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SAHEL
Epidemiological and Environmental Assessment Studies

VOLUME II

Documentation on Status of Five Major Endemic Diseases in Ten African States

Documentation of Five Major Endemic Diseases in Ten African Countries

Part A

Introduction and Format

As part of the Sahel Epidemiological and Environmental Assessments (SEEA) Project, the American Public Health Association (APHA) has documented the current status of Schistosomiasis, Onchocerciasis, Malaria, Trypanosomiasis and Filariasis in ten African countries, viz., Benin, Cameroon, Chad, Liberia, Mali, Niger, Senegal, Swaziland, Upper Volta and Zaire.

I. Resources

The information has been assembled from a very comprehensive literature review involving a wide variety of sources listed below. Also included are the data collected within the specific countries by the various APHA assessment teams during the past year.

Libraries and Document Collections

American Public Health Association/IHP In-House Library - Washington, D.C.

National Library of Medicine-Interlibray loans, stacks, and Medlars - Bethesda, Maryland

Center for Disease Control Library - Atlanta, Georgia

Organization for African Unity - Addis Ababa, Ethiopia

Commonwealth Agricultural Bureau - Farnham Royal, Slough, U.K.

Organization for Economic Co-operation and Development - Paris, France

Office of International Health/Public Health Service, DHEW - Washington, D.C.

Pan American Health Organization Library - Washington, D.C.

Africare - Washington, D.C.

U.S. - Japan Co-operative Schistosomiasis Conference, July 1977 National Institutes of Health - Bethesda, Maryland

World Health Organization Publications - Geneva, Switzerland

Technical Assistance Information Clearing House - New York, N.Y.

Walter Reed Army Medical Library - Washington, D.C.

Literature Searches

Library of Congress - Washington, D.C.

UNPDB - New York, N.Y.

Literature Research Co.

Biosciences Communication - George Washington University Medical Center, Washington, D.C.

Biosis Bioresearch Index

Smithsonian Institution Science Information Exchange - Washington, D.C.

International Bank for Reconstruction and Development - Washington, D.C.

U.S. Department of Agriculture - Washington, D.C.

National Institute of Allergy and Infectious Diseases - Bethesda, Maryland

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II. Format

An expandable format has been developed for presentation of the information by country, disease, and a matrix of headings and sub-headings. The use of this matrix format has made it possible to identify information gaps very readily and hence future research needs.

The following is an outline of the format used for schistosomiasis in Benin:

BE 1.0 Schistosomiasis in Benin

1.2 Epidemiology of the Disease

1.2.1 Geographical distribution

1.2.2 Prevalence

1.2.3 Intensity

1.2.4 Incidence

1.2.5 Population most affected

1.3 Vector Bionomics

1.3.1 Species of the vector transmitting the disease

1.3.2 Distribution of the vector

1.3.3 Environmental factors influencing vector distribution

1.4 Diagnostic Procedures or Techniques

1.4.1 General diagnostic methods

1.4.2 New diagnostic techniques

1.5 Therapeutic Trials

1.5.1 Studies on new drugs

1.5.2 Mass treatment

1.5.3 Problems encountered

1.6 Control Measures Directed Against Human Infection by the Disease

1.6.1 Chemoprophylactic measures

1.6.2 Other protective control measures

1.6.3 Problems encountered

1.7 Vector or Intermediate Host Control Program

1.7.1 Eradication of the vector by mechanical means

1.7.2 Eradication by chemical means, e.g. insecticides

1.7.3 Eradication by biological methods, e.g. use of natural vector or parasite predators

1.7.4 Other control measures

1.7.5 Problems

1.8 Disease Impact

1.8.1 Impact on the Population Distribution

1.8.2 Impact on the Economy

1.8.3 Programs aimed at overcoming or improving the situation

1.8.4 Problems

1.9 Laboratory Studies

1.9.1 Laboratory studies done on the vector

1.9.2 Laboratory studies done on the parasite

1.10 Clinical Studies and Observations

The matrix has been repeated for remaining diseases in Benin thus:

BE 2.0 Onchocerciasis in Benin

BE 3.0 Malaria in Benin

BE 4.0 Trypanosomiasis in Benin

BE 5.0 Filariasis in Benin

The above has been repeated for each country and assembled by country in alphabetical order.

Documentation on Studies of Five Major Endemic Diseases in Ten African States

Part B
National and Regional Disease Profiles

Section I
Peoples Republic of Benin
1977

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BE 1.0 SCHISTOSOMIASIS IN BENIN

1.2 Epidemiology of the Disease

1.2.1 Geographical Distribution

Ansari (1973): Schistosomiasis is widely distributed in Benin. Infection has been reported in several southern and central towns. No reports of schistosomiasis in northern Benin were available.

1.2.2 Prevalence

Ansari (1973): Michejda (WHO unpublished report, 1970) reported that more than 80% of the schoolchildren examined in a health survey, undertaken as part of an agricultural development project in the Oueme River valley, were found to be infected.

Deschiens (1951), noting foci of S. mansoni at Savalou and Cotonou, estimated the average national prevalence rate at 0.2%.

Deschiens (1951) also reported S. haematobium in Cotonou. He gave a figure of 27% as the average national prevalence rate for that strain.

Gaud (1955), reported S. haematobium prevalence rates of 4% at Porto Novo (Attake), 8% at Porto Novo (Bekon), 60% at Savalou (Agouagon), 8% at Parakou, and 25% at Abomey.

Pampligione and Ricciardi (1971) noted five cases of S. haematobium infection and one case of S. mansoni infection in the lake village of Ganvie (194 inhabitants).

1.2.3 Intensity

No country-specific information found.

1.2.4 Incidence

No country-specific information found.

1.2.5 Population Most Affected

No country-specific information found.

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari (1973): Gaud (1955) and Mandahl-Barth (1957) pointed to B. (B.) forskalii as a possible vector.

Deschiens (1951) mentioned B. (Ph.) africanus and B. dybowski (B. truncatus) as intermediate hosts of S. haematobium. He implicated B. pfeifferi as the host of S. mansoni.

1.3.2 Vector Distribution

Ansari (1973): B. (B) forskalii was noted in Ouidah by Gaud (1955) and in Porto Novo by both Gaud (1955) and Mandahl-Barth (1957).

1.3.3 Environmental Factors Influencing Distribution

No country specific information found.

1.4 Diagnostic Procedures or Techniques

No country specific information found.

1.5 Therapeutic Trials

No country specific information found.

1.6 Control Measures Against Human Infection

No country specific information found.

1.7 Vector or Intermediate Host Control

No country specific information found.

1.8 Disease Impact

No country specific information found.

1.9 Laboratory Studies

No country specific information found.

1.10 Clinical Studies and Observations

No country specific information found.

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1. Ansari, N.: Epidemiology and Control of Schistosomiasis (Bilharziasis). University Park Press, Baltimore, 1973.

2. Pampiglione, S. and M. Ricciardi: "Parasitological Survey of the Inhabitants of the Pile-Built Lake Village of Ganvie (Dahomey, West Africa)". Parassitologia 13½: 271-280, 1971 .

BE 2.0 ONCHOCERCIASIS IN BENIN

2.2 Epidemiology of Onchocerciasis

2.2.1 Geographical distribution

Onchocerciasis is mostly found in the north of Benin, along the Volta River valleys in particular. Areas affected most severely are those around Banikoara, Kandi, Natitingou, Kouande, Kerou, Bembereke and Tobre. High endemicities of the disease are found among these communities. This region is included in the WHO Onchocerciasis Control Program of the Volta River Basin Area along the lower Alibori and Pako river valleys, the Faba area and the Longou Diada area (OCP/73.1, WHO, Geneva 1973, WHO OCP/73.1 Annex IV-3).

2.2.2 Prevalance

Prevalence studies and surveys have been conducted in the Volta River Basin Area by the Onchocerciasis Control Program which is sponsored by WHO, the Fonds European de Developpment (FED), the Organisation de Coordination et de Cooperation pour la Lutte Contre les Grandes Endemies (OCCGE), and other international agencies. The aim of the program is to determine the magnitude and significance of the disease. (WHO: OCP/73.1, WHO: OCP/73.1 Annex V-4)

An epidemiological survey was conducted in 193 communities with an estimated population of 247,577 (WHO OCP. Annex IV-2). Onchocerciasis examinations

were done on 158,472 (64%) residents and results showed that the disease was prevalent in all the communities investigated.

Results showed that onchocercal nodules were prevalent among the residents of Tamande, Gorgobe, Birni, Tassigourou, Kerou, Kerou-Ouirou, Kosso-Oinra, Brignamao, Berekossou, Yakrigourou, Kangourou, Bipotoko, Pikire, Feterou, Gambore and Kahobagou. High percentages of Onchocerca nodules were found among individuals from the villages of Kahobagou (38.15% of the 671 persons examined), Yakrigourou (37%, 121 of the 327 persons), Gorgoba (30.36% of the 415 persons), Tissigourou (28.97%, 142 out of 490 residents) and Kangourou (28.38% of its 303 people). Blindness was also high in these communities but with varying degrees. Examination of 94,741 men and women showed that 55% of the men were blind as compared to 45% among the women (WHO OCP. Annex VI-5).

2.2.3 Intensity

The intensity of infection by O.volvulus is definitely high in those areas where the transmission potentials and the degree of population exposure to the biting activities of infected female Simulium damnosum is high and where the infective strains of O. volvulus are prevalent. The intensity of infection is high in those areas where the population is heavily infected with infective strains of O. volvulus and where the type of work activities makes the population more vulnerable to

the bites of infected female S. damnosum species. (WHO OCP /73.1, OCP/73.1 Annex IV-1)

2.2.4 Incidence

Although no specific incidence rates were given in any of the studies reviewed, areas with high transmission and infection rates will have high incidence rates. Areas heavily inhabited by S. damnosum species that transmit O. volvulus parasites have high incidences of onchocerciasis especially during the high transmission seasons (in the savannah zone; perennial in the forest bioclimatic zone). Incidences of blindness are also high among individuals living in these areas. (WHO: OCP/73.1; WHO:OCP/73.1 Annex V-4).

2.2.5. Population most affected

Sex and age specific studies show that onchocerciasis affects more adult males than females of the same age group.

Of the 94,741 individuals examined for blindness, 55% of the blind persons were men while 45% were women. It is well established that males suffer most from the disease although minor reverse conditions may exist in areas where the women's activities outside the house make them more exposed to the biting of infected female S.damosum (WHO:OCP. Annex VI-5).

The appearance and development of ocular lesions in onchocerciasis depends on the duration and intensity of

the infection. The age at which ocular lesions appear, their severity and the frequency of impaired vision and blindness are closely related to the intensity of infection in the area. Ocular lesions, however, tend to appear at an earlier age and are more serious in males (WHO: Onchocerciasis Symptomalogy, Pathology diagnosis, edited by Buck, A.A., Geneva, 1974).

2.3 Vector

2.3.1. Species of the vector transmitting onchocerciasis

Species of the black fly Simulium damnosum complex are the vectors of onchocerciasis in Benin. Several forms of the vector have been identified in the Volta River basin area of which the affected regions of Benin are a part. Some studies have been conducted in Benin in order to identify the specific species of Simulium damnosum in the endemic areas. In Benin, one of the countries covered by the WHO Onchocerciasis Control Program in the Volta River Basin Area, the forest and savannah forms of S. Damnosum exist in their respective bioclimatic zones. Eight species of S. damnosum have been identified (Vajime, WHO OCP/SAP/76.1), which are:

S. squamosum ("Bille")

S. yahense ("Yah")

S. soubrense ("Soubre")

S. sanctipauli ("Bandama")

S. damnosum ("Nile")

S. dieguerense ("Dieguera")

S. sirbanum ("Sirba")

S. sudanense ("Sirba")

S. dieguerense, S. sirbanum and S. sudanense are predominately found in the savannah while the others are found in the rain forest zone.

Dunbar and Vajime (WHO/ONCHO/71.87; WHO/VBC/71.320) recognized 17 cytological categories in two subgroups and believe that most of them represent distinct species. In West Africa, the "Nile" subgroup included Nile, Bandama, Sirba, Soubre, Bille and Yah.

However, these forms were not identified in Benin due to either cytological identity uncertainty or because of poor quality of the slides (Dunbar and Vajime, WHO/ONCHO/71.87; WHO/VBC/71.320).

2.3.2 Vector distribution

The distribution of the S. damnosum species group is primarily related to the two main climatic regions, namely the forest and savannah bioclimatic zones. Each species of the vector is therefore very much restricted to the climatic region suitable for its survival. Hence, S. yahense, S. damnosum, S. squamosum, S. sanctipauli and S. soubrense dominate the forest area while S. dieguerense, S. sirbanum and S. sudanense colonize the savannah areas. Among the species associated with the forest only, S. squamosum, S. soubrense and S. damnosum,

have been found in the savannah region, of the onchocerciasis area. S. sirbanum is persistent in the dry areas and clearly predominates in such areas.

The correlation of known foci of the species with endemic areas of onchocerciasis strongly indicate that S. squamosum, S. damnosum and S. sirbanum are potent vectors. (WHO:OCP/SAP/76.1)

2.3.3 Environmental factors influencing the distribution and activity of S. damnosum complex species

Environmental factors play an important role in the distribution of the S. damnosum complex species. Climatic conditions such as temperature, wind velocity and precipitation are factors that contribute to the regional localization and colonization of S. damnosum vector flies.

The flight range of the vector is affected by wind velocity as well as other factors and the biting activity of the fly is very much dependent on the temperature conditions. Seasonal variations determine the transmission and the intensity of infection. Hence, the meteorological, climatological and hydrological conditions are very important factors as far as the distribution, flight range, biting activity and the survival of the larval stages of the vector are concerned (Phillippon et al, WHO/VBC/76.619).

All species of S. damnosum complex, except S. yahense, breed in large rivers. S. yahense breeds in creeks and small tributaries of large rivers while S. sirbanum prefers the extreme savannah conditions. The physico-chemical properties of the water are important for the immature stages of S. damnosum complex. The pH value, the conductivity and the concentration of certain ions determine, to a certain extent, the breeding sites of a given species, e.g. S. sanctipauli, S. yahense. "Mangense" cytotype breed in an acid water with a pH value below 7 and a conductivity always below 50 microhms. Larvae of S. sanctipauli and S. yahense were always found in water with a high potassium sodium sulfate content, and "Mangense" was found in a magnesium carbonate water. S. sirbanum, S. sudanense, S. damnosum, S. squamosum, which include species and cytotypes of the tropical rain forest zone, the savannah zone and mountain areas, breed in neutral, weakly alkaline water with the conductivity ranging from 50 to 150 microhms (OCP/SAP/76.1, Geneva, Oct., 1975). The water current speed, the availability of organic matter and the water level fluctuations are equally significant factors (Philippon et al, WHO/VBC/76.619, 1973).

2.4 Diagnostic Procedures

2.4.1 General Diagnostic Methods

Many studies have been done regarding the diagnosis of onchocerciasis in the Volta River Basin Area, in which the onchocerciasis areas of Benin are included. The parasitological diagnosis of onchocerciasis by skin snips is considered by most authorities as the best method. The number of microfilariae emerging from a skin snip reflects the intensity of infection (WHO, Onchocerciasis: Symptoms, Pathology, Diagnosis. edited by Buck, A.A., Geneva, 1974). This method is most frequently used in prevalence surveys in both qualitative and quantitative assessments of O. volvulus microfilariae in the given population, though with slight modifications in the technique to meet the specific needs of the desired study (qualitative or quantitative). The Mazzotti test is used quite often as a diagnostic aid. Urine examination for the presence of the microfilariae of O. volvulus has been reported as a useful diagnostic method (the triple-concentration technique is used).

In the case of microfilariae in the eye, onchocerciasis can be diagnosed by the presence of microfilariae in the cornea by using a good slit-lamp at a magnification of x25 (for living mf; dead microfilariae can be seen at a magnification of x16; sometimes they show up only by retroillumination).

Ocular onchocerciasis can also be diagnosed by

finding microfilariae in the anterior chamber of the eye, in conjunctival biopsies (this procedure is not recommended by WHO; skin snips taken at the outer canthus provide adequate information on the microfilariae load around the eye and a slit-lamp examination of the cornea and anterior chamber provides a more direct evidence of ocular involvement). Other diagnostic techniques for ocular onchocerciasis include observation of punctate keratitis, disc shaped corneal opacities (by differential diagnosis method; common in the savannah area), sclerozing keratitis, iridocyclitis, found particularly in the more heavily infected patients, mild uveitis (in a non-injected eye), severe plastic inflammation, secondary glaucoma, iris atrophy, choroidoretinal lesions, and postneuritic optic atrophy. Choroidoretinal lesions are diagnosed by differential diagnosis technique (WHO: Onchocerciasis; Symptoms, Pathology and Diagnosis, 1974).

2.4.2 New diagnostic techniques

There is a continued effort in the study and development of new diagnostic tools and techniques for the diagnosis of onchocerciasis in the Volta River Basin Area, which includes the endemic regions of Benin. Among these are: the complement fixation test (Lartigue, WHO/ONCHO/66.50) which is useful in individual cases when a decision is to be made regarding the suitability of a

given type of treatment; the intradermal test, valuable in the diagnosis of onchocerciasis in patients in whom the microfilarial densities are low. Fulsang and Anderson used intradermal diethylcarbamazine citrate as a possible diagnostic procedure (Fulsang and Anderson, WHO/ONCHO/77.132). Although a high dose of DEC (0.1 - 10mg) might give fewer false negative results, the practical values of the test remain to be investigated further. The Enzyme Linked Immunosorbant Assay (ELISA) developed at the Minerva Institute for Medical Research, Helsinki, has been reviewed by WHO for possible use in the early diagnosis of onchocerciasis. Studies to evolve a highly sensitive ELISA technique for mass diagnosis of O. volvulus are being encouraged. A comparative study on the impact of physiological saline and Hanks balanced salt solutions on the emergence of microfilariae from skin snips is being conducted.

2.5 Therapeutic Trials

2.5.1 Studies on new drugs

Clinical trials in the treatment of onchocerciasis have been conducted mainly by WHO Onchocerciasis Control Programme in the Volta River Basin Area and the Organisation de Coordination et de Cooperation pour le Lutte Centre les Grandes Endemies (OCCGE), Centre Muraz, at Bobo-Dioulasso, Upper Volta. Drugs such as diethyl-

carbamazine plus levansiole, nifurtimox, TWSb, TWAS, other compounds containing arsenic and antimony, macrocyclon and PAA 2056 have been tried. However, the only drugs used in treating onchocerciasis under clinical supervision are suramin, diethylcarbamazine and Mel W. Even these are not used in mass therapeutic campaigns becuase of their side effects (Duke and Lartigue, WHO/ONCHO/66.46; WHO/STAC/76.1; WHO/STAC/76.2 Rev. 1 Third & Fourth meetings, March and November, 1976).

