Ubombo | Aug 1971 | 48 | 25.0 | 62 | 48.4 | 49 | 20.4 | 48 | 31.3 | 32.4 |
| | Ubombo | 1972 | 82 | 15.8 | 71 | 42.2 | 90 | 18.9 | 60 | 30.0 | 25.7 |
| | Ubombo | 1973 | 74 | 10.8 | 19 | 26.3 | 97 | 9.3 | 30 | 20.0 | 12.7 |
| | Siphofaneni | 1973 | - | - | 15 | 26.7 | 2 | 0.0 | 39 | 23.1 | 24.1 |
| | Ngcina | Apr. 1975 | 55 | 70.9 | 33 | 78.8 | 44 | 61.4 | 35 | 57.1 | 67.1 |
| | Sivunga | May 1975 | 35 | 25.7 | 29 | 35.9 | 41 | 7.3 | 37 | 32.4 | 26.8 |
| | AVERAGE | | 294 | 27.6 | 229 | 47.6 | 323 | 20.4 | 249 | 32.1 | 37.8* |
| NGWAVUMA | Lubuli | Sep. 1975 | 116 | 9.5 | 150 | 24.0 | 124 | 11.3 | 160 | 13.7 | 15.1 |
| | Ikhwezi | Dec 1975 | 67 | 0.0 | 130 | 0.8 | 90 | 0.0 | 151 | 1.3 | 0.7 |
| | Mfanampela | Dec 1975 | 8 | 50.0 | 8 | 37.5 | 2 | 100.0 | 1 | 100.0 | 52.6 |
| | Nsoka | 1975/ 1976 | 23 | 30.4 | 29 | 17.2 | 27 | 40.7 | 23 | 21.7 | 27.5 |
| | AVERAGE | | 214 | 10.3 | 317 | 14.2 | 243 | 11.5 | 335 | 9.3 | 11.3 |

* includes 359 school children at Big Bend and Bhuli who were not analysed by age and sex

APPENDIX A

TABLE 2: PREVALENCE OF S. MANSONI INFECTION IN CHILDREN AGED 5-14 YEARS BY TOPOGRAPHICA ZONES AND RIVER BASINS (SWAZILAND)

I MIDDLEVELD

| RIVER BASIN | LOCALITY | DATE | MALES | | | | FEMALES | | | | OVERALL PREVALENCE RATES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5-9 years No. tested | % positive | 10-14 years No. tested | % positive | 5-9 years No. tested | % positive | 10-14 years No. tested | % positive | |
| LOMATI | Ngonini | 1972 | 30 | 80.0 | 38 | 86.8 | 19 | 78.9 | 37 | 94.6 | 86.3 |
| | Ngonini | 1976 | 15 | 40.0 | - | - | 16 | 56.2 | - | - | 50.0 |
| | Ntonjeni | July 1973 | 31 | 74.2 | 33 | 48.5 | 29 | 69.0 | 20 | 55.0 | 61.9 |
| | AVERAGE | | 76 | 69.7 | 71 | 69.0 | 64 | 68.7 | 57 | 80.7 | 71.6 |
| MBULUZI | Lutfotja | July 1975 | 30 | 0.0 | 87 | 4.6 | 32 | 0.0 | 88 | 9.1 | 5.1 |
| | Sidokodo | July 1975 | 50 | 4.0 | 10 | 20.0 | 41 | 7.3 | 9 | 33.3 | 10.0 |
| | AVERAGE | | 80 | 2.5 | 97 | 6.2 | 73 | 4.1 | 97 | 11.3 | 6.3 |
| USUTU | Manzini (Mthonjeni) | 1973 | 37 | 2.7 | 35 | 0.0 | 34 | 5.9 | 34 | 2.9 | 2.9 |
| | Manzini (St.Michaels) | June 1974 | 44 | 2.2 | 63 | 1.8 | 92 | 1.1 | 55 | 0.0 | 3.1 |
| | Manzini (Sikolo) | July 1975 | 53 | 7.5 | 11 | 18.2 | 38 | 5.3 | 8 | 25.0 | 9.1 |
| | Manzini (Guava) | July 1975 | 23 | 0.0 | 25 | 0.0 | 70 | 2.9 | 25 | 8.0 | 2.8 |
| | AVERAGE | | 157 | 3.8 | 134 | 2.2 | 234 | 3.0 | 122 | 4.1 | 3.2 |

APPENDIX A

TABLE 2: PREVALENCE OF S. MANSONI INFECTION IN CHILDREN AGED 5–14 YEARS BY TOPOGRAPHICA (cont.)
ZONES AND RIVER BASINS (SWAZILAND)

II LOWVELD

| RIVER BASIN | LOCALITY | DATE | MALES | | | | FEMALES | | | | OVERALL PREVALENCE RATE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5–9 years No. tested | % positive | 10–14 years No. tested | % positive | 5–9 years No. tested | % positive | 10–14 years No. tested | % positive | |
| MBULUZI | Nakwane | Feb 1976 | 31 | 16.1 | - | - | 17 | 29.4 | - | - | 20.8 |
| USUTU | Ubombo (Ranches) | Aug 1971 | 37 | 21.6 | 49 | 63.3 | 45 | 31.1 | 42 | 45.2 | 42.2 |
| | Ubombo (Ranches) | 1972 | 79 | 15.2 | 72 | 36.1 | 92 | 17.4 | 68 | 23.5 | 22.5 |
| | Ubombo (Ranches) | 1973 | 74 | 21.6 | 18 | 16.6 | 90 | 22.2 | 24 | 16.6 | 20.9 |
| | Sivunga | May 1975 | 31 | 16.1 | 22 | 27.0 | 40 | 2.5 | 25 | 0.0 | 9.3 |
| | AVERAGE | | 221 | 18.5 | 161 | 38.5 | 267 | 19.1 | 159 | 24.5 | 28.3* |
| NGWAVUMA | Lubuli | Nov/ Dec 1975 | 85 | 16.5 | 83 | 16.9 | 94 | 13.8 | 142 | 12.7 | 14.6 |
| | Mfana ) Mpela ) | Dec 1975 | 8 | 50.0 | 7 | 57.1 | 2 | 0.0 | - | - | 47.1 |
| | Nsoka | Dec 1975 | 7 | 57.1 | 6 | 66.6 | 1 | 0.0 | 1 | 0.0 | 53.3 |
| | AVERAGE | | 100 | 22.0 | 96 | 22.9 | 97 | 13.4 | 143 | 12.6 | 17.2 |

* includes 672 individuals from Big Bend, Bholi and Tambuti not analysed by age and sex.

APPENDIX B

TABLE 1: SUMMARY OF PRESENT SNAIL CONTROL PROGRAMME IN NATURAL DRAINAGE SYSTEMS (SWAZILAND)