2.5.2 Mass treatment

Field trials of onchocercal macro- and microfilarial drugs have been restricted due to the severe side effects associated with these drugs as well as the difficulties related to their administration. Combined chemotherapeutic treatment of onchocerciasis (e.g. by simple dose treatments) would be the most effective method. Development of a single or new combination of those drugs now known to be effective against the adult worms and microfilariae will be quite a breakthrough in mass treatment campaign of onchocerciasis. (WHO: OCP/73/1, OCP/73.1; Annex II-I).

2.5.3. Problems encountered

Clinical trials are hampered by the lack of facilities, lack of trained pharmacists, chemists, pharmacologists and other qualified clinicians capable of carrying out and supervising these trails. A careful observation,

supervision and evaluation of these macro- and microfilaricidal drugs are absolutely essential. Therefore, lack of qualified clinicians is a serious setback. (WHO:OCP/73.1 OCP/73.1; Annex II-I).

Field trails suffer from the same impediments. There is a critical shortage of personnel qualified for undertaking field trails under the strict conditions set by WHO concerning mass use of drugs on humans. (WHO: OCP/73.1; OCP/73.1; Annex II-I).

2.6 Control Measures Directed Against Human Infection by Onchocerciasis

2.6.1 Prophylactic Measures

So far no chemoprophylactic measures have been employed in Benin, although investigations are being made by WHO along these lines. The use of macro- and microfilaricidal drugs for chemoprophylaxis has not been feasible due to their toxic effects and other contraindications associated with them. Lack of suitable chemoprophylactic drugs is an obvious setback in launching such a protective control measure. The use of insect repellents such as diethyltoluamide has been tried. (WHO: OCP/73.1; OCP/73.1, Annex II-1)

2.6.2 Other Protective Control Measures

There are some protective measures being used in the endemic areas against the bites of Simulium flies. The population in the affected areas is being advised to wear protective clothes such as long trousers, long sleeved shirts, shoes and headgears, (for women) and to avoid vector contacts during the peak biting activity time of the day, such as the mornings and evenings when temperatures and other meteorological conditions are conducive to vector biting (WHO: OCP/73.1).

In heavily infected areas, there is increased population shift from onchocercal areas along the river valleys to the onchocercal free plateaus in order to avoid the

vector transmitting the disease. Studies have shown that infection rates are high among the population in communities that are close to the vector's breeding sites (along the rivers). Denodulization is also used as another control method. (WHO/OCP/73.1)

2.6.3 Problems involved

The major problem involved in trying to protect the population at risk against infection by O. volvulus parasites is the lack of effective drugs that can be used for chemoprophylactic measures. The mass or collective treatment of individuals infected by O. volvulus parasites in order to reduce the microfilariae pool in the population and thus reduce the level of transmission has not been practical because of the severe and undesirable side effects of the drugs currently used as well as the difficulties involved in handling them, especially in a mass treatment campaign. (WHO: OCP/73.1; WHO: OCP/73.1 Annex II-1)

2.7 Vector Control

The World Health Organization (WHO) has undertaken a vector control program in the endemic areas in Benin which fall into the Volta River Basin Area. However, the FED/OCCGE campaign against S. damnosum forms the core of the regional program. Several methods are being used in controlling or trying to eradicate the vector. (WHO: OCP/73.1)

2.7.1 Eradication Control by Mechanical Means

The mechanical approach in the control of S. damnosum involves the destruction of all the identified breeding sites along the rivers. There has been some detailed geographical reconnaissance and appropriate mechanical control measures are being applied in order to alter the ecological conditions, thus destroying both the breeding areas of the vector as well as its general habitat. For example, destroying all identified breeding places, deforestation and construction of dams up stream to slow water current. (WHO:OCP/73.1)

2.7.2 Eradication by Chemical Means

The FED/OCCGE campaign against S. damnosum is based on weekly ground applications of emulsifiable DDT concentrate in all river reaches containing S. damnosum larvae. Therefore, insecticides are used against the developmental stages of S. damnosum. Other insecticides have been selected to supplement the larvicides and these include OMS1170 and OMS1197 (OMS786 and OMS1155 correctly formulated). Tests are being done on the toxicity on the non-target fauna. DIDICOL has been found to be ineffective as a larvicide. Abate 200 CE and Cholorforxim 200CE are also used. Spraying insects by use of helicopters and other types of aircrafts have been some of the alternative methods used in those areas which cannot be reached either by foot, by boats or by road surfaces. (WHO: OCP/73.1)

2.7.3 Vector Control by Use of Biological Vector Predators

The use of natural predators of S. damnosum in the larval or adult stages has been proposed as a means of controlling the vector flies. The use of such predators as Mirmithidae parasites for controlling the vector is being studied. Although these parasites affect only a certain proportion of the Simulium population, they could, however, constitute a useful adjunct to maintenance measures. (WHO: OCP/73.1 Annex III-3; WHO: OCP/73.1)

2.7.4 Other Vector Control Measures

Building dams downstream to transform fast flowing waters into still reservoirs, insect trapping, etc., have been among the alternative methods used in controlling the Simuludae flies. These alternatives seem to have some disadvantages and these are discussed in section 2.7.5 below. (WHO: OCP/73.1; WHO: OCP/73.1 Annex III-3)

2.7.5 Problems Encountered

A number of problems have been faced in carrying out these control measures.

The eradication of the vector flies by completely destroying their breeding sites as well as their natural habitats has been hampered by the lack of manpower and also by logistics problems. The undesirable effects on the non-target organisms in the rivers due to high toxic levels and cumulative properties of DDT and other insecticides and larvicides are setbacks in control campaigns by chemical means. (WHO: OCP/73.1)

The construction of dams downstream in order to retard the water flow thus discouraging the breeding of S. damnosum in these watercourses has some significant disadvantages, e.g. dam spillways may provide an excellent S. damnosum breeding site if not properly designed. The economic aspects are equally important. Carrying out all the programs simultaneously requires a large sum of money in order to meet the costs and maintenance of each of the control measures. The lack of trained personnel and insufficient facilities are major factors which contribute to the difficulties faced in controlling S. damnosum. An effective control program must last at least 15 to 20 yrs. because of the long life span of the parasite. (WHO: OCP/73.1; OCP/73.1 Annex II-1; Annex III-2; III-3; III-4)

2.8 Impact of Onchocerciasis

Onchocerciasis as a disease has a very significant impact on the population distribution as well as the economic aspects of the country. The disease is a public health problem and its impact on the health of the people is a recognized fact. (WHO: OCP/73.1; Annexes 1-1, IV-1, VI-5)

2.8.1 Impact of Onchocerciasis on Population Distribution

The population distribution in the endemic areas is strongly influenced by the intensity of infection, transmission potential and the population density of S. damnosum. It is also influenced by the biting activities of the flies and the ineffectiveness of the O. volvulus strains. (WHO:

OCP/73.1)

In those areas where these conditions are prominant, the population has been forced to abandon their communities. This shift in settlement caused by onchocerciasis has led to overpopulation in some areas (especially in the plateau where conditions are undesirable for S. damnosum's survival), while other areas are sparsely populated. e.g. about 800 sq. km. of land has been abandoned. (WHO: OCP/73.1 Annex VI-5)

The human suffering and the handicapping conditions caused by the disease are indeed major public health concerns. (WHO: OCP/73.1, OCP/73.1 Annex VI-5)

2.8.2 Impact of Onchocerciasis on the Economy

The population shift from onchocercal river valleys which are the most fertile, hense suitable for farming purposes, has caused a decline in agricultural production. Areas which could be used for agricultural activities have been abandoned as a result of the intensity of the disease. (WHO: OCP/73.1 Annexs 1-1; VI-5)

Economic blindness is a limiting factor in terms of production and manpower resources. Blind individuals are not in the productive labor force of the community and thus make very little contribution to the community's output and gross income per capita. (WHO: OCP/73.1, OCP/73.1 Annex VI-5)

2.8.3 Ameliorative Programs

The World Health Organization (WHO), the FED/OCCGE

and other agencies have launched onchocerciasis control programs in the affected areas. The WHO onchocerciasis control program in the Volta River Basin Areas has an economic development component designed to improve the economic conditions of the country by maximum utilization of the land which has been abandoned. The resettlement scheme is geared towards reclaiming the fertile land and also reducing the population density in onchocercal free areas as well as introducing appropriate cash crops and farming activities that will boost the local economic productions. Integrated projects are being carried out in areas such as the Akora, Borgou, the lower Alibori and Pako river valleys, Faba and Longou Diada areas, as well as the Zou-Borgou Cotton Project. (SONACO) (WHO:OCP/73.1) (OCP/73.1 Annex VI-5)

2.8.4 Problems Encountered

The major setbacks in carrying out these programs include those discussed in sections 2.6.3 and 2.7.5. Among these are the lack of existing infrastructures and facilities as well as back up systems in the areas affected by the disease. There are obvious financial and manpower constraints. The poor transportation systems and the lack of trained nationals who can assume the responsibilities, and the lack of suitable or effective drugs for treating patients already infected with O. volvulus and lack of drugs that are effective against both stages of the vector S. damnosum complex are important factors which play a role in

the progress and effectiveness of the programs being undertaken by the respective agencies. (WHO: OCP/73.1 Annex 1 - 1; VI-5; WHO: OCP/73.1)

2.9 Laboratory Studies

2.9.1 Laboratory Studies on the Vector

Laboratory studies on S. damnosum complex have revealed some interesting characteristics about the different species.

Thompson et al found that S. damnosum can fly up to 40 to 60 km and that emerged S. damnosum settle in the light position at the top of the mesh sides of the cage indicating the positive phototaxis of the species. They also observed that the emerged S. damnosum die at high temperatures and low-humidity (Thompson et al, WHO/ONCHO/72.98). Raybould and Clark observed that larvae of S. lewisselum could survive in still water, which is considered unsuitable for S. damnosum larvae survival (Raybould and Clark, WHO/ONCHO/74.106). Two lots of eggs were developed to adult stages at Tubingen. Two adults were blood-fed and induced to breed. The offsprings were found to be sterile. Mating has not been observed and S. damnosum have not been known to breed in the laboratory. The adult male flies are grown from specimens bred from wild-caught larvae (Waddy, Bull. WHO 40(6): 843-58, 1969). Studies on the chromosomal materials (Garms and Vajime, 1975).- Cytotaxonomic and morphological studies have led to the identification and classification of several forms of S. damnosum species. The ecological requirements of the different forms of S. damnosum complex are discussed under 2.3.1 and 2.3.2.

2.9.2 Laboratory Studies on the Parasite

Studies done of the morphological characteristics of O. volvulus have shown that there are at least two strains of the parasite--one strain develops in the species of S. damnosum found in the savannah zone while the other develops only in the rain forest forms of S. damnosum. Differences in the degree of infectivity between the savannah and forest strains of O. volvulus have been observed by some investigators, such as Garner et al (1973). The savannah and forest strains of O. volvulus differ not only in their developmental preferences but also in the infectivity and pathogenicity levels (Garner et al, 1973)

2.10 Clinical Studies and Observations

Clinical studies and observations have shown that the pelvic region (the crista iliaca and major trochanters), the calves and the thorax regions are the most common anatomical sites where microfilariae localize themselves after being introduced into the human host by the vector fly. High yields of microfilariae are obtained from skin snips taken from these anatomical sites. Head nodules are prevalent among onchocerciasis patients in Latin American and children in Africa (Fulsang et al, 1976). Ocular involvement is quite frequent among individuals living in heavily infected hyperendemic areas. (WHO: OCP/73.1; Buck, 1974)

Hanging groins, lymphoedema (in children under ten years of age in particular), papulo-macular rashes (usually on the buttocks, back, and thighs and lower abdomen),

thickening of epidermis, "Sclerodermia", increased skin folds, dilation of pilo-sebaceous and sudoriferous pores formation are some of the clinical syndromes of onchocerciasis. Loss of elastic fibers and xerodermia ichthyosiforme are also seen. (Buck, Onchocerciasis, Symptomology, Pathology, diagnosis-WHO '74)

Hanging groins and other regional lymphadenopathies are observed in onchocercal dermatitis. Association between onchocerciasis and elephantiasis of the genetalia has been observed in onchocerciasis patients in Chad and Zaire. Large numbers of O. volvulus microfilariae have been seen in the superficial dermal lymphatics and the regional lymph nodes. Microfilariae have been in blood vessels also. These observations including deep organ involvement suggest microfilariae dissemination via the haemolymphatic system. A marked loss of weight has been observed in chronic onchocerciasis cases and the weight loss differences were associated with the intensity of infection (WHO: Onchocerciasis: Symptoms, pathology diagnosis, 1974) (edited by A.A. Buck)

Sclerozing keratitis and anterior uveitis are more severe in the savannah region than in the rain forest zone. In hyperendemic areas, heavy invasion of the eye by microfilariae is common in early childhood and permanent lesions may develop in youth leading to blindness at that early age. However, there is an observable decline in microfilariae quantity among the elderly onchocerciasis patients. (WHO: OCP/73.1, Buck, Onchocerciasis, symptomatology, pathology, diagnosis, WHO; 1974)

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BE 3.0 MALARIA IN BENIN

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975): One hundred percent of the population of Benin lived in malarious areas which had no antimalarial measures in effect in 1974. More specific data about geographical distribution was not given by this source.

3.2.2 Prevalence

Pampiglione et al. (1971): Malaria was reported as mesoendemic in Benin in 1971, with a parasite index of 39.1%.

WHO (1975): In 1974 in areas with antimalarial measures, the parasite rate ranged from 11 - 45%. In areas without antimalarial measures the parasite rate was 32 - 89%. Malaria mortality was estimated to be 49.850 per 100,000 in Benin for that year.

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

No country-specific data found.

3.2.5 Population Most Affected

No country-specific data found.

3.3 Vector or Intermediate Host Bionomics

No country-specific data found.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

No country-specific data found.

3.6 Control Measures Against Human Infection

No country-specific data found.

3.7 Vector or Intermediate Host Control

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.2 Eradication by Chemical Means

No country-specific data found.

3.7.3 Eradication by Biological Methods

No country-specific data found.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

Hamon et al. (1969): Resistance of the vector *Anopheles funestus* Giles to Dieldrin was noted in northern Benin in 1963.

WHO (1975): Vector resistance to Dieldrin was reported in 1974.

3.8 Disease Impact

No country-specific data found.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

No country-specific data found.

3.9.2 Laboratory Studies on the Parasite

Pampiglione (1971): The parasite formula in Benin in 1971 was *P. falciparum* - 79%; *P. malariae* - 14%; *P. ovale* - 7%.

WHO (1975): The relative prevalence of *P. falciparum* was 90% in 1974 in areas with antimalarial measures.

3.10 Clinical Studies and Observations

No country-specific data found.

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BE 4.0 TRYPANOSOMIASIS IN BENIN

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Trypanosomiasis is found primarily in northern Benin.

4.2.2 Prevalence

WHO (1969): The prevalence of trypanosomiasis in 1967 was 186 patients out of a total population of 2,505,000.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

WHO (1969): Eleven new cases were reported in 1967.

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

No country-specific data found.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trails

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specific data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): Domestic animals are susceptible to infection by *Trypanosoma brucei* and other zoophilic *Trypanosomae*.

4.10 Clinical Studies and Observations

No country-specific data found.

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BE 5.0 FILARIASIS IN BENIN

5.2 Epidemiology

5.2.1 Geographical Distribution

Sasa (1976): Brengues (1973) indicated that bancroftian filariasis is very common in the south of Benin, but rare in the north.

5.2.2 Prevalence

Sasa (1976): Pfister (1954) reported, based on his examinations of 62 persons from the wooded savannah zone of northern Benin, that 9.7% of the individuals were infected with D. perstans, but none were infected with W. bancrofti or D. streptocerca. Brengues et al. (1969) noted a prevalence rate for filariasis of 20.3% among the people in the region of Athieme on the lower valley of the Mono River. In villages around Lake Aheme (Ouidah region) he gave a prevalence rate of 8.1%. Only 0.2% were found to be infected on the coast near Grand-Popo.

Pampligione and Ricciardi (1971) reported 2 cases of L. loa infection among the 194 inhabitants of Ganvie (day blood).

5.2.3 Intensity

No country-specific information found.

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

No country-specific information found.

5.3 Vector of Intermediate Host Bionomics

5.4 Diagnostic Procedures or Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Against Human Infection

No country-specific information found.

5.7 Vector or Intermediate Host Control

No country-specific information found.

5.8 Disease Impact

No country-specific information found.

5.9 Laboratory Studies

No country-specific information found.

5.10 Clinical Studies and Observations

No country-specific information found.

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Documentation on Studies of Five Major Endemic Diseases in Ten African States

Part B
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Section II
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CA 1.0 SCHISTOSOMIASIS IN CAMEROON

1.2 Epidemiology

1.2.1 Geographical Distribution

Three types of schistosomiasis - S. mansoni, S. haematobium, and S. intercalatum - are reported in Cameroon. Each will be discussed in turn:

a. S. mansoni

Ansari (1973): The following information was given by Deschiens (1960), cited by Ansari. The main territory for S. mansoni infection includes the Adamaoua plateau and extends into the departments of M'Bam and Loum and Kadei.

S. mansoni is also found in the northern province of Diamare, (with S. haematobium), but south of Diamare, in the plain region, the disease is rare. In the northwest moutainous region of the country, prevalence is moderate. The cities of the central south (Yaounde, Mbalmayo) are variably affected, but prevalence rates are sometimes very high. Finally, in the east and extreme south of Cameroon, there exist S. mansoni foci of varying importance. Of these foci, the ones at Ebolowa in Ntem Department as well as those in Kribi and Mungo Departments are especially important.

b. S. haematobium

Ansari (1973): S. haematobium is found throughout northern Cameroon, from the banks of Lake Chad to the northern slope of the Adamaoua plateau. As the result of worker migration from the main northern focus, new foci have been established elsewhere

in the country, in cities like Ngaoundere, Bafia, and Bertoua. Native pockets of S. haematobium have also been found, in Barombi-Mbo, Barombi-Kotto, Kribi, Vallee du Loum and Kadei. Furthermore, it appears that S. haematobium is spreading in Mungo Department and in the southwest.

Ngalle - Edimo (1972): The new Mungo focus extends from Loum to Njombe.

c. S. intercalatum

Deschiens et al. (1969): The first published report of S. intercalatum in Cameroon came in 1966, from the town of Eseka in Nyong and Kele. Since the first report, several additional foci of S. intercalatum have been discovered. The eight foci known as of 1969 are, in order of discovery:

Eseka	(maritime Sanage),
Obala	(Nyong and Sanaga),
M'Balmayo	(Nyong and Sanaga),
Edea 1	(maritime Sanaga),
Edea 11	(maritime Sanaga),
Yaounde	(Nyong and Sanaga),
Bokito	(M'Bam)

Deschiens (1971): Cases of S. intercalatum have also been found in Ngaoundere (Adamaoua Department), Garoua (Benue Dept.), and at Maroua (Diamare).

A disagreement exists in the literature concerning the geographical dynamics of S. intercalatum in Cameroon: Sigam 1971 claimed that S. intercalatum was only recently introduced into the country, brought by workers from Gabon and the Congo.

Deschiens (1971) supported this view based on his discovery of additional S. intercalatum foci, first in Central Cameroon and then in Chad. He stated that the disease is spreading north within Cameroon, via traditional nomadism and the exchange of laborers into area where the vector snails are already present.

Southgate et al. (1976) has recently proposed an opposing viewpoint, as the result of snail studies in Loum. Southgate has suggested that S. intercalatum is actually endemic to Cameroon and that, rather than spreading, it is losing out to S. haematobium. According to the Loum study, the S. haematobium vector snail, B. rohlfsi, is larger and sheds more cercariae than B. forskalii, the vector for S. intercalatum. Plus, the Loum data suggests that extensive hybridization is occurring between the two schistosome strains. Southgate has suggested that these two factors, when combined, tend to favor the expansion of S. haematobium by a competitive process known in genetics as "introgressive hybridization". Also, according to Southgate, recent forest clearance favors B. rohlfsi and thus S. haematobium.

1.2.2 Prevalence

a. S. mansoni

Deschiens et al. (1960) found the following prevalence rates in the Adamaoua plateau, the main Cameroonian S. mansoni focus:

Ngaoundere	6%	Tibate	5%
Dourou plain	26%	Tignere	6%
Meiganga	16%		

In the northwest moutainous region of the country, Deschiens et al. quoted a rate of 30% at Godola. In the south, two studies cited by Deschiens et al. found infection rates near 70% in the Melen quarter of Yaounde.

b. S. haematobium

Deschiens et al. (1968) quoted an average infection rate for northern Cameroon of 15-20%, with certain areas (e.g. Logone flood plain) reaching 90-98%. At Njombe, in the new Mungo focus, Deschiens et al. stated that S. haematobium prevalence was about 10%.

Ansari (1973) gave further prevalence information for S. haematobium. The new S. haematobium foci of Ngaoundere and Bafia were found to have infection rates of 20% and 60%, respectively. Data were also given for the following native foci: Barombi Mbo (over 80% prevalence), Barombi - Kotto (45-95%), and Kadei river valley (over 50%).

c. S. intercalatum

Deschiens et al. (1969) gave the following information for the eight original Cameroonian foci of S. intercalatum infection:

City	Department	No. exams	No. cases	%Infec.
Eseka	(maritime Sanaga)	1,541	277	17.90
Obala	(Nyong and Sanaga)	140	8	5.71
M'Balmayo	(Nyong and Sanaga)	16	2	12.50
Edea 1	(maritime Sanaga)	123	11	8.90
Edea 11	(maritime Sanaga)		216	
Yaounde	(Nyong and Sanaga)	251	61	24.30
Bokito	(M'Bam)	600	35	5.83

1.2.3 Intensity

Van Wijk (1969) published a study on schoolchildren in Loum. On the basis of that study, he suggested that there may be a relationship between a low infection rate of young age groups in a population and more serious clinical symptoms when the disease becomes apparent. In short, the degree of acquired immunity might determine the clinical course of the infection.

Van Wijk (1976) examined 500 schoolchildren in Loum. Of the 54% found to be infected by S. intercalatum, less than 1% of the cases sought medical attention for symptoms of schistosomiasis. Most children were asymptomatic. No deaths occured. Observations on 500 hospital patients also generally failed to associate significant disease with the infection.

1.2.4 Incidence

No country-specific information found.

1.2.5 Type of Population Most Affected

Deschiens (1968) showed that in Edea and Eseka, women and children under 9 were most affected by S. intercalatum. Children were especially affected. Deschiens explained the sex specificity by noting that in the two villages studies, women did most of the water chores.

Deschiens (1969) wrote that in Melen, a lake quarter of Yaounde, the sex specificity found in Edea and Eseka did not exist: the fishermen and their wives and other workers in water-related industries had similarly high prevalence rates. Children in that area, however, whose contact with water was limited due to the steepness

of the banks, had a low prevalence of infection. In short, water contact was clearly the determinant of infection rates.

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari, (1973), Deschiens et al (1968), Ngalle-Edimo (1972):

S. haematobium	
In North Cameroon	B. truncatus, B. globosus, B. (Physopsis) africanus
Central Cameroon	B. truncatus
West and South Cameroon	B. truncatus rohlfsi
S. mansoni	
Adamaoua and West Cameroon	B. pfeifferi
Adamaoua and elsewhere (most common vector)	B. camerunensis
S. intercalatum	B. (P) forskalii

1.3.2 Deschiens, et al (1968) sampled the snail population at Eseka and found 30% B. (P) forskalii (60% infected) and some Biomphalaria (60% infected). The location and size of these snail population was found to correspond nicely with nearby disease prevalence rates: 18% S. intercalatum, 2.4% S. mansoni.

1.3.3 Environmental Factors Influencing Distribution

Southgate et al. (1976) studied the competition between B. truncatus rohlfsi and B. forskalii. He noted that rohlfsi and other S. haematobium vectors are commonly found in water bodies in open savannah, but are less common in forested areas. On the other hand, he suggested a forest origin for S. intercalatum, carried by

B. (P) forskalli.

Deschiens et al (1968): B.P. forskalii has a wide tolerance of ecological conditions but is generally found in streams or small channels rather than in large bodies of water.

1.4 Diagnostic Procedures or Techniques

1.4.1 General Diagnostic Methods

Sigam (1971), working in Cameroon, provided diagnostic descriptions to distinguish between S. haematobium, S. mansoni, and S. intercalatum:

S. haematobium

a - male worm has 4 testicles

b - female worm has posterior genitals; uterus contains several eggs with posterior spurs

c - mollusks of genus Bulinus act as hosts

d - eggs are Ziehl negative

e - worms localize in the vesical plexus, so eggs are found in urine.

S. mansoni

a - male worm has 8 testicles

b - female has anterior genitals, and produces only one lateral-spurred egg at a time

c - Mollusks of genus Planorbus act as hosts

d - Worms inhabit inferior mesenteric veins, so eggs are found in stools.

S. intercalatum

a - like S. haematobium, eggs have posterior spur.

b - Ziehl methyl green test positive

c - Worms localize in lower intestine (very occasionally, they are found in a vesical biopsy)

Species	Ziehl - color		Spur
S. mansoni	+	bright red	lateral
S. haematobium	-	green	terminal
S. intercalatum	+	red	terminal

1.4.2 New Diagnostic Techniques

No country specific information found.

1.5 Therapeutic Trials

1.5.1 Studies on New Drugs

No country specific information found.

1.5.2 Mass Treatment

Van Wijk (1969) in a hospital in N'doungue, compared the effects of treating S. intercalatum with three drugs: anthiomaline, Astiban, and niridazole. Niridazole showed the least number of side effects. This drug also led to the highest percentage of patients in whom the AMS concentration method failed to reveal eggs in the feces 1 month after the completion of treatment.

Duke and Moore (1976) studied the effects of mass treatment of S. haematobium with niridazole at the Barombi foci (Barombi-Mbo and Barombi-Kotto) in Cameroon. Treatment began 2 months after snail control; it consisted of 25 mg/kg/day of Ambilhar CIBA (niridazole) to all egg passers for 7 days in 2 equal morning and evening doses. Most treated patients stopped passing live eggs. Those who became positive again were thought to be reinfected, not relapsed. The drug was well tolerated. With concurrent snail

control, the total load of S. haematobium eggs decreased to less than 1% of the pre-control figure. This reduced level was maintained by subsequent treatment. Still, 0.6-50.9% of persons continued to pass some live eggs, so when the program stopped, transmission built up again. Prevalence in man rose faster than intensity of infections.

1.5.3 Problems Encountered

No country-specific information found.

1.6 Control Measures Against Human Infection

1.6.1 Chemoprophylactic Measures

No country-specific information found.

1.6.2 Other Protective Measures

Gamet (1964) reported a reduction in schistosomiasis in Yaounde, effected by educating people to keep out of infected water. The reduction from 1960 to 1963 was from 283 to 122 annual cases.

1.6.3 Problems Encountered

No country-specific information found.

1.7 Vector or Intermediate Host Control

1.7.1 Eradication by Mechanical Means

No country-specific information found.

1.7.2 Eradication by Chemical Means

Duke and Moore (1976), as part of the Barombi foci schistosomiasis control efforts described above in 1.5.2, applied Frescon-Shell (N-trityl morpholine) in the lakes as a molluscicide. The chemical was distributed from a boat using a pump with a long hose to give

2 ppm throughout the bottom 0.5 meters of water, extending to the 1.5 meter depth line on all transmission beaches. Initially, double applications, 12-14 days apart, were made at 3 month intervals. Later it was found that single applications at 6 week intervals gave even better results; double applications were not necessary despite the fact that Frescon does not kill eggs. With this program, snails were reduced to 1% of pre-control levels at Barombi Kotto and below the measuring threshold at Barombi Mbo.

Gamet et al. (1964) reported the successful use of cuprous oxide as a selective molluscicide in the ponds of the Yaounde pisciculture station.

Deschiens et al.(1965) compared cuprous oxide and cuprous chloride in a molluscicide field test. Of the two compounds, cuprous chloride was found to be the more active and less expensive, but shorter-lasting choice. (For a detailed review of Cameroonian government laboratory efforts in snail control, from 1963 to 1972, see Ngalle-Edimo, 1972)

1.7.3 Eradication by Biological Means

Ngalle-Edimo (1972), reviewing government efforts in snail control, described the use of the predatory fish astatoreochromis alluaudii to reduce snail numbers. Between 1963 and 1966, the fish, imported from Uganda, were tested in a reservoir tank, lab aquarium, and two lakes. Malacophagic action was verifiable in the tank and the lab, but in the lake fish numbers were greatly reduced due to predation and lake drainage. By 1967, it was impossible to count how many fish remained, but the number was very small.

1.7.4 Other Control Measures

No country-specific information found.

1.7.5 Problems Encountered

Duke and Moore (1976): The Barombi lakes control program, described under headings 1.52 and 1.72, sucessfully controlled snails at the lake margin as well as reducing S. haematobium prevalence to a very low level. However, the control could not reach the "breakpoint" of transmission, which for S. haematobium seemed so low as to be synonomous with eradication. A continuing program of this sort, aimed at keeping prevalence of infection low, would cost 9-10 U.S. dollars per year per head. This is too expensive, considering that $9-10 is 3 times the total yearly per capita health expenditure in that region.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

1.9.1 Laboratory Studies on the Vector

Southgate et al. (1976) studied the natural hybrids of S. intercalatum and S. haematobium found in Loum, Cameroon. The two possible hybrids were bred in the laboratory. In addition, a small group of children passing hybrid eggs were studied. The hybrid S. haematobium ♂ x S. intercalatum ♀ was found to be successful. Many eggs were passed through the urine. (The male worm, after mating, carries the female to the egg laying site, so passage of eggs through the urine was predictable in this case). The reciprocal cross, S. haematobium ♂ x S. intercalatum ♀, was non-viable. Only a few eggs were passed through the feces.

Frandsen (1975) examined the susceptibility of 13 different B. forskalii strains to infection with S. intercalatum from Cameroon.

The best snail hosts (59.0-94.4% infection rates, 0-28.4% death rates) proved to be from Zaire, Cameroon, and Gabon. B. forskalii from Senegal and Rhodesia, as well as B. reticulates wrighti from Aden, gave intermediate results. The Tanzanian strain of B. forskalii was resistant to infection.

1.9.2 Laboratory Studies on the Parasite

Sigam (1971) concluded, after a search for other natural hosts, that S. intercalatum is specific to humans. However, lab tests have shown susceptibility to infection in sheep, a species of monkey (Cercopithecea), and mice. Some authors have suggested that an infective reservoir of S. intercalatum exists in these animals, but no supportive field evidence has been uncovered. (See also Frandsen's study under 1.9.1)

1.10 Clinical Studies and Observations

Becquet (1976) studied an infected patient from Edea in Cameroon. The patient reported generalized coldness, diffuse pain, anorexia, constipation, and attacks of pruritis. Becquet noted tachycardia, sensitivity in the descending colon, and enlargement of the spleen and liver. The rectal mucosa was congested, edemic, and bled easily. A rectal biopsy showed numerous S. intercalatum eggs. The patient's stools also contained viable eggs.

Van Wijk (1969) studied 228 patients from 1965 to 1968 in the hospital of N'doungue (Mungo Department). The following information was collected:

Eggs in urine	0
Toxemic symptoms, others (Abdominal symptoms predominated)	4/228
Blood in stools	148/228

Anorexia, nausea, vomiting, diarrhea	24/228
Liver enlargement (slight)	50/140
Spleen enlargement (slight)	8/140
Portal hypertension	0

Van Wijk (1975), in a later study, took 49 needle biopsies and 16 rectal biopsies from S. intercalatum patients at N'doungue hospital. The histopathology of S. intercalatum was compared to that of S. mansoni, with the following conclusions:

a. Outside the portal triangle, eggs are less frequent in S. intercalatum infection, perhaps because S. intercalatum eggs are larger than those of S. mansoni.

b. S. intercalatum granulomata are smaller than those resulting from S. mansoni.

c. S. intercalatum infection does not cause liver cell destruction, nor does it lead to the profound vascular changes sometimes found in S. mansoni hepatosplenic schistosomiasis.

d. Pigment formation is more extensive in S. intercalatum infection than in S. mansoni infection.

e. Kupfler cells are hypertrophied in S. intercalatum infection.

f. The cause of the difference in liver lesions due to S. intercalatum and S. mansoni infections in man might be a lower immune response to S. intercalatum egg antigens.

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CA 2.0 ONCHOCERCIASIS IN CAMEROON

2.2 Epidemiology of Onchocerciasis

2.2.1 Geographical Distribution

Epidemiological surveys done in different parts of Cameroon show that onchocerciasis is found in both the rain-forest and savanna zones. Villages in forested areas of the Mungo River have moderately heavy transmission of O. volvulus, while in the villages of Bolo and Wemę on the upper tributaries of the Mungo River transmission O. volvulus is known to be very heavy. Prevalence studies (see 2.2.2) in both the savanna and rain-forest regions have shown onchocerciasis to be common in all of the two bioclimatic zones (prevalences in the rain-forest villages was 95.4% and in the savanna zone it was 92.5%. The ranges were 87.0 to 97.1 in the rain-forest and 84.6 to 99.2 in the savanna). Baoussi, on the northern part of the Adamaoua Plateau (approximately 7° 32' N. and 13° 54' E) is an endemic area. Other areas where the disease is found include Bolo, near Bolo village on the tributary of the Mungo River, (West Cameroon, 4° 50' N. and 9° 25'E.), Sanago on the bank of the Sanaga River East Cameroon, along the banks of Dja River (East Cameroon), along the Rio Tiburones River, along the Kimbe River, West Cameroon; along the Loum, Faro and the Benoue Rivers in East Cameroon. (Duke et al, 1966).

2.2.2 Prevalence

Onchocerciasis is prevalent in Cameroon. Epidemio-

logical surveys and studies have been conducted in various parts of the country which indicate significance of the disease in endemic areas.

Anderson et al (1975) examined 1,220 persons from 8 heavily infected savanna villages and 1,151 from 8 villages in the rain-forest zone equally infected. The results from the 16 villages showed a prevalence rate of 95.4% in the rain-forest villages and 92.5% in the savanna villages with ranges of 87% to 99.2% in the savanna (Anderson et al, 1974). The overall prevalence of nodules was 69.5% in the rain-forest, ranging from 60.6 to 80%, and 54.3% in the savanna with ranges between 40.0 and 70.5. Prevalence among the 5-9 year olds in the rain-forest communities was over 80% (this prevalence was in both sexes). In the savanna communities, that level of prevalence was not reached until the age range of 10 to 14 years. Both sexes were almost 100% infected by age of 20 years.

Anderson and others conducted another study in the village of Bavussi on the northern part of the Adamaoua Plateau in 1975 (Anderson et al, 1975), which showed that nearly one half (½) of the population was infected with Onchocerca volvulus.

Duke et al (1972) did some skin snips and nodule counts on approximately 910 residents of Bakingili, Barombi Mbo, and Bolo communities from 1968-1969. A transmission potential of 3,000 and above was observed. This high transmission potential is associated with high

prevalence and intensity of infection, and with significant skin and eye lesions (Duke et at, 1972).

2.2.3 Impact on Economy

The economic impact caused by onchocerciasis is clearly seen in those areas where the disease is found. As stated below (2.8.1), many fertile arable areas have been left due to the high transmission and infection rates. Such agriculturally suitable areas are not utilized for farming activities. As a result, the total agricultural output is affected. This could cause the government to spend a significant amount of money and time to eradicate the disease and/or resettle people. (WHO: OCP/73.1)

Thomson (1974) found that onchocerciasis was endemic in the N'dian Oil Palm Estate situated in the tropical rain-forest zone northwest of Mount Cameroon, where the disease accounted for over 20% loss of all working days. According to Thomson, onchocerciasis constituted the main cause of ill-health and loss of working days in the Oil Palm Estate in Cameroon.

In the 1970/72 survey at Kumba in Southernwestern Province, the prevalence of head nodules was 1.7% in 1,098 onchocerciasis cases reported in the rain-forest region and 0.6% in 1,128 cases from the savanna zone of Cameroon. A follow-up survey in the same community 3-4 years later showed that the prevalence of head nodules was 5.5% and 5.0% in the respective zones. There was a strong association between head nodules and lesions of both the anterior and posterior segments of the eye. The relative

risks of having eye lesions in patients with head nodules were 2.9 in the rain-forest and 7.5 in the savanna zone. Clinical cases in a group of 483 with ocular onchocerciasis (from the savanna) palpable head nodules were detected in 23.6%. In a further 140 selected cases from the same area with posterior segment eye lesions, head nodules were found in 31.4%. Onchocercal origin of nodules was confirmed by biopsy and many head nodules probably remain undetected in onchocerciasis surveys (Duke et al, 1972).

A high rate of blindness coincides with areas where the Sudan-savanna parasite-vector (O. volvulus - S. damnosum) complex has been found e.g. blindness is more prevalent in the Sudan-savanna zone than in the rain-forest area (Duke et al, 1966). Prevalence of onchocerciasis in persons aged 5 years and over ranged from 85 to 94% (Anderson et al, 1974). Blindness rate among Onchocerciasis positives was 48% in the savanna and 1.8% in the rain-forest.

2.2.4 Intensity

The intensity of infection is high in endemic areas where there is heavy infection. Areas with very heavy infection and transmission rates have also high intensity of the disease. The mean intensity value at Baoussi on the northern part of Adamaoua Plateau was found to be 8.8/skin snip in the 30-39 age group, 9.2/skin snip in the 40-49 year olds and 9.7/skin snip among individuals 50-59 years of age. The respective ranges were 1-32, 1-55 and 1-64. (Anderson et al, 1975)

In general the intensity of infection is definitely high in the heavily infected population and increases with the increase in age, being higher in males than females. However, Duke et al (1975) found that the intensity of O. volvulus infection was related to the annual transmission potentials to which the communities were exposed. Seasonal transmission was a significant factor. The more perennial the transmission the heavier the degree of intensity of infection, eye lesions, and blindness. Annual transmission potentials of about 500,1750, 1800 + and 2900 were associated with an increase in the mean intensity of infection. Annual transmission potentials of 440 and 19000 were recorded on the riverbanks where the S. damnosum breed near the four hyperendemic communities, in the Cameroon-Sudan-Savanna (Ndiki, Mbai-Mboum, Koumban and Bedara). But no dwellings were sited at such places, as no community could possibly survive under such conditions (Anderson et al). Anderson et al (1974) also showed, that the intensity of skin infection was higher in the rain-forest zone than in the savanna and attributed this difference to the early onset of infection in the rain-forest region. The infective biting density of S. damnosum is equally important as far as the intensity of infection is concerned.

2.2.5 Incidence

The incidence rates of onchocerciasis are related to the degree of infective biting density of S. damnosum in the peak seasons and the population's level of exposure

to the bitings of the infected flies. Although no specific rates of incidences are given in any of the studies reviewed, it is quite obvious that incidence rates vary from one endemic area to another depending on the factors influencing the biting density of the vector and the transmission potentials. The variation also depends on the quantity of infective O. volvulus larvae introduced into the human body during the biting activity of female Simulium flies. (Anderson et al, 1973; Duke, 1968)

2.3 Vector or Intermediate Bionomics

2.3.1 Species of the Vector Transmitting Onchocerciasis

Species of the black fly, Simulium damnosum complex, are the vectors responsible for the transmission of Onchocerca volvulus, the parasite causing onchocerciasis in man. Both the savannah and the rain-forest types of S. damnosum complex species are found in Cameroon.

There have been no cytotaxonomic studies done in Cameroon in order to identify the specific forms of S. damnosum found in Cameroon. Differential dispersal of S. damnosum in the Cameroon-Sudan Savannah all fell into color class C of Lewis and Duke (1966) (Duke, 1960) and belonged to cytotaxonomic form "Nile" (Dunbar and Vajime, 1971, cited by Duke, 1966); flies from the Guinea savannah were of color class B, probably belonging to the "Bille" form of S. damnosum, and those from the Vina du Sud River near Wakwa were shown by Duke et al (1966) to support the Cameroon forest strain of O. volvulus.

Experiments on the Meme River indicated that the forest flies, which belonged to the color class A (Lewis and Duke (1966), cited by Duke, 1966) and were probably of the cytotaxonomy "Bille" form, showed a different dispersion pattern to the species in the savannah. These flies contribute to the more widespread infection with O. volvulus found in the forest zone (Budden, 1963, cited by Duke, 1966).

2.3.2 Vector Distribution

As mentioned in 2.3.1 above (Budden, 1963; Duke 1966) species of Simulium damnosum was found in both the Sudan Cameroon savannah and the forest bioclimatic zone. Parous flies were not found further inland from the Meme riverbanks whereas nulliparous flies did move into the inland. Hence the two main O. volvulus - S. damnosum complex groups of the vector are widely distributed in their respective bioclimatic zones. The vector flies are common along the Vina du Nord River, the Vina du Sud, the Mbere and the Benoue Rivers as well as along the Meme River.

2.3.3 Environmental Factors Influencing the Distribution and Activity of S. damnosum

There are definite environmental factors which strongly influence the distribution, survival and activity of the vector flies. Among these are the climatic conditions of the area, the relief and rainfall, and the vegetation along the riverbanks where the vector breeds. Temperature fluctuations, the water levels (in the savannah) during different times of the year, the availa-

bility of support for larval attachment, adequate water speed and food availability for the larvae as well as blood meal in the immediate breeding sites for female S. damnosum.

The biting activity of the vector is also influenced by such factors as temperature (the tolerable ranges being between 17°C and 30°C), winds, rains and other meteorological factors which may be favorable or unfavorable for the biting of S. damnosum (WHO: Onchocerciasis Control in the Volta River Basin Area. Annex III-1, Geneva, 1973)

2.3.4 Breeding Sites

S. damnosum in Cameroon breed in similar ecological conditions as those found in other onchocercal areas of western Africa. In the Cameroon-Sudan savannah zone S. damnosum breed in well shaded rivers where the current speed and water conditions are most suitable for the survival of the larvae and pupal stages of the fly. Similar conditions are also observed in the forest region where breeding is less influenced by the seasonal changes. Breeding sites were located by Duke (1975) in the Guinea savannah on the Vina du Sud River, on the Mbere, Vina du Nord and Benoue Rivers in the Sudan savannah and on the Meme River in the forest zone (Duke, 1975).

2.4 Diagnostic Procedure

2.4.1 General Diagnostic Methods

Methods used in the diagnosis of onchocerciasis in the Cameroon include the search for nodules by palpation, examination of microfilariae in skin snips taken from different parts of the patient, the use of the Mazzotti test and examination of the urine specimen for microfilariae as well as the demonstration of microfilariae in the eye chambers (in advanced stages). (WHO: OCP/73.1)

2.4.2 New Diagnostic Techniques

No extensive studies have been done relevant to the development of new diagnostic techniques for onchocerciasis in Cameroon. (Fuglsang and Anderson, WHO/ONCHO/77.133) did try to use diethylcarbamazine (DEC) intradermally instead of orally by injecting 0.01% and 0.001% solutions of DEC in 25 volunteers with proven onchocerciasis from the Cameroon rain-forest area. The higher dose produced a localized papular eruption after 24 hours in one heavily infected patient and it was concluded that a higher dose of DEC (0. 1 -10 mg.) might give fewer false negative results but the practical value of the technique must be further studied (Fuglsang and Anderson, WHO/ONCHO/77.132) Gibson *et al* (1976) observed some distinguishing ultrastructural features in microfilariae of *O. volvulus*. These included lack of sheath, the greater distance between striae, the larger diameter and longer cephalic and caudal spaces (Gibson *et al*, 1976).

2.5 Therapeutic Trials

2.5.1 Clinical trials

Duke (1968) studied the intake and transmissibility of O. volvulus microfilariae by Simulium damnosum fed on patients treated with diethylcarbamazine, suramin or Mel. W. From his study, Duke concluded that in order to eliminate the reservoir of transmissible microfilariae in man, treatment should include the macrofilaricide and microfilaricide drugs. The only two macrofilaricides known to be effective were suramin and Mel. W. while DEC was the known microfilaricide effective against microfilariae. Duke also studied the effects of the antimonial preparations TWSb and MSbE on O. volvulus (Duke, WHO/ONCHO/ 67.62) in Kumba, West Cameroon. Results of the effects of TWSb and MSbE on the concentration of microfilariae in the skin led him to the conclusion that (1) the action of antimonials TWSb and MSbE against O. volvulus varies from patient to patient; (2) antimony has definite microfilaricidal properties almost similar to those of diethylcarbamazine; (3) it has some action in blocking embryogenesis and killing adult worms at high concentrations in a few patients; and (4) the toxicity and dangers of the products tested, together with the uncertainty of their parasiticidal action make them unsuitable for use in the treatment of onchocerciasis. The dosage for

TWSb was 26-58 mg/kg and for MSbE it was 7-29 mg/kg. There was evidence of micro- and macrofilaricidal action even though the actions of both drugs against the parasites varied greatly. There was one fatal case and toxic reactions were common thus making these preparations unsuitable for the treatment of onchocerciasis.

In another study, Duke (1968) treated patients (adult males) from Bolo, Weme and Baduma community complex and from Bombe, Mundame and Bombele communities, all of which are in areas where transmission is known to be moderate to very heavy, with Melarsonyl Potassium (Mel W.). The patients were infected with the Cameroon forest strain of O. volvulus while another group from Voko and Djełop was infected with the Cameroon-Sudan savannah strain of O. volvulus. The Mel W. used was Trimelarsan (specia, Paris). Two intramuscular dosage schedules of four consecutive daily doses of 200 mg (2(4 x 200 mg) and a single dose of 500 mg (7.1 - 10 mg/kg) were used. Results showed that in most trials the drug had no immediate action on microfilarial concentrations. A slight microfilaricidal action was detected after the 2 (4 x 200 mg) Mel W. course against the Sudan savannah strain of O. volvulus. The 2 (4 x 200 mg) Mel W course apparently killed or sterilized most or all of the adult female worms. Single doses of Mel W at 7.1 - 10 mg/kg were less effective against the adult worms, but if higher doses were repeated

annually, the microfilariae could be eliminated at the end of the third year. However, the risks of arsenical encephalopathy preclude the use of Mel. W in the treatment of onchocerciasis (Duke, WHO/ONCHO/68.72). Duke also showed that diethylcarbamazine kills microfilariae in the skin but has no effect on the adult O. volvulus. This was shown by the fact that microfilariae concentration built up again and after one year they reached 30 to 100% of their pretreatment level.

Anderson et al (1976) in a study of the effect of diethylcarbamazine on ocular onchocerciasis, concluded that diethylcarbamazine (DEC) was a very difficult drug to handle in cases with severe ocular involvement of onchocerciasis; the drug can reduce the numbers of microfilariae in the eye and skin; and when used in combination with a corticosteroid can quieten lesions of the anterior segment but not the posterior. Anderson et al also found that the drug must be handled with great care in heavily infected patients with ocular complications and the drug has some adverse effect on the optic nerve (Anderson et al, WHO/ONCHO/76.122).

2.5.2 Studies on New Drugs

The use of Mel. W, DEC, TWSb and MSbE in mass therapeutic trials have not been carried out in Cameroon because of the severe adverse effects observed during the clinical trials of the drugs (Anderson et al WHO/ONCHO/76.122; Duke, 1968).

2.5.3 Problems

The problem in therapeutic trials in regard to the treatment of onchocerciasis is the lack of a drug that is effective against both the microfilariae and the adult O. volvulus parasites. Drugs that have been tried and are not being used for the treatment of onchocerciasis require very careful handling and supervision by an experienced clinician so that they cannot be used in large-scale therapeutic campaigns. (Anderson et al, WHO/ONCHO/76.122; Duke, 1968)

2.6 Control Measures Directed Against Human Infection

2.6.1 Prophylactic Measures

There are no prophylactic (chemoprophylaxis) programs being conducted in Cameroon according to reports reviewed. The use of DEC, suramin, Mel. W, and other macro- and microfilaricidal drugs for chemoprophylaxis has hot been feasible due to their toxic effects and other serious adverse reactions. Also, there are great difficulties involved in handling them. (Duke, 1968)

2.6.2 Other Protective Control Measures

No specific information found.

2.6.3 Problems Encountered

No specific information found.

2.7 Vector Control

2.7.1 Vector Control by Mechanical Means

There are programs in the endemic areas of Cameroon aimed at eradicating the vector by mechanical means such as destroying the breeding sites of S. damnosum flies and clearing the vegetations along the riverbanks thus destroying the vector's habitat.

2.7.2 Eradication by Mechanical Means

No country specific information found.

2.7.3 Eradication by Biological Means

No country specific information found.

2.7.4 Other Control Measures

No country specific information found.

2.7.5 Problems Encountered

No country specific information found.

2.8 Disease Impact

2.8.1 The Impact of Onchocerciasis on the Population

Onchocerciasis has a very significant impact on the population in the endemic areas. In heavily infected parts of the country there is a constant migration to less affected or onchocerciasis free areas. Such a population shift from the areas where the transmission and intensity of infection are very high causes unnecessary overpopulation in certain parts and underpopulation in others. In many cases, the hyperendemic areas are those along the river valleys which are most suitable for agricultural products. Hence such fertile arable land is abandoned. (WHO: OCP/73.1)

2.8.2 Ameliorative Programs

No country specific information found.

2.8.4 Problems

No country specific information found.

2.9 Laboratory Studies or Research

2.9.1 Studies done on the Vector Simulium damnosum

Several studies have been done on S. damnosum, the vector transmitting Onchocerca volvulus (the parasite causing onchocerciasis) by the Helminthiasis Research Unit, Centre de Researches Medicales, Kumba, West Cameroon. Phoretic simuliid were classified in two subgenera1 (Crosskey, 1969, cited by Lewis & Disney). Subgenus Lewisellum includes S. atyophilum, the pupae of which are attached to prawn (Disney, 1969, quoted by Lewis and Disney). The other species,which include S. neavi and S. woodi; vectors of O. volvulus, are associated with crabs. The subgenus Phoretomyia includes S. dukei which may transmit O. volvulus occasionally (according to Duke, 1962) and is associated with prawns while the other species are associated with mayfly numphs and do not bite man. Duke (1975) found that parous Simulium flies in the Guinea savannah belonged to the cytotaxonomic form "Bille" although their dispersal pattern was different from that of flies in the forest zone. Dissections of Simulium damnosum in the Sudan savannah indicated that nulliparous flies dispersed inland away from their breeding sites while parous flies stayed along the banks, close to their breeding sites.

2.9.2 Studies Done on Onchocerca volvulus

Garner et al (1973) did a comparitive study of the lesions produced in the cornea of the rabbit eye by microfilariae of the forest and Sudan savannah strains of O. volvulus. Results showed that microfilariae of the Cameroon-Sudan savannah strain of O. volvulus provoke a greater degree of inflammation in rabbits subconjunctiva than the forest strain of O. volvulus. Live microfilariae of both strains caused severer reaction in the conjunctiva than dead ones. Duke and Anderson (1972) (cited by Garner et al, 1973) also showed that microfilariae of O. volvulus from the Sudan savannah region of Cameroon have a greater propensity to invade the cornea and evoke an inflammatory response when injected into the subconjunctiva of the rabbit than microfilariae from the forest region.

Brycesón et al 1975 showed that microfilariae lack some antigens possessed by adult worms. The results also showed consistent savannah/forest differences in worm antigen patterns and antibody responses (Brycesón et al, 1975). Gibson et al in ultrastructural studies of microfilariae and host tissues before and after treatment with DEC (Hetrazan) found that microfilariae of O. volvulus have ultrastructural features similar to those of microfilariae of other genera. However, there are some distinguishing features which include the lack of a sheath, the greater distance between striae, the larger diameter and longer cephalic and caudal spaces.

No ultrastructural differences were noticed between strains from the forest and savannah regions.

Duke and others (1966) showed that microfilariae of O. volvulus from the forest areas of Cameroon developed well in S. damnosum species from the forest and Guinea savannah zones while microfilariae of O. volvulus from the Sudan savannah did well in S. damnosum flies from the same bioclimatic zone. Phillipon and Bain (1972) (quoted by Duke et al, 1975) observed that when Sudan savannah S. damnosum ingested large numbers of microfilariae, many of the parasites were eliminated at the microfilarial stage in the gut of the fly-- few developed.

2.10 Clinical Studies and Observations

Microfilariae of O. volvulus are mostly found in the lower extremities (the pelvic girdle, calves, and ankles) among patients in the African onchocercal areas and in the head in Latin American patients and young children in Africa. The parasites have also been found in other anatomical sites and organs of the body, particularly in heavily infected patients, e.g. in the groins, the lymph nodes, etc. (Duke, 1968)

Altered pigmentation is usually the first clinical manifestation in onchocercal dermatitis. Pruritus is most common in the lower trunk, buttocks, thighs and shins among patients in the onchocercal areas in Africa. Focal swelling of the skin ("peau d'orange"), lichenoid change and atrophy of the skin (in the late stage) are observed conditions in onchocercal dermatitis. (Buck, 1974)

Vascular proliferation with thickening of the capillary walls and increased endothelial cells as well as the disappearance of the fine elastic tissues are among the histopathological conditions in onchocerciasis. (Hamilton et al, 1974)

Anderson et al (1974) observed that itching and associated acute papular eruption were prominent features in the early stages of onchocerciasis infection. Skin atrophy was common among patients from both the rain forest and savannah zones of Cameroon and was most pronounced on the buttocks and thighs. Skin depigmentation was much more common among the rain forest onchocercal patients and it often extended to the posterior aspects of the leg. Lymphoedema of the superficial surface of the skin of the trunk was frequent in patients from the savannah also, and it involved the scrotum and vulva. Visible inguinal and/or femoral lymphadenopathy was found in both the rain forest and savannah areas. Moderate and severe sclerosing keratitis were seen only in the savannah area and trachoma pannus was observed only in the savannah zone. (Hamilton et al, 1974; Fulsang et al, 1976)

Ngu and Blackett (WHO/ONCHO/75.114) showed that there was less marked cellular immune response in patients with diffuse microfilariae skin infiltration than in patients with localized onchocercal lesions in which the microfilariae were difficult to demonstrate (patients with onchocercal eye lesions were included in the latter group). By using indirect immunofluorescence tests, specific IgG and IgM antibodies

appeared to be present in large amounts in sera of patients with diffuse microfilariae infiltration than in the other group. Ngu and Blackett also observed that patients with high lymphocyte transformation had the highest readings for IgG and IgM. There was significant changes in C_3 levels. IgG and IgM complement-fixing antibodies to microfilariae of O. volvulus were detected in the sera of the same patients (Ngu and Blackett, 1976).

The dermatologic and ophthalmologic components of the disease are, therefore, caused by an allergic reaction due to the disintergrating microfilariae (Scheie et al, 1971). Ocular morbidity is the most significant.

CA 2.0 ONCHOCERCIASIS IN CAMEROON

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CA 3.0 MALARIA IN CAMEROON

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975 (4)): One hundred percent of the population of Cameroon resided in malarious areas in 1974. Seventy-eight percent of the population lived in areas that were malarious and without any specific antimalarial measures in operation. More specific data about geographical distribution was not given by this source.

Lantum (1971): Malaria was observed in the northern scrublands and plains, e.g. Dembo; in the wooded savannas and plateaus, e.g. Cumnela; in the equatorial forests and plantation areas, e.g. at Bipindi and in the tropical zone along the western slopes of the Adamaoua Mountains and Foumbat Town.

Pampiglione et al. (1975): Studies of malaria were conducted at Mingongol and Besam in Abong Bang Prefecture and at Nyabitande, Ebenwok, Ngoyang and Kwambok in Kribi Prefecture.

3.2.2 Prevalence

Lantum (1971): In 1962, 1,640 patients received treatment for malaria in Cameroon hospials while 17,2[illegible] were reported as having been treated as outpatients. Mortality due to malaria in 1962 was 10%. In 1964, the Annual Report of the Medical Department of West Cameroon reported that government hospitals treated 3,118 in patients and no record was submitted for the many more treated for malaria in dispensaries. Thirty-nine or 1.25% of the 3,118 inpatients died.

The 1966 Annual Report of the Medical Division of the Cameroon Development Corporation reported that out of a total of 7,917 blood films, 1,267 or 16% were positive for malaria. The Cameroon Development Corp. reported that in 1966 the total number of death due to malaria was 34 and in 1967, it was 27. A study reported that malaria is holoendemic in the northern scrubland and plains, e.g. the city of Dembo. It is hyperendemic in the wooded savanna zones and plateaus; e.g. in Cumnela; it is mesoendemic in the equatorial forests and plantation areas where DDT and Dieldrin were sprayed; e.g. at Bipindi; and the disease is hypoendemic in the tropical zone of Cameroon especially the western slopes of the Adamoua Mountains and the Foumbat Town area.

WHO (1975, (4)): The parasite rate was 3 - 26% in 1974 for areas in which antimalarial measures were operant. In areas in which there were no anti-malarial measures the parasite rate was 28 - 92% and the spleen rate was 30 - 80%. Malaria mortality for that year was 47.059 per 100,000.

Pampiglione (1975): A study was conducted on malaria in several camps in the two prefectures of Abong Bang and Kribi. The camps were identified in 3.2.1. The variation in spleen rates and crude parasite rate as presented below lead the authors to conclude that different epidemiological factors are operant even in a homogeneous environment.

Spleen Rates (%)

Prefecture	Camp	Children	Children & Adults
Abong Bang			
	Mingongol	59.2	35.1
	Besam	33.3	35.8
Kribi	Nyabitande	90.9	63.6
	Ebenwok	60.0	61.5
	Ngoyang	70.0	68.6
	Kwambok	100.0	94.5

Crude Parasite Rate (%)

Prefectures: Abong Bang & Kribi, Dry Season, 1975

Age Group	Range	Average
children	40 - 60	50.9
adults	13.3 - 36.0	22.6
total		33.1

3.2.3 Intensity

Pampiglione (1975): The study of malaria in several camps in Abong Bang and Kribi prefectures revealed the following parasite density indices:

Parasite Density Index (PDI)

infants (0 - 2 years)	1.00 - 5.33
children	1.94 - 2.83
adults	1.33 - 2.53

The average enlarged spleen for the overall population studied was 1.97 with a range of 1.00 - 2.53.

3.2.4 Incidences

No country-specific data found.

3.2.5 Population Most Affected

Abba (1970): Infants less than three months old are considered relatively insusceptible to infection be-

cause of passive immunity received from immune mothers. Out of 290 deaths due to malaria in 1970, 16% were children from birth to fours years old.

Lantum (1971): The first five years of life have high morbidity and fatality rates due to malignant falciparum. After five years of age premunition and tolerable levels of parasitemia without overt disease exist but leave the child debilitiated and with increased susceptibility to concomitant infections such as pneumonia, measles and malnutrition. Thus malaria increases morbidity and fatality due to these other conditions. This acquired immunity to malaria is reported to break down under stresses such as pregnancy.

In a 1958 study malaria parasites were found in blood films of infants three to four months old in the southern Cameroon highlands. In the 1964 Annual Report of the Medical Department of W. Cameroon it was reported that most of the 39 deaths out of 3,118 patients were infants with complications of anemia, parasitic worms and malnutrition. Malaria ranked as the third leading cause of death during the first year of life causing 17 of 94 deaths or 20%. In the pre-school population, ages one to four years, malaria claimed 28 out of 124 deaths or 23% in that year (1964)

3.3 Vector or Intermediate Host Bionomics

3.3.1 Species Transmitting the Disease

Mouchee and Garion(1966): *Anopheles moucheti* and

A. hargreavesi were identified.

3.3.2 Vector Distribution

Mouchee and Garion (1966): Anopheles moucheti and A. hargreavesi were identified in South Cameroon. The former was considered the most important vector for malaria in that region.

3.3.3 Environmental Factors Influencing Distribution

Mouchee and Garion (1966): A. moucheti breeds among the floating vegetation e.g. Pistia at the edge of slow-running rivers. Adults are more common near the river and are rarely found further than 2 kms. from breeding sites. There are relatively small fluctuations seasonally in the resting adult population. Consequently, there is little seasonal variation in their feeding activity. Variation is found in the species' predilection for exophily. In a study of the adult female Anopheles feeding on man indoors, it was found that 7.3% left before 12 a.m., 37% left between the hours of 12 - 7 a.m., mostly between 5 - 6 a.m., and 50% stayed indoors for all of their gonotropic cycle. This latter group therefore demonstrated less of a tendency for exophily.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

3.5.1 Studies on New Drugs

Caterinella and Donno (1971): A 1971 study was conducted on the effectiveness of a combination of sulfametopyrazine and pyrimethamine as compared to the

of chloroquine in abatement of malaria symptoms. Three groups were studied. The first group of 89 patients received sulfametopyrazine and pyrimethamine in a 100:5 dose ratio. The second group of 51 patients received the drug combination in a 100.1 dose ratio. The third group received chloroquine, 41 mgs./kgs., total in divided doses for 2-3 days. The results were abatement illness by the following schedule.

	Abatement of	
Group	Fever	Parasitemia
1 (S:P - 100:5)	33.9 hrs.	46.2 hrs.
2 (S:P - 100:1)	51.5 hrs.	55.0 hrs.
3 (chloroquine)	37.9 hrs.	55.4 hrs.

From these results it was concluded that the efficiency of therapeutic and suppressive effectiveness of the drug combination may be compared to that of chloroquine and that the sulfametopyrazine-pyrimathamine combination at a dose ratio of 100:5 proved to be most immediately effective. It should also be noted that the larger dose ratio aided in the prevention of resistance, whereas resistance is induced more readily by smaller doses. The investigators found no difference in therapeutic response in different age groups.

A comparison of the combination of sulfametopyrazine and trimethoprim in a dose ratio of 2:1 with the drugs described above concluded that it was as effective as the others. Fever was noted to have disappeared in 49 hours and the parasitemia in 52.8 hours.

3.5.2 Mass Treatment

WHO (1975 (4)): Antimalarial drug controls were available to only 12.8% of the population of Cameroon in 1974.

WHO (1973): A chloroquine mass drug distribution project which began in 1956 had covered 800,000 school children by 1971.

3.5.3 Problems Encountered

Mbomo and Ochrymowicz (1970): An investigation of a report of the possible development of a chloroquine-resistant strain of *P. falciparum* which may have arisen from massive inoculation programs in schools concluded that a resistant strain had not developed.

3.6 Control Measures Against Human Infection

3.6.1 Chemoprophylactic Measures

Abba (1970): This author recommends that suppressive therapy be given to children between six months and three years of age after which the child's own partial immunity may take over.

WHO (1975 (6)): Cameroon has conducted a major chemoprophylactic protection program against malaria for most infants, children and pregnant women.

3.6.2 Other Protective Measures

Lantum (1971): Cameroon instituted a ten-year Malaria Pre-eradication program in 1962. The goals of the program were to develop a network of basic health services upon which an eradication program could be built; to train personnel; to survey the epidemiology

of malaria; to improve diagnostic facilities and to increase the availability of antimalarial drugs. Both the GOC and the World Health Organization have made substantial contributions of personnel and money. For instance, in 1966 and 1967, the GOC supported this program with $355,000 each year and WHO contributed $75,000 in 1966 and $40,000 in 1967.

3.6.3 Problems Encountered

No country-specific data found.

3.7 Vector or Intermediate Host Control

WHO (1975 (4)): Only 9.2% of the population of Cameroon had the benefit of antimosquito measures in 1974.

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.2 Eradication by Chemical Means

Mouchee and Garion (1966): The use of DDT and Dieldri reduced the *Anopheles moucheti* population in South Cameroon for 15 months.

3,7.3 Eradication by Biological Methods

No country-specific data found.

3.7.4 Other Control Yeasures

No country-specific data found.

3.7.5 Problems Encountered

Abba (1970): Distance, poor communications, inadequat financing and insufficient manpower have been among the problems which have made the use of residual insecticides ineffective.

WHO (1975 (4)): Vector resistance to DDT and Dieldri was reported in 1974.

3.8 Disease Impact

3.8.1 Impact on Population Distribution

Lantum (1971): This author believes that the eradication of malaria in Cameroon would affect the present pattern of primary demographic variables to such an extent that a population growth rate, presently at 2.2% and already termed explosive, would be tremendous increased. The present crude birth rate is 50 per 1,9 while the crude death rate is 26 - 28 per 1,000. The success of malaria, measles and small pox eradication programs would, even by conservative estimate, decrea the mortality rate of Cameroon by 8 per 1,000. Meanwhile, the crude birth rate is expected to increase before a decline in fertility is naturally effected. This would set the population growth rate above 3%. The estimated doubling time for the population of Cameroon is 32 years.

3.8.2 Impact on Economy

Lantum (1971): This author reports that Cameroon is an agrarian extractive economy and the per capita gros national product is only $142. These conditions would be aggrevated by the effects of malaria eradication upon the population of Cameroon.

3.8.3 Ameliorative Programs

Lantum (1971): This author strongly advises that an effective family planning program be implemented.

3.8.4 Problems Encountered

No country-specific data found.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

No country-specific data found.

3.9.2 Laboratory Studies on the Parasite

Lantum (1971): A 1958 study revealed *P. falciparum* to be the most prevalent species of Plasmodia in the southern Cameroon highlands with *P. ovale* and *P. malariae* only rarely seen.

WHO (1975 (4)): The relative prevalence of *P. falciparum* in 1974 was 85%.

Pampiglione et al. (1975): In an investigation of the distribution of malaria in several camps of the prefectures of Abong Bang and Kribi produced parasite formula and species infection data for the Cameroon in 1975.

Parasite Formula (S. Cameroon, 1975)

P. falciparum	--	84.4%
P. malariae	--	8.2%
P. ovale	--	7.4%

Species Infection Rate (S. Cameroon, 1975)

P. falciparum	--	23.1% - 42.8%
P. malariae	--	3.8%
P. ovale	--	7.3%

3.10 Clinical Studies and Observations

Abba (1970): The characteristic clinical manifestations of malaria in children are a weak and anemic appearance with splenomegaly which may often be associated with therapeutic lacerations. The history usually includes anorexia, frequent attacks of fever and diarrhea. Acute malarial attacks are often accompanied by unconsciousness, convulsions and high fever.

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CA 4.0 TRYPANOSOMIASIS IN CAMEROON

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Cases of trypanosomiasis were found in Bafia, which is in the department of M'Bam, in Douala, which is in the department of Wouri and in Dschang, which is in the department of Menoua in 1967. Cases were also reported in 1968 in Fontheim, which is in the Mamfu district of West Cameroon.

4.2.2 Prevalence

WHO (1969): The prevalence of trypanosomiasis for 1967 was 543 patients. The total population of Cameroon reported for that year was 5,470,000.

4.2.3 Intensity

Blackett and Ngu (1976): In a study of antibody titers to *Trypanosoma* in patients with congestive cardiomyopathy it was found that out of 12 patients, three had antibody titers of 1/16 and nine had antibody titers of 1/64. In the control group which had no heart disease only one out of 32 had an antibody titer of 1/16.

4.2.4 Incidence

WHO (1969): The following incidences of trypanosomiasis in Cameroon for 1967 and 1968 are presented below.

Incidences of Trypanosomiasis, Cameroon, 1967 & 1968

Year	Town	No. of New Cases
1967	Bafia (dept. of M'Bam)	384
	Douala (dept. of Wouri)	18
	Dschang (dept. of Menoua)	4
	Total for 1967	425

Incidences of Trypanosomiasis, Cameroon, 1967 & 1968

Year	Town	No. of New Cases
1968 Jan. - Nov.	Fontheim (Mamfu district)	21
	Total for 1968, Jan. - Nov.	71

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

No country-specific data found.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trails

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specific data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): All animals in Cameroon are susceptible to *Trypanosoma brucei* and other zoophilic *Trypanosomac*

4.10 Clinical Studies and Observations

Blackett & Ngu (1976): It was found that 27.5% (11 out of 40) of the patients who suffered with congestive cardiomyopathy had evidence of trypanosomal

infection in the form of antibodies to T rhodesiense. Antibody titers in three of these cases were 1/16 and 2/64 in nine other cases. Two patients in this latter group were found to have trypanosomal antibodies in their pericardial fluid. Only 1.9% (1 out of 32) of the subjects in the control group which did not have cardiomyopathy had antibodies to Trypanosoma. This titer was 1/16. In a third group which had heart disease other than congestive cardiomyopathy only 8.5% had antibodies to T. rhodesiense.

The authors conclude that African trypanosomiasis stimulates immunoconglutinins and immunoglobulins, especially IgM and IgA. These induce an alteration in complement components and a deposition of immune complexes which further damage the cardiac tissue in which the parasites are lodged, particularly in untreated subclinical attacks of African trypanosomiasis. This secondary auto-immune phenomenon manifests itself as congestive panmyocarditis, valvulitis and disseminated vasculitis in the heart and brain.

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CA 5.0 FILARIASIS IN CAMEROON

5.2 Epidemiology

5.2.1 Geographical Distribution

Sasa (1976): At least five different kinds of human filariasis have been recorded in Cameroon. These include Wuchereria bancrofti, Loa loa, Dipetalonema perstans, Dipetalonema streptocerca, and Onchocerca volvulus. Onchocerca volvulus is covered in a separate report. The remaining four infections are considered here.

Wuchereria bancrofti: Kershaw et al. (1953, 1954, 1955), working in the former British Cameroons, found infection with W. bancrofti to be widespread. Within this region, prevalence rates were high in the savannah country and the Bauchi plateau. In reference to the former French Cameroons, Languillon (1957) split that area into four regions and studied the distribution of filariasis in each. The four regions were a) extreme northern Cameroon, b) Adamaoua, the northern savannah, c) the western mountain region, and d) the southern forest region. Of these regions, W. bancrofti was found only in the extreme north, but not in the other regions (with the exception of Douala). Even in the north, elephantiasis was not encountered. In another study, Brengues (1966) also found W. bancrofti to be absent in the forest areas of Cameroon.

Loa loa: Kershaw (1953, 1954, 1955) noted that L. loa transmission did not occur in the mountain grasslands of the former British Cameroons. The disease was also not often found in the coastal mangrove swamps. In general, L. loa infection in the former British Cameroons was limited to the rain forest and its fringes and to the freshwater swamps. In the former French Cameroons, Rousseau (1919) found microfilariae of L. loa in the blood of several coastal dwellers. Languillon (1957) indicated that infection was highest in the southern forest region, decreasing to the north in Adamaoua only to increase again in the western mountain region. No cases were found in extreme northern Cameroon.

D. perstans was common, Kershaw (1953, 1954, 1955) noted, in the Cameroon rain forest, part of the former British section. The disease was found by Languillon (1957) in all regions of the former French section, especially in the southern forest. As with L. loa and in contrast to W. bancrofti, incidence was lowest in the north and moderate in the western mountains. Rousseau (1919) also observed D. perstans microfilariae in the blood of many coastal dwellers.

D. streptocerca: Kershaw (1953, 1954, 1955) found D. streptocerca infection in the Kumba and

Mamfe divisions of former British Cameroons. Languillon (1957), working in four regions of the former French area, found D. streptocerca only in the southern forest region, but not in the north or west.

5.2.2 Prevalence

Sasa (1976): W. bancrofti: No prevalence figures were found for W. bancrofti infection in the former British section of Cameroon. In the French section, Languillon (1957) found a rate of 2.7% at Mokolo in the north. He also found a composite infection rate of 18.2% (189/1037) in four other northern villages--Guider, Poli, Diamare, and Fort Foureau. The rate for Douala, the only non-northern focus discovered, was 6.8% (6/88).

Loa loa: As stated above, L. loa infection in British Cameroons was found by Kershaw (1953, 1954, 1955) to be highest in the rain forest zone. No specific rates have been found. In former French Cameroons, Becquet et al. (1969) obtained a rate of 2.6% for L. loa infection in Bamileke, in the southern forest region.

D. perstans: Sharp (1928) gave 77% as the overall prevalence of D. perstans infection in the Mamfe division of former British Cameroons.

In the French Cameroons, Languillon (1957) found D. perstans infection centered in the southern forest region, with a prevalence rate in that region of 78%. Becquet et al. (1961), however, recorded a much lower rate of 12.8% at Bamileke in that region. The western mountain region, according to Languillon, had a moderate prevalence rate of 27%.

D. streptocerca: No prevalence data were found for the British section of Cameroon. In the French section, Languillon (1957) gave a rate of 8.7% for the southern forest region, the only area where D. streptocerca was found.

5.2.3 Intensity

No country-specific information found.

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

No country-specific information found.

5.3 Vector or Intermediate Host Bionomics

5.3.1 Species Transmitting The Disease

Sasa (1976): For W. bancrofti - Anopheles gambiae (Languillon, 1957).

For L. loa - Chrysops silacea (principal vector), Chrysops dimidiata, Chrysops zahri?

(Kershaw et al, 1953),

For D. perstans - Culicoides austeni (=Culicoides milnei), Culicoides grahami, Culicoides inornatipennis, Culicoides fulvithorax (Hopkins, 1952; Nicholas, 1953)

Of these species, C. austeni is the principal vector; C. fulvithorax does not commonly bite man.

For D. streptocerca - Culicoides grahami (Nicholas et al, 1965), Culicoides austeni (Duke, 1958). C. grahami is the principal vector.

5.3.2 Vector Distribution

Sasa (1976): In the former British section, investigated by Nicholas et al. (1953) and Kershaw et al. (1953):

a) C. grahami, C. milnei (=C. austeni), C. inornatipennis and C. fulvithorax were found in the rain forest zone. C.grahami was abundant in the villages and forest reserves. C. milnei was less common in the forest reserves but abundant in the villages. C. inornatipennis thrived in areas that had been extensively cleared. C. fulvithorax was found only in the forest reserves.

b) In the mountain grassland zone, only C. grahami was found.

c) In the savannah zone with relict forest, C. grahami and C. inornatipennis were noted.

Kershaw et al. (1953) observed Chrysops dimidiata and Chrysops silacae mainly in the rain forest zone, associated with high human infection rates. In the forest fringes, C. zahri also appeared. Chrysops was unknown or absent in the grassland.

No data were found on vector distribution in the French section of Cameroon.

5.3.3 Environmental Factors Influencing Distribution

Sasa (1976): Hopkins (1952) studied the biology of Culicoides in relation to D. perstans infection. The work was done in the British Cameroons, in and around Kumba and in the forests. C. grahami was found in the day near villages. Also in the day, C. inornatipennis predominated away from villages. C. austeni was identified as the main night-biting village vector.

Hopkins (1952) also noted that C. grahami and C. austeni bred mainly in decaying banana and plantain stems, associated with human dwellings. Nicholas et al. (1953) and Kershaw et al. (1953) added that C. inornatipennis also bred in decaying banana and plantain stems, and that the cultivation of these nonindigenous plants had increased the biting density of C. milnei near the villages.

Nicholas (1953) further studied the bionomics of Culicoides in the British Cameroons. He found the following: C. austeni feeds at night, C. grahami

mainly in the morning and evening. C. austeni is the only species of Culicoides that readily feeds indoors; C. grahami, C. inornatipennis, C. fulvithorax normally bite in the forest canopy. The biting density of C. austeni, unlike that of C. grahami, falls sharply with the onset of the dry season.

5.4 Diagnostic Procedures

5.4.1 General Diagnostic Procedures

Sasa (1976): In regard to survey methods for infections with L. loa and D. perstans, Kershaw (1950) found daily periodicity in blood microfilariae. He also noted that higher counts were observed in thumb blood samples than in samples taken from veins.

5.4.2 New Diagnostic Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Against Human Infection

No country-specific information found.

5.7 Vector or Intermediate Host Control

No country-specific information found.

5.8 Disease Impact

No country-specific information found.

5.9 Laboratory Studies

5.9.1 Laboratory Studies on the Vector

Sasa (1976): Nicholas (1953) studies C. austeni and related species in Cameroon. He noted that C. austeni was obliged to take a blood meal before eggs could develop. Three to four nights after the blood meal, the flies oviposited. The eggs hatched three days after being laid; development from eggs to adulthood took 25 to 28 days.

Several studies done in Cameroon have investigated the compatibility of D. perstans. D. streptocerca and L. loa with various vector species of Culicoides.

Hopkins and Nicholas (1952) showed that D. perstans larvae would develop completely in clean-bred C. austeni (= C. milnei) and wild C. grahami. The results indicated, though, that D. perstans was less adapted to C. grahami than to C. austeni.

This finding was confirmed by Nicholas and Kershaw (1964), who added that C. austeni ingested D. perstans at a higher rate than did C. grahami.

A controlled infection study by Duke (1954), in Kumba, suggested that C. grahami was an efficient vector of D. streptocerca but not of D. perstans. Duke (1956) also studied the intake of D. perstans microfilariae by C. grahami and C. inornatipennis.

In support of Duke's 1954 results, less D. perstans microfilariae than expected were taken up by C. grahami, and by C. inornatipennis as well. However, in both vector species, full development of D. perstans larvae was shown to occur. Duke (1958) further demonstrated, in a later study, that C. grahami ingested D. streptocerca at a much higher rate than did C. milnei. This result should be compared to the complementary result found by Nicholas and Kershaw (1964), mentioned above, who found D. perstans more suited to C. austeni than to C. grahami.

5.9.2 Laboratory Studies on the Parasite

Sasa (1976): Kershaw (1954) studied the distribution of D. streptocerca microfilariae in the human skin. He found that the microfilariae located in the skin of the shoulders and trunk, but were generally absent in the extremities. The foreams and legs below the knee were especially unaffected.

See 5.9.1 for a description of studies done in Cameroon on vector-parasite compatibility.

5.10 Clinical Studies and Observations

Garin (1975) reported the case of a patient infected with L. loa who developed ocular difficulties, including partial loss of visual acuity and eye lesions. The patient was cured with DEC.

Successful treatment of L. loa with piperazine was reported by Bendelac. No side effects were encountered.

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Documentation on Studies of Five Major Endemic Diseases in Ten African States

Part B
National and Regional Disease Profiles

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CD 1.0 SCHISTOSOMIASIS IN CHAD

1.2 Epidemiology

1.2.1 Geographical Distribution

S. mansoni, S. haematobium, and S. intercalatum are all found in Chad.

S. mansoni

Ansari (1973): Foci are found at many places around Lake Chad as well as in the valley of the Chari and Logone Rivers and their tributaries. Intestinal schistosomiasis also occurs north of the 12° latitude. The desert areas in far-northern Chad are not affected by the disease, except for a focus near Faya-Largeau.

Schneider et al. (1977): S. mansoni infection is important only in the southernmost part of the country bordering the Central African Republic (Buck, 1970). The disease is extremely prevalent in Moyen Chari Prefecture (Masumbuko, 1976).

Buck et al. (1970): S. mansoni is predominant in Ouli Bangala.

S. haematobium

Ansari (1973): S. haematobium appears to be widespread throughout all of Chad.

Buck et al. (1970): The disease is important mainly in Djimtilo and Ouarai.

S. intercalatum

Becquet (1970): recently reported S. intercalatum from southwest Chad, north of Pala.

Deschiens (1971): considered this extension of the previously unreported disease into Chad to be the result of natural inter-country migration and exchange of workers.

1.2.2 Prevalence

S. mansoni

Ansari (1973): Watson (1970) estimated that S. mansoni affects 3% of the country's population. Near Fort Archambault, infection rates of 5 to over 15% were observed by Guyon (1975). Buck et al. (1968) as part of a 1964-1970 multi purpose health survey, found the following prevalence rates for S. mansoni infection. The methods used were slide flocculation and complement fixation.

Area	S. mansoni infection
Djimtilo (Lake Chad region)	0.8%
Ouli Bangala (Southwest)	44.0%
Ouarai (South-Central)	0.0%
Boum Khebir (Lake Iro region)	0.8%
Faya-Largeau (North)	0.0%

Buck and Anderson (1972): gave further prevalence data for S. mansoni infection:

Area	S. mansoni infection
Lake Chad and South Central	0.8%
Lake Iro	1.1%
Ouli Bangala (Southwest)	46.0%
Sahara (North)	0.0%

Barkhuus (1976): gave a prevalence figure of 15% S. mansoni infection for the Chari-Logone drainage area. He reported that 810/44,781 = 1.8%

of stool samples examined by the Service des Grandes Endemies in 1975 were positive for S. mansoni.

S. haematobium

Ansari (1973): According to Guyon (1965), prevalence rates for children throughout Chad were usually in the range of 20-50%, and never fall below 10%. Ranque and Rioux (1963) reported that 77.5% of 214 children in the oasis of Faya-Largeau in the Borkow - Tibesti region of North Chad had haematuria. Guyon (1965) indicated that the infection rate in Bousso, Fianga, Kelo and Kyabe was higher than 50%. Estimates for prevalence of infection in the general population vary from 27% (Watson, 1970) to 43% (Deschiens, 1951).

Buck et al. (1968): in the multi-purpose health survey mentioned above, found the following prevalence rates for S. haematobium. The survey methods used were slide flocculation and complement fixation:

Area	S. haematobium infection
Djimtilo	26%
Ouli Bangala	7%
Ouarai	32%
Boum Khebir	0%
Faya-Largeau	1.5%

Barkhuus (1976): According to 1975 WHO figures, 22,675 cases of vesical schistosomiasis were reported for that year in Chad. S. haematobium ranked, consequently, as one of the top causes of morbidity for the country.

During 1975, the Services des Grandes Endemies examined 18,897 urine samples, and found 4935 (26.1%) positive for S. haematobium. Barkhuus reported the following rates based on single urine examination:

Area	S. haematobium (%)
Northern Oasis (Faya Largeau)	5.2% in schoolchildren
Lake Coast (general)	85-90% in schoolchildren
Lake Coast (Bol)	100% in schoolchildren
Mayo Kebbi area (Lake Fianga)	50% in children
Mayo Kebbi area (general)	74% in general population
Chari-Logone drainage area (North of Central African Republic)	34% in general population
Republic of Chad (general)	27% in general population

Buck and Anderson (1972): gave the following prevalence data:

Lake Chad and South Central	28.7%
Lake Iro	0.3%
Ouli Bangala (Southwest Chad)	3.7%
Sahara	1.6%

S. intercalatum

Becquet (1970): reported two cases of S. intercalatum, contracted in the southwest, near Cameroon, north of Pala.

1.2.3 Intensity

No country specific information found.

1.2.4 Incidence

No country specific information found.

1.2.5 Population Most Affected

Guyon (1965) and Rangue and Rioux (1963) suggested that infection rates are especially high for children, generally falling in the 20-50% range.

Schneider (1977): provided the following age-specific information:

Urinary schistosomiasis in 1,595 individuals of the Primary School of Lai, in 1974

Age	No. examined	No. positive	Percentage
6-8	511	97	19.0
9-11	437	88	20.1
12-14	478	116	24.3
15-59	169	48	28.4
Total	1595	349	21.9

Buck et al. (1970), in his study, observed that 14 year olds had the highest percentage of urine specimens containing ova. A drop in infection with increasing age (after 14) was noted for S. haematobium, but not as much for S. mansoni.

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari (1973): Possible Vectors - B. truncatus rohlfsi, B. (B) forskalii, B. jousseaumi.

Schneider (1977) reported the following:

Bulinine pulmonates (vectors of Schistosoma haematobium) reported for Chad

	WHO (1966)	Leveque (1967)	Buck et al. (1970)	Degremont (1976)
Bulinus (Bulinus) Truncatus	+	0	0	0
B. (B.) t. rohlfsi	+	+	+	+
B. (physopsis) globosus	0	0	0	+
B. (Ph.) jousseaumei	+	+	+	0
B. (Pyrgophysa) forskalii	+	+	0	+
B. (Pyr.) Senegalensis	+	0	0	0

Schneider, C.R. et al.: "Environmental Assessment Report - Southern Zone Republic of Chad". AID/APHA, 1977

1.3.2 Vector Distribution

Ranque and Rioux (1963), found B. (B.) truncatus infected with S. haematobium at Faya in North Chad. However, the infection rate at this site was only 0.4% for B. (B.) truncatus. Furthermore, none of the 495 samples of Biomphalaria pfeifferi smapled were infected.

1.3.3 Environmental Factors Influencing Distribution

Barkhuus (1976) suggested that schistosomiasis transmission in Chad mainly takes place during the dry season (November - May, peak in February - March). This pattern does not apply to Eake Chad, where transmission occurs all year round.

1.4 Diagnostic Procedures or Techniques

1.4.1 Buck and Anderson (1972), working in 5 areas of Chad, compared the usefulness of two immuno-diagnostic tests - Complement fixation (CF) and slide flocculation (SF) - for mass schistosomiasis screening. Slide flocculation (testing for cercarial antigens) showed a high

5C

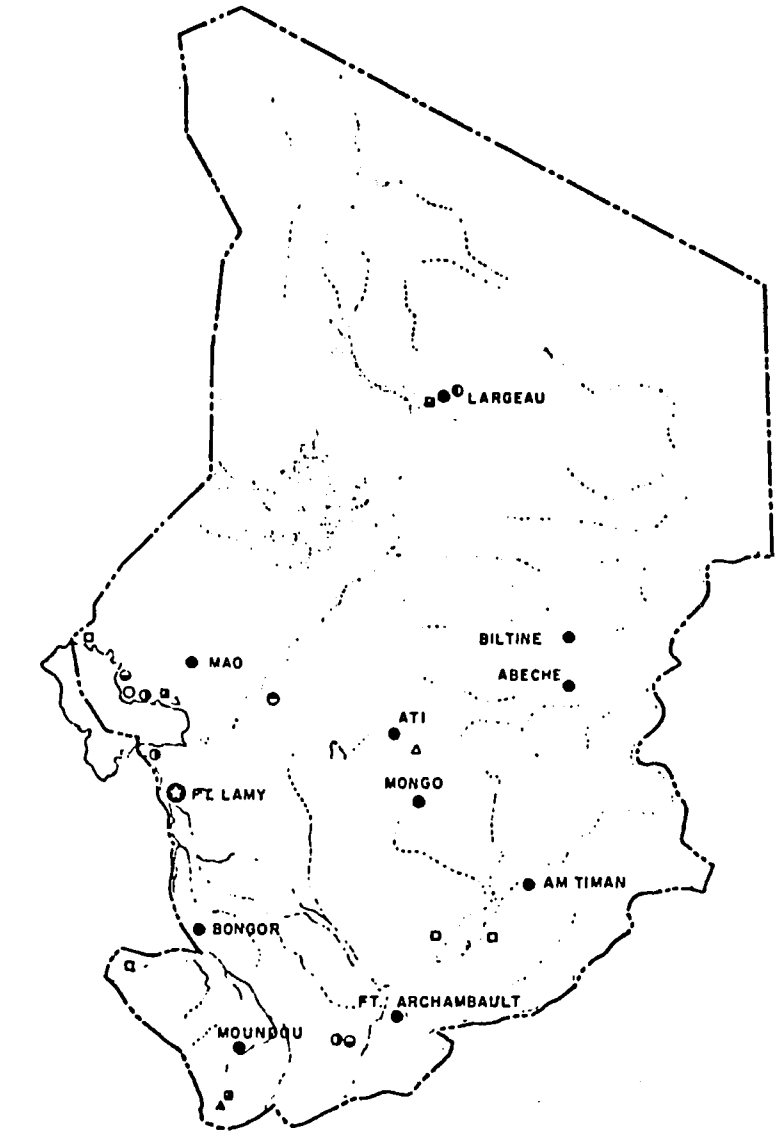

FIGURE 2–4. GEOGRAPHICAL DISTRIBUTION OF THE INTERMEDIATE HOSTS OF SCHISTOSOMES IN CHAD

FROM BUCK, A. ET AL.: HEALTH AND DISEASE IN CHAD. JOHNS HOPKINS PRESS, BALTIMORE, 1970.

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sensitivity but very low specificity and was judged ineffective for screening. Three conditions were associated with false positives: ascariasis, serologic reactions in the trichinosis card test, and the presence of hemagglutination antibodies to Echinococcus granulosus. The complement fixation technique gave high specificity, but low sensitivity.

Delpy et al. (1972): gave a diagnostic warning: Terminal - spurred schistosome eggs found in some patients' stools were not S. intercalatum but rather ingested animal schistosome eggs. Low sensitivity was especially noted with children, with chronic infections, and with patients suffering from severe hyperendemic onchocerciasis.

1.4.2 New Diagnostic Techniques

No country specific information found.

1.5 Therapeutic Trials

No country specific information found.

1.6 Control Measures Against Human Infection

No country specific information found.

1.7 Vector or Intermediate Host Control

Barkhuus (1976), claimed that, as of March 1976, no organized efforts were being made to control schistosomiasis in Chad. In support of this claim, no information on vector control measures has been found.

1.8 Disease Impact

No country specific information found.

1.9 Laboratory Studies

No country specific information found.

1.10 Clinical Studies and Observations

Becquet et al. (1970): In noting the extension of S. intercalatum into Chad, described two cases of the disease.

Patient 1 - a case of multiple infection

Symptoms

a. gastrointestinal problems and weight loss

b. headache

c. occasional mucus in stools

d. spleen enlargement, liver protrusion of three fingers' breadth

e. abdominal pain on palpation

f. in urine - traces of albumin and numerous live S. haematobium eggs

g. in stool - S. mansoni and S. intercalatum eggs, also rare eggs of S. haematobium. (plus Ankylostome, Trichostrongylus, and Entamoeba cali eggs)

h. Blood test results.

red cells	4 800 000
white cells	7 800
Hemoglobin	100%
Hematocrit	45%
Poly. neutrophiles	55%
Poly. eosinophiles	18%
Lymphocytes	20%
Monocytes	7%

i. Sedimentation speed-8mm in 1 hour, 26 mm in 3 hours.

Treatment

a. 1500 mg Ambilhar/day in 2 doses, for 7 days.

b. Subsequently, betaine salts, interspersed with Alcopar

Results

a. fresh haematuria which disappeared by 4th day of treatment

b. weight gain

c. disappearance of all eggs

d. disappearance of complaints

e. return to normal sedimentation speed (to 5mm/12mm)

Patient 2 - A case of double infection

Symptoms

a. abdominal pain

b. glairy diarrhea

c. painful, spastic colon

d. spleen even with left costal ridge

e. *S. mansoni* and *S. intercalatum* eggs in stool

f. 22% eosinophiles

Treatment

Ambilhar, 1500 mg/daily in two parts, for 7 days

Results

a. recovery of good general health

b. spleen no longer perceptible

c. weight gain

d. blood examination showed continued esoinophilia, but also low-level filarial infection with *D. perstans*.

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CD 2.0 ONCHOCERCIASIS IN CHAD

2.2 Epidemiology of Onchocerciasis

2.2.1 Geographical distribution

Onchocerciasis is widely spread in the savannah zone of Chad. The major onchocercal areas in this bio-climatic zone are: the Mayo Kebbi, Logone Oriental, Mayen-Chari Laround Fort Achambault in Moussafoyo and Danamdji Counties (in the villages of Gribingi and L'Aouk in Chari) (Lagraulet et al, March-April, 1967). The disease is also found in Baibokoum region in the extreme southern part of the country where the relief and hydrography represents the most favourable conditions for the breeding of Simulium damnosum, the vector transmitting Onchocerca volvulus the parasite causing the disease in humans. Two holoendemic foci, Ouli Bangala 7°50' North and 15°50' East) and Masidjanga (10°10' North and 19°25' East) on the southern shores of Lake Iro, opposite Boum Khebir were also identified as having the disease while sporadic cases were observed in Ouarai as well (Buck et al, 1969). The middle and the extreme southern parts of Chad are the areas most affected by the disease.

2.2.2 Prevalence

The epidemiological surveys and studies done in Chad in reference to onchocerciasis confirm the

prevalence of the disease in different parts of the country with varying endemicity. An important area of onchocerciasis was prospected and delimited in the entire region of Baibokoum in the extreme southern portion of Chad. The prevalence in this area was 50 p. 100 giving a minimum of 25,000 patients (Nebout, 1971). Lagraulet (Lagraulet et al, 1967) and his coworkers in their epidemiological studies in Middle Chad, from March to April 1967, found that onchocerciasis was widespread in this region. In a study of a population of 373 in Ouli Bangala, 316 persons (84.7%) were infected with O. volvulus microfilariae (the results were based on the microfilariae recovered from skin snips taken from the patients' backs). Only sporadic cases of the disease were observed in Ouarai and Boum Khebir areas (in extreme southern Chad). No cases of onchocerciasis were found in Djimtilo or in Faya-Largeau. Prevalence in a population of 398 in Ouli Bangala routinely examined for onchocerciasis was 42.5% (169 persons out of the 398 examined). In asidjanga the prevalence was 46% (33 out of 71 of those examined) and in Boum Khebir and Ouarai they were 1.6% and 1.1% respectively.

Prevalence of infection in Ouli Bangala was high in the 5-49 age group. The same was observed among the 50 years and over group. The percentages in this analysis were based on microfilariae found in the skin snips obtained from the population sample.

Urinalysis for microfilariae in a population of 386, 44 (11.4%) cases were positive. The highest percentage of positive cases were found among the five and above age group (Buck et al, 1969, tables 4-23 and 4-24). The disease presents a serious problem in the Lera-Fianga area and around the falls of Gauthiot which are heavily infected with onchocerciasis (Barkhuus, A.; Health services, Consultant's Report on Chad, APHA March 20, 1976).

The prevalence of blindness was highest among persons above 30 years of age (50% of the subjects examined were blind). Corneal opacities were also common in this same age group. Blindness increased with age as well as the intensity of infection. Prevalences of onchocercoma, skin atrophy and microfilaruria were related to the intensity of skin infection with O. volvulus. (Buck et al, 1970)

2.2.3 Intensity of the disease

The intensity of onchocerciasis varies with increased infection and reinfection rates in the endemic areas. In Ouli Bangala area, mild to heavy intensities of skin infection were observed; (estimates were made from microfilarial counts in skin snips: mild intensity = 1 to 20 microfilariae in the skin snips; heavy intensity = 21 and more microfilariae in the skin snips). Of the 266 persons with mild intensity of infection, 142 (53.4%) had onchocercoma,

166 (62.4%) had onchocercoma and/or skin atrophy, and 34 (12.8%) had microfilaruria. In the heavy intensity of infection group, 15 (57.7%) of the 26 persons diagnosed as such, had onchocercoma, 20 (76.9%) had onchocercoma and/or skin atrophy and 7 (26.9%) were found to have microfilaruria. The population studied included all persons five (5) years old and over who had skin snips taken for the examination of microfilariae, had physical examinations and urine examinations for nodules and microfilaruria (Buck et al, 1969, table 4-26).

2.2.4 Incidence

The incidence rates of onchocerca volvulus infection are high in those areas where the transmission and infection rates are high and are related to the seasonal transmission of the disease. As pointed out elsewhere, the biting activity of the female S. damnosum species responsible for the disease, is strongly influenced by the seasonal variations. Incidences of onchocerciasis are usually high in the rainy seasons in the savannah zone where seasonal transmissions are observed, and in the rain forest bioclimatic zone, where perennial transmissions prevail, incidence rates are somewhat constant. (Buck et al, 1970)

2.2.5 Population most affected

The disease is most common among persons over 5 years of age and incidences of infection increase with age. Blindness is also high among the older population. (Buck et al, 1970)

Sex-specific studies have shown that males are more affected by the disease than females. Prevalences, intensity and incidence rates are usually higher in males than in females. These discrepencies are attributed to the type of occupation, the duration of exposure to the vector flies during their active seasons and the transmission potential of the vector. Adult males whose working conditions necessitate long exposures to the flies bites account for the high rates observed in almost all the studies (Buck et al, 1970). Blindness was found to be high in males than in females. (12.1% in males and 7.0 in females)

In hyperendemic areas, however, children younger than 4 years old have been found to have microfilariae.

2.3 Vector or Intermediate Host Bionomics.

2.3.1 Species of the vector transmitting the disease

Simulium damnosum is the only vector of onchocerciasis in the Chad Basin. Several forms of the vector have been identified in West Africa, in those areas where onchocerciasis is found. However, no entomological studies have been made in Chad in order to identify the specific forms of *S. damnosum* complex.

On the other hand, epidemiological studies conducted in different parts of the country show that onchocerciasis is found in both the savannah and the rain forest zones, thus indicating that the two main groups, the savannah and the forest types are found in their respective favourable ecological zones (Buck *et al*, 1970).

2.3.2 Vector Distribution

Simulium damnosum complex species are mainly found in the Chad Basin where the Chari and Logone rivers provide suitable breeding ground for parous *S. damnosum* during the optical season. Flies of the same species are also found along the Lim River and around Lake Iro. *S. damnosum* were caught regularly around the Lim River indicating that conditions for continued breeding were favourable. (Buck et al, 1970).

2.3.3 Environmental Factors Influencing the Distribution.

The distribution of S. damnosum complex is strongly influenced by the climatic conditions such as temperature, relative humidity, rainfall, etc., and the ecology of the area, e.g. vegetation, drainage and altitudes.

Seasonal variations are very important as far as the activity and availability of the flies are concerned. Shaded areas along fast flowing rivers and optimal temperatures and current speeds (tolerable temperatures are between 17 and 30°C and current speeds are between 0.5 m/sec and 1.7 m/sec), are major factors for the existence of S. damnosum species. Wind movement is equally important.

Adequately vegetation, and supply of mammalian blood in the immediate vicinity are factors which determine the habitat of S. damnosum.

The biting activity of S. damnosum is temperature related. The vector's activity is slowed or stopped when temperatures are below 17°C or above 30°C. (WHO: Onchocerciasis Control in the Volta River Basin Area, OCP/73.1. Geneva, 1973).

Simulium damnosum species breed in rapidly flowing, well aerated river waters. The conditions of the water such as the amount of oxygen in the water, current velocity, rocky and shallow river bed, the vegetations along the riverbanks and the availability of mammalian blood for parous *S. Damnosum* are essential conditions for breeding of *S. damnosum*. The climatological conditions are also important factors for the survival of *S. damnosum* larvae while surfaces of submersed stones and rocks or trailing twigs and vegetations are ideal for attachment of the larvae and puape of the vector flies. (WHO: OCP/ 73.1; Buck et al, 1970)

2.4 Diagnostic Procedure or Techniques

2.4.1. General Diagnostic Methods

General diagnostic methods used in the diagnosis of onchocerciasis are employed in the studies done in Chad. These diagnostic techniques are discussed in great details under CA 2.4.1 (Onchocerciasis in Cameroon). Skin snip technique as well as examination of microfilariae in the urine are the most common diagnostic methods used in many of the studies referred to in this writing (Buck et al, 1970)

2.4.2. New Diagnostic Techniques

Buck *et al* (1970) used the triple concentration of complete urine specimens technique in examining microfilariae in the urine. The technique proved to be quite useful in the diagnosis of microfilariae as shown by the

results of their study in Ouli Bangala: 44 (11.4%) of 386 residents of Ouli Bangala had microfilariae of O. volvulus in the urine-- a significant yield.

2.5. Therapeutic Trails

2.5.1 Studies on New Drugs

There are no studies done in Chad in regard to clinical trails of new drugs or combination of known drugs (new dose levels). (Buck et al, 1970, 1971).

2.5.2. Field trails

No field trails were mentioned in the literature reviewed.

2.5.3. Problems Encountered

The lack of a single drug effective against the adult O. volvulus and microfilarie of the same parasite, the shortage of trained personnel, both clinicians and entomologists as well as the inadequacy of facilities for pharmacological studies are major limiting factors in both clinical and field therapeutic trails. (WHO OCP/73.1)

2.6. Control Measures Directed Against Human Infection

2.6.1 Prophylactic Measures

No information was found, in the literature reviewed concerning prophylactic (chemoprophylaxis) measures being used in Chad in order to protect the population at risk against infection with onchocercal microfilarial parasites or from being bitten by the disease transmitting vector, S. damnosum complex species.

2.6.2 Other protective control measures

No information was found as far as any type of control program aimed at protecting the population in endemic areas is concerned.

2.6.3 Problems encountered

No control measures were indicated in the studies done in Chad.

2.7 Vector or Intermediate Host Control

2.7.1 Eradication by Mechanical Means

2.7.2 Eradication by Chemical Means

Insectcides such as DDT and larvicides are extensively used in vector control programs. A mixed campaign aimed at destroying larvae and adult S. damnosum was conducted. Riverside vegetations were treated with gamma-BHC by helicopter, and by use of the same insecticide as larvicide applied at ground level. The vector was eradicated temporarily. Tauffieb 1955 and 1956, cited by WHO:OCP/73.1 Annex III-2.

2.7.3 Eradication by Biological Means

Vector control by use of natural parasites and vector predators has been experimented in onchocercal areas,

especially in the Volta River Basin Area. The use of such natural biological control measures was not found.

2.7.4. Other control measures

No other control or vector eradication measures in Chad were found in the literary research.

2.7.4 Problems Encountered.

Although there are no vector control programs now available in Chad similar problems encountered elsewhere in onchocercal areas could be faced in Chad too. These would include the long flight range of the vector. The long life span of the vector, the lack of proper combination of insecticides and larvicides, lack of trained entomologists and other personnel who can efficiently and effectively carry out such control campaigns, financial constraints are among the problems encountered. (WHO; OCP/73.1; Annex III-2)

2.8 Disease Impact

2.8.1 Impact on Population Distribution

Onchocerciasis has a significant impact on the distribution of the population in the endemic areas. In heavily affected location, there has been an increase in migration from onchocercal areas to onchocercal free or less affected areas. This population shift has obviously led to overcrowdedness in some parts of the country and the abandonment of the fertile land. (WHO: OCP/721.)

2.8.2 Impact on the Economy.

The impact of onchocerciasis from an economic standpoint is indeed clear. Constant migration of the population and the physical suffering caused by the disease as well as the loss of eyesight as a result of onchocerciasis, are major economic setbacks in a poor country such as Chad. Economic blindness is directly related to the total national economic output in terms of agricultural productivity. Equally important are the medical and health costs that are incurred by the Ministry of Health each year. (WHO:OCP/73.1)

2.8.3 Ameliorative Programs

There were no economic developments or resettlement programs aimed at improving or reclaiming the abandoned areas through vector eradication campaigns found in literature reviewed.

2.8.4 Problems Encountered

Data on economic or resettlement programs in onchocercal areas of Chad were not found. These problems and many others would be major limiting factors as far as launching any development programs are concerned.

2.9. Laboratory Studies

2.9.1 Laboratory Studies on the Vector

There are laboratory studies to show that S. damnosum complex is not a uniform species. The forest and savannah forms exist. (WHO:OCP/73.1; Annex IV-1 Buck et al, 1970).

2.9.2 Studies done on O. volvulus

No specific studies were found concerning the morphology or any other aspect of the adult worms or microfilariae of O. volvulus, the parasite responsible for onchocerciasis. However, the savanna and forest strains are recognized. (WHO:OCP/73.1; Annex IV-I citing Buck et al, 1969, 1971, 1973).

2.10 Clinical Studies and Observations

The pelvic girdle (Crista iliaca) is the most common anatomical site for Onchocerca volvulus microfilariae among the African onchocerciasis patients. The next region where microfilariae are localized is the thorax. Most experts agree, however, that the crista iliaca and the trochonter major are the pelvic areas where most onchocercal nodules are found. Microfilariae of O. volvulus are easily obtained from skin snips taken from these anatomical sites.

The sites for microfilariae localization are related to the biting activities of S. damnosum, e.g. the vector flies bite those parts of the body closest to their resting places. This means the ankles and the lateral sides of the calves for persons in the upright position, buttocks and loins in the squatting position, on the head and throax region when lying down. Children are bitten on the feet and legs when standing close to the riverbank, and above the waist while standing among bushes or tall grasses. Persons standing waist deep in water are bitten on the shoulders and chest. Also, at altitudes above 1,500 m (4,500 ft) the face is frequently bitten (Gratama, 1966).

In severe onchocerciasis, ocular involvement is quite

common and microfilariae are usually found in all media (in the posterior lesions) including the choroid, the retina and the optic nerve. (Buck et al, 1970)

There are some observable histopathological conditions related to onchocerciasis. Among these are inflammation around the invading worm, vascular congestion, hyperplasia of the capillaries and exudation of fluid, and formation of fibrous capsula at the periphery of the nodule. The main lesion is a vascular proliferation with thickening of the capillary walls and increased endothelial cells as well as a gradual disappearance of the fine elastic fibers. (Buck et al, 1970).

Buck et al (1970) observed that more children had lymphoedema than adults. Many of the adults had either hanging groins or enlarged inguinal lymph nodes. The palperbral conjuctiva was found to be pale in all patients examined, limbal pigmentation appeared to be common in patients with severe corneal involvement and superficial stippling accompanied by intense photophobia, opacification (in advanced cases). Also, sluggish reaction of the pupils to direct and indirect illumination as well as extensive posterior synechiae, secclusio of occlusio pupillae were observed in onchocerciasis patients (Buck et al, 1970). Patients with the urinary complications have heavy infections, are underweight, may have gross kidney lesions and abnormally high serum transaminase levels (Buck et al, 1971, cited by WHO in document OCP/73.1; Annex IV-I p.8)

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CD 3.0 MALARIA IN CHAD

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975): Eighty-eight percent of the population of Chad lived in malarious areas in 1974. The percentage of that population which lived in malarious areas without antimalarial measures was 84.2%. More specific data about geographical distribution was not given by this source.

Barkhuus (1976): Malaria's geographic distribution in Chad was divided into the following zones:

Zone 1 extends from the northern limits of the Chad Basin south to the 200 mm. isohyet some 50 mm. north of the Lake.

Zone 2 extends south from the 200 mm. to the 500 km. isohyets and follows a concave curve through Zinder, Baga, Ati and Abeche.

Zone 3 extends from the 500 mm. isohyet south to the 1200 mm. isohyet in the latitude of Moundou. This includes some of the Basin's most densely populated regions.

Zone 4 extends from the 1200 mm. isohyet to the southern border of the Basin. The northern oases comprise a fifth zone.

3.2.2 Prevalence

Barkhuus (1976): Malaria is absent in zone 1 (described above) with only sporadic imported cases. Malaria is present between the Lake borders and the drier areas east and west of the lake in zone 2. The disease is hyperendemic in the rural areas of zone 3 except in the Logone flood plain where it is mesoendemic. In zone 4 the disease is holoendemic. The northern oases are free of malaria because of chemoprophylaxis, chemotherapy and antivector measures. This situation should be considered as unstable because of nomadic migrations between this area and malarious areas.

The same source described the prevalence of malaria from 1964-1975 (see below) and estimated that in 1976 80% of the infant mortality was due to malaria.

PREVALENCE OF MALARIA IN CHAD, 1964-1975

Year	No. of Cases	No. of deaths
1964	86,236	81
1966	101,042	149
1967	87,851	212
1968	99,006	140
1969	125,498	163
1970	127,487	110
1971	148,675	288
1972	142,526	340
1973	99,766	384
1974	132,815	247
1975	165,475	370

WHO (1975): In 1969, the parasite rate was 25-50% in areas with control measures and 38-80% in areas without specific control measures. The malaria mortality for 1974 was 43.893 per 100,000.

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

No country-specific data found.

3.2.5 Population Most Affected

No country-specific data found.

3.3 Vector Bionomics

3.3.1 Species Transmitting the Disease

Barkhuus (1976): The principal vectors in Chad are *Anopheles gambiae* and *A. funestus* (the latter especially in the dry season). Secondary vectors are *A. pharoensis*, *A. nili* and *A. rufipes*. Potential vectors include *A. coustani*, *A. wellcomei*, *A. pretoriensis*, *A. hancocki*, *A. squamosum* and *A. mouchetti*.

3.3.2 Vector Distribution

No country-specific data found.

3.3.3 Environmental Factors Influencing Distribution

Barkhuus (1976): Transmission of the disease by the vector was nil in Zone 1 (see 3.2.1). There was seasonal transmission despite the hyperendemic status of the disease in Zone 2. Transmission occurs year round in Zones 3 and 4 with some decrease in intensity of transmission during the dry season in Zone 3. Rainy season transmission is important in Chad. This is supported by the fact that morbidity and mortality are maximal during Oct.-Nov., the height of the rainy season while they are minimal during May-June, the height of the dry season.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

No country-specific data found.

3.6 Control Measures Against Human Infection

3.6.1 Chemoprophylactic Measures

Barkhuus (1976): Two to three percent of the children of Chad, ages 0-6 years, receive Nivaquine as prophylactic therapy.

3.6.2 Other Protective Measures

No country-specific data found.

3.6.3 Problems Encountered

No country-specific data found.

3.7 Vector or Intermediate Host Control

WHO (1975): Although 15.8% of the population of Chad live in malarious areas which do have some antimosquito efforts operant, there was no large-scale antimalarial campaign in Chad as of March, 1976.

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.2 Eradication by Chemical Means

Barkhuus (1976): Antivector measures such as treatment of breeding places and spraying of houses were undertaken in N'Djamena but were reported as being inadequate.

3.7.3 Eradication by Biological Methods

No country-specific data found.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

WHO (1975): Resistance of vectors to DDT and Dieldrin in Chad was reported in 1974.

3.8 Disease Impact

No country-specific data found.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

No country-specific data found.

3.9.2 Laboratory Studies on the Parasite

WHO (1975): The relative prevalence of *P. falciparum* in 1974 was 78%.

Barkhuus (1976): *P. falciparum* was reported as being the dominant species throughout the Chad

drainage basin. No P. vavax was found and P. malariae and P. ovale while not dominant were more frequent in hyperendemic regions as illustrated by the statistics that in Logone Plain, a mesoendemic area, the prevalence of P. falciparum was 87%, P. malariae was 12.5% and P. ovale was 5.0%; on the other hand, in Chari-Bagurimi, a hyperendemic area, the prevalence of P. falciparum was 81.5%, P. malariae was 18.2% and P. ovale was 11.3%.

3.10 Clinical Studies and Observations

No country-specific data found.

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CD 4.0 TRYPANOSOMIASIS IN CHAD

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Foci of trypanosomiasis exist along the tributaries of Lake Chad. Incidence figures were given for Dressa, Fort-Lamy; Bohr-Erguig, Massenya; Deli, Moundou; Timberi and Bekan, Gore; and Bakamba and Dobadene, Moissala.

Barkhuus (1976): Trypanosomiasis remains a menace in the south Chad basin.

4.2.2 Prevalence

Barkhuus (1976): The prevalence of trypanosomiasis in Chad for 1955 was 4,687 cases.

Nebout (1968): In 1968 it was 643 cases.

WHO (1969): In 1969 the prevalence was 685 out of a population of 3,410,000. By 1975 the prevalence was 81 cases.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

Barkhuus (1976): The incidence for 1955 was 470 new cases and for 1975, 8 new cases.

WHO (1969): Incidences for 1967 in the following locations are:

Incidence of Trypanosomiasis, Chad, 1967

Location	No. of New Cases
Dressa, Fort-Lamy	7
Bohr-Erguig, Massenya	7
Deli, Moundou	18
Timberi and Bekan, Gore	20
Bakamba and Dobadene, Moissala	9
Total	61

In 1968 there were only 35 new cases reported in all of the above areas.

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

4.3.1 Species Transmitting the Disease

Barkhuus (1976): 12 species of Glossina are found in the Chad Basin, particularly G. palpalis, G. tachinoides and G. morsitans submorsitans.

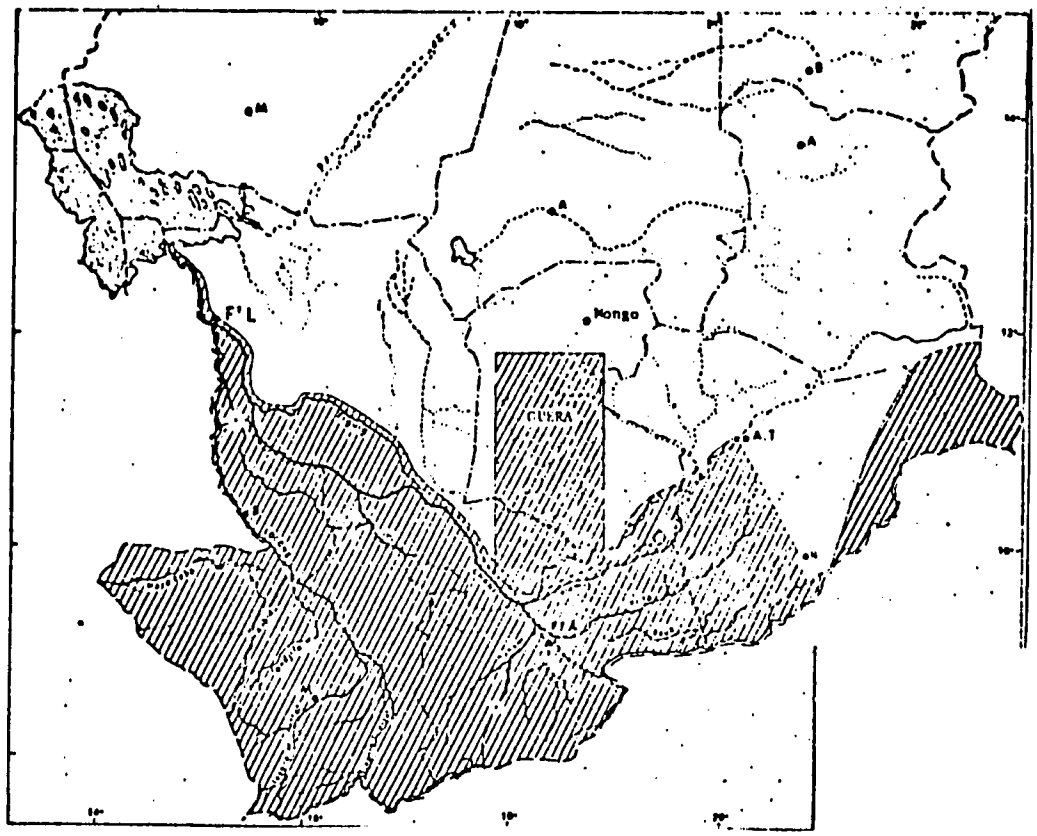
Gruvel (1966): Three species of Glossina exist in Chad. They are the following: Group: palpalis, subgenus: Nemorhina, Glossina tachinoides Westwood 1850; Group: palpalis, subgenus: Nemorhina, Glossina fuscipes fuscipes Newstead 1910 and Group: morsitans, subgenus: Glossina, Glossina morsitans submorsitans Newstead 1910. Trypanosomiasis is also transmitted by Tabanus and Stomaxys group besides the tsetse fly.

4.3.2 Vector Distribution

Gruvel (1966): Glossina is found in a large area (see Map 1) south of the twelfth parallel except for a straight band corresponding to the flow of the Chari River from Fort-Lamy to Lake Chad which restricts the vector to the sahelo-sudanese and sudano-guinean geographical zones. Not all regions in this area are infested. The infested regions are the Chari Basin and its affluents and the Logone Basin plus a central band (120 km. wide) running north-south from below Mongo to the Bahr Salamat near Fort Archambault. The northern limit extends east-west from Lake Chad following the right bank of the Chari to Bougoumene and the right bank of Erguig bahr to Batha de Lairi from which point the limit continues along Karma bahr bending towards the north at the level of Djember. From here, the limit follows a more or less north-south direction, by

MAP 1

Distribution of Glossina in Chad, 1966



LEGEND

— — — Limit of the state

— - — - — Limit of a prefecture

River

M● Chief center of a prefecture

by Melfi to the south of Bitkine at the foot of the Massif du Guera. The limit curves to the east, then the south below Massif de l'Aboutelfan and east of the mountainous zone of Abou-Deia. It then stretches to the south of Djebren on the Korom bahr. The limit continues in a large curve which climbs again to the northeast, engulfing two-thirds of the Zakouma reserve and a part of the Djourf bahr. It continues west of Am-timan heading towards Haraze to the south until it reaches the Central African Empire. The limit continues north in a line to the east of the Babonski and Diokana bahrs on to the latitude of Tedji. Finally the limit heads to the east to the Sudanese border, 50 km. south of Mongororo.

See Map 2 for an illustration of the distribution of species of Glossina in Chad.

4.3.3 Environmental Factors Influencing Distribution

Gruvel (1966): Tsetse require fairly constant temperature and humidity (levels varying for different species) as well as suitable shade vegetation. Glossina fuscipes prefers man as its source of food. G. submorsitans prefers large mammals. G. tachinoides feeds on either man or large mammals. (Gruvel (1966) provides a lengthy and detailed description of specific habitats for each strain in his article).

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

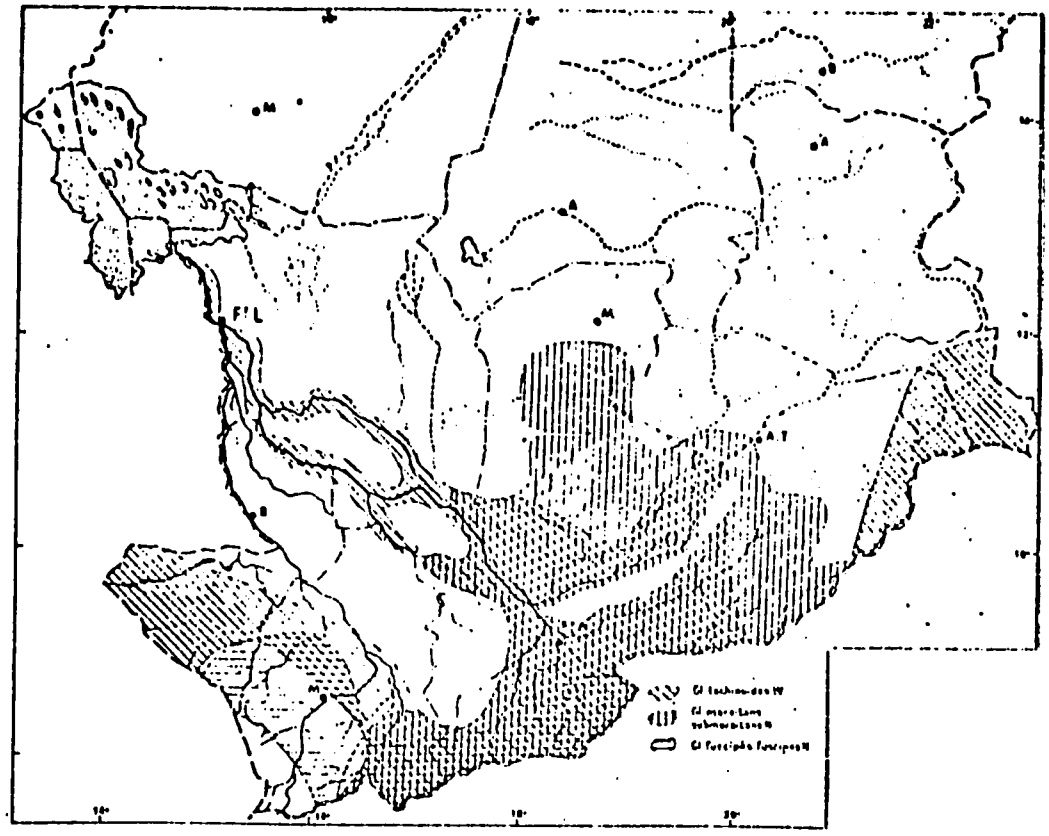
4.6 Control Measures Against Human Infection

4.6.1 Chemoprophylactic Measures

Barkhuus (1976): Chad conducts active programs against

MAP 2

Distribution of Species of Glossina in Chad, 1966



LEGEND

— — —	Limit of the state
— - — - —	Limit of a prefecture
~	River
M •	Chief center of a prefecture
	Gl. tachinoides W
	Gl. morsitans submorsitans N
	Gl. fuscipes fuscipes N

trypanosomiasis. The chemoprophylactic program, called lomidinization, is reported to have protected 10,684 people in 1975.

4.6.2 Other Protective Measures

No country-specific data found.

4.6.3 Problems Encountered

Graber (1968): One case of resistance of *Trypanosoma vivax* to berenil was reported in Fort-Lamy in 1956.

4.7 Vector or Intermediate Host Control

Barkhuus (1976): Chad has active tsetse eradication campaigns in effect. No more specific data was given.

4.7.1 Eradication by Mechanical Means

No country-specific data found.

4.7.2 Eradication by Chemical Means

No country-specific data found.

4.7.3 Eradication by Biological Methods

No country-specific data found.

4.7.4 Other Control Measures

No country-specific data found.

4.7.5 Problems Encountered

Barkhuus (1976): Governmental security measures limit visits to and investigation of health conditions in eastern Chad.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

See Gruvel (1966).

4.9.2 Laboratory Studies on the Parasite

Gruvel (1966): Three other groups of *Trypanosomes* are trans-

mitted by tsetse flies. These are T. vivax, T. brucei and T. congolense. Barkhuus (1976): T. gambiense is probably the primary parasite agent in Chad.

4.10 Clinical Studies and Observations

No country-specific data found.

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CD 5.0 FILARIASIS IN CHAD

5.2 Edidemiology of the Disease

5.2.1 Geographical Distribution

No country-specific information found.

5.2.2 Prevalence

Sasa (1976): Current prevalence data concerning filariasis in Chad is almost non-existent. Boulliez, in 1916, surveyed region of southern Chad and found W. bancrofti in 47/217 (21.7%) night examinations. He also found D. perstans in 64/181 (35.4%) day examinations. Shabel'nik (1970) examined 4,253 school children and 1000 hospital patients in the Prefecture of Guera. Eight percent of the children were infected with microfilariae (including O. volvulus). Nearly sixteen percent of the hospital patients (at Mongo) were positive. Of these patients, 6.4% were infected with D. perstans, 5% with W. bancrofti, and 1.2% with both parasites.

Buck et al. (1970) reported the following:

Prevalence of D. perstans, L. loa, and W. bancrofti in Single Blood Smears (Percentages listed are age-adjusted)

Locality	No. examined	D. perstans	L. loa	W. bancrofti	
		%	%	Day %	Night %
Djimtilo	352	0	0	0	-
Ouli Bangali	395	23.6	1.2	1.2	-
Ouarai	363	59.7	8.4	4.7	9.1
Boum Khebir	372	27.1	0.4	0	-
Faya-Largeau	199	0	0	0	-

5.2.3 Intensity

Buck et al. (1970) observed that even in villages with L. loa infection, loaiasis (calabar swelling or eye lesions) was not present. He also gave the following data: Prevalence of Edema and Elephantiasis (Percentages listed are age and sex adjusted)

Locality	No. examined	Edema of Feet and Legs %	Elephantiasis
Djimtilo	375	4.2	0
Ouli Bangala	397	10.1	0
Ouarai	363	4.5	1.5
Boum Khebir	374	3.3	0
Faya-Largeau	207	2.1	0

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

Buck et al (1970) reported that L. loa infection was lowest in children less than five years of age. Infection reached a maximum in individuals aged 40-50. More males than females were affected. For D. perstans, children under five again were least affected; adults over 40 showed the highest prevalence of infection. No significant sex differences were found for D. perstans Infection.

5.3 Vector or Intermediate Host Bionomics

No country-specific information found.

5.4. Diagnostic Procedures or Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Against Human Infection by the Disease

No country-specific information found.

5.7 Vector or Intermediate Host Control

No country-specific information found.

5.8 Disease Impact

No country-specific information found.

5.9 Laboratory Studies

No country-specific information found.

5.10 Clinical Studies and Observations

No country-specific information found.

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Documentation on Studies of Five Major Endemic Diseases in Ten African States

Part B
National and Regional Disease Profiles

Section IV
Republic of Liberia
1977

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LB 1.0 SCHISTOSOMIASIS IN LIBERIA

1.2 Epidemiology

1.2.1 Geographical Distribution

Ansari (1973): S. mansoni and S. haematobium have been reported in Liberia. Of the two strains. S. haematobium is far more prevalent. No snail hosts or transmission of either strain have been reported from a 70-mile wide coastal strip or from the large eastern and western regions of dense forest. The highest prevalence of infection is found in Liberia's Central provinces where the disease extends up to the border with the Ivory Coast. Reports of snails and infection have also been documented in the western provinces to the border of Sierra Leone and Guinea.

1.2.2 Prevalence

Miller (1957), in the Central Province between the St. Paul and St. John rivers, reported infection rates above 50%. Vogel (1958, 1959) carried out a house-to-house survey in 27 communities in the Central Province of Liberia.
By examining urine and stool specimens, then surveying snails from the same localities, Vogel attempted to determine in which villages schistosomiasis was autochthonous. Fourteen of the 27 communities were thought to be active foci of S. haematobium transmission.

Out of 1,181 persons living these 14 villages, a total of 493 (41.7%) excreted eggs in their urine. Village prevalence rates varied from 23.1% to 58.5%. For S. mansoni, 10 out of 24 communities where stools were examined

were found to be foci. The infection rate in these villages ranged from 20.1% to 61.0%, averaging 32.9%.

Haas (1969), as part of his health profile of Gipo, a rural town in north central Liberia, found 23/169 (14.2%) of the townspeople infected with S. haematobium and only 1/169 (0.6%) infected with S. mansoni.

Sodeman (1973), made a survey of the schoolchildren of two villages - Suakoko and Gbarnga - in Central Liberia. For S. haematobium, he found 49.7% of 380 children infected in Suakoko and 44.4% of 234 children infected in Gbarnga. The infection figures for S. mansoni were 49.6% of 328 examined in Suakoko and 66.9% of 221 children in Gbarnga.

Hiatt and Ruiz Tiben (1976), reported that 14.1% of 10,261 examinations in Upper Lofa County were positive for S. haematobium.

Gibson et al. (1977) examined the records of Phebe hospital for the period from July 1 to December 31, 1976. The records showed 22 persons hospitalized with schistosomiais as a primary or secondary diagnosis. Included in this number were 13 infections with S. mansoni and 10 with S. haematobium (1 double infection).

Gibson et al. (1977) also gave the following village-specific prevalence information:

I Stool exam.	Village					
	Velezela (N=76)		Gbatala (N=150)		Palala (N=124)	
	Upper Lofa Co.		Bong Co.		Bong Co.	
	No. Pos.	%	No. Pos.	%	No. Pos.	%
S.haematobium	1	1.3	7	4.7	30	24.2
S. mansoni	19	25.0	25	16.7	58	46.8

II Urine exam	Velezela (N=76)		Gbatala (N=153)		Palala (N=141)	
S. haematobium	7	9.2	38	24.8	74	52.5
S. mansoni	0	0	2	1.3	10	7.1

1.2.3 Intensity

Gibson et al. (1977) recorded the geometric mean egg counts, as a measure of infection intensity, in 3 Liberian villages:

Velezela, Lofa County

July 1976

	% Pos.	$\bar{X}_G$ (geometric mean)	Range
	30.0	5.9/gm. stool	-
	20.5	6.1/10 ml urine	-

Feb. 1977

S. mansoni	25.0	8.9/gm. stool	1-1855
S.haematobium	9.2	4.5/10 ml urine	1-35

Palala, Bong County

Feb. 1977

S. mansoni	50.4	26.1/gm. stool	1.2054
S.haematobium	53.2	11.8/10 ml Urine	1-543

Gbatala, Bong County

Feb. 1977

S. mansoni	16.3	20.1/gm. stool	1-1164
S.haematobium	25.3	8.6/10 ml. urine	1-1200

1.2.3 No incidence country specific information found.

1.2.4 Population Most Affected

No country - specific information found.

1.2.5 Vogel's (1958, 1959) house-to-house survey in the central Province of Liberia uncovered some age-and sex- specific information. Infection with S. haematobium for the 14 communities affected was 57.2% in the 5-15 year age groups compared to only 21.7% in persons aged 36 or more. The sex distribution was almost equal. In contrast, for S. mansoni (10 villages) the infection rate was 41.3% for females and only 24.9% for men. Women excreted almost twice as many eggs as men.

As an additional unexplained departure from the S. haematobium pattern the infection rates for S. mansoni did not vary substantially according to age group.

Haas (1969), in his data from Gipo, included age-specific information concerning S. haematobium infection. The prevalence rates were 7.5%, 26.2% and 10.3% for the 0-5 years, 6-12 years and adult groups, respectively.

1.3. Vector or Intermediate Host Bionomics

1.3.1. Species Transmitting the Disease

Sodeman (1973), Gibson (1977): Vogel (1958 and 1959) Walter (1960) and Sodeman (1973) have confirmed that Bulinus (Ph.) globsosus is the intermediate host for

S. haematobium