GROUP I BAYLUSCIDE

| LOCALITY | FIRST SURVEY | | | | 1975 SURVEY | | |
|---|---|---|---|---|---|---|---|
| | YEAR | FINDINGS | | | FINDINGS | | |
| | | Physops* | Biomp* | Others* | Physops* | Biomp* | Others* |
| Mzimunene River | 1970 | + | - | B.f. | + | - | B.f. |
| Town Furrow | 1970 | + | - | B.f. | + | - | - |
| Francis Stream Dam | 1970 | + | - | B.f.L. | - | + | - |
| Madonsa Stream | 1970 | + | - | B.f.B.t.L. | - | - | B.f.L. |
| Gulf Coast Stream | 1970 | + | - | B.f.L. | - | - | - |
| Nhlambamasoka Stream | 1970 | No record | | | | | |
| Jabavu Stream | 1970 | + | - | - | + | - | - |
| S.D. Stream | 1970 | + | - | B.f.L. | - | - | B.f. |
| R.C. Furrow | 1970 | + | - | B.f.L. | - | - | B.f.B.t. |
| Nazarene Stream | 1970 | + | - | B.f.L. | - | - | L. |
| Mhobodleni Stream | 1971 | + | - | B.f.L. | + | - | B.f.L. |
| Mgubudla Stream | 1970 | + | + | B.f.L. | + | - | B.f.L. |
| Manzini Stream | 1970 | + | - | B.f.L. | - | - | B.f.L. |
| Gobhogobho Streams (tribs) | 1970 | + | - | B.f.L. | + | - | - |
| Gobhogobho Stream | 1970 | + | - | B.f.L. | + | - | B.f.L. |
| Maguti Stream | 1970 | + | - | B.f.L. | - | - | B.f.L. |
| Shebedze Stream | 1969 | + | - | B.f.L. | - | - | - |
| Lomayisela Stream | 1969 | + | - | B.f.L. | - | - | B.f.L. |
| Majaheni Stream | 1970 | + | - | B.f.L. | - | - | B.t. |
| Mabejwane Stream | 1970 | + | - | B.f.L. | - | - | B.f.L. |
| Mabejwane Dam No.2 | 1970 | + | - | B.f. | - | - | - |
| Mabejwane Dam No.1 | 1970 | + | - | B.f. | - | - | M. |
| Phonjwane Well No. 1 & 2 | 1970 | - | - | L. | - | - | L. |
| Phonjwane Dam/ Stream | 1971 | - | - | L. | - | - | L.B.f. |
| Lomahasha Clinic Dam | 1971 | + | - | B.f.L. | + | - | L. |
| Lomahasha Police Dam | 1971 | + | - | B.f.L. | - | + | B.f.L. |
| Lomahasha Nkaleshane Dam | 1971 | + | + | L. | + | + | L. |
| Bulandzeni Dam/ Stream | 1971 | + | - | B.f.L. | + | - | B.f.L. |
| TOTAL | | 25 | 2 | | 10 | 3 | |

Physops = Bulinus (Physopsis) globosus; Biomp = Biomphalaria pfeifferi;
B.f. = Bulinus forskalii; L = Lymnaea;
M = Melanoides; Bt = Bulinus tropicus

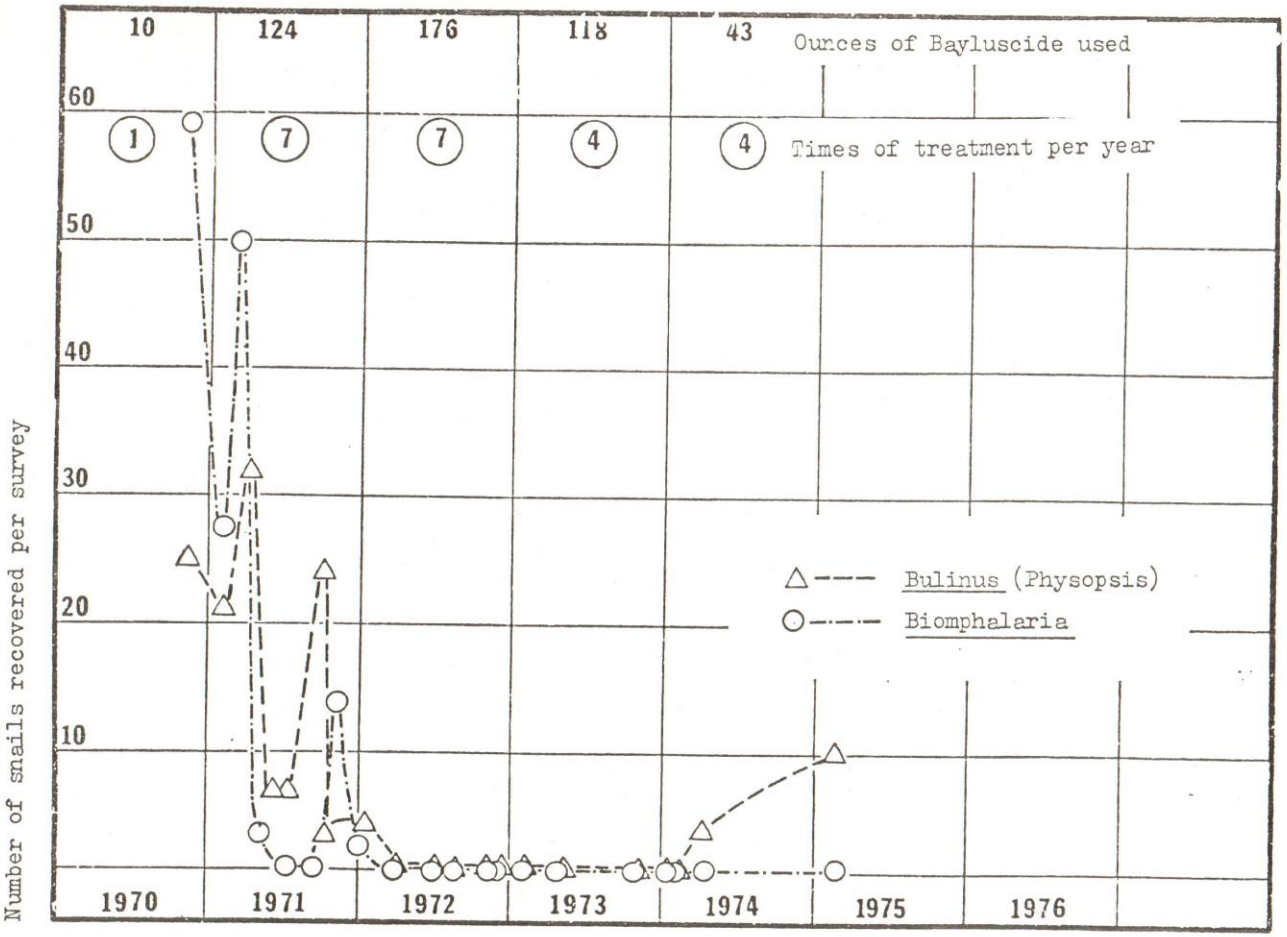
APPENDIX B

TABLE 2: SUMMARY OF PRESENT SNAIL CONTROL PROGRAMME IN NATURAL DRAINAGE SYSTEMS (SWAZILAND)

GROUP II BAYLUSCIDE

| LOCALITY | FIRST SURVEY | | | | 1975 SURVEY FINDINGS | | |
|---|---|---|---|---|---|---|---|
| | YEAR | FINDINGS | | | | | |
| | | Physops | Biomp | Others | Physops | Biomp | Others |
| Ntonjeni 3 dams/ streams | X 1974 | - | - | - | + | + | B.t. |
| Mshingishingini dam/stream | XII 1974 | + | - | B.f.L. | + | + | L. |
| Luntsansama stream | X 1974 | + | + | L. | + | + | L. |
| Chinese Experimental Farm | X 1974 | + | - | B.f.L.B.t. | + | - | B.f.L.B. |
| Mbasheni dams/ streams | XII 1974 | + | + | B.f.L. | + | + | B.f.L. |
| Kutsimuleni 11 dams | II 1974 | + | + | B.f.L.M. | + | + | B.f.L.M. |
| Mbekelweni 5 dams | I 1975 | + | - | B.f.L. | + | - | B.f.L. |
| Siteki 5 dams/str. | II 1975 | + | + | B.f.L. | + | + | B.f.L. |
| Ngcina, Sivunga 3 dams | V 1974 | - | - | B.t. | - | - | B.t. |
| Ngcina, Sivunga 5 dams | V 1974 | + | + | B.f.L.M. | + | + | B.f.L.M. |
| Mankaiana 8 dams | II 1975 | + | + | B.f.L. | + | + | B.f.L. |
| Bekinkosi streams | II 1975 | + | - | B.f.L. | | | |
| Nkiliji streams | II 1975 | + | - | B.f. | | | |
| Luftotsho streams | III 1975 | + | + | B.f. | | | |
| Mahlanya | III 1975 | + | - | - | | | |
| Bethany | III 1975 | + | - | L. | | | |
| Nhlambeni | I 1975 | + | - | B.f. | | | |
| Mbelebeleni | I 1975 | + | + | B.f.L. | | | |
| TOTAL | | 16 | 8 | | 10 | 8 | |

Snail and Molluscicide Data for Area No. 12 - Mgubudla Stream (19 Stations)



APPENDIX C (Figure 2)

Snail and Molluscicide Data for Area No. 26 - Clinic Dam and Swamp (4 Stations - Lomahasha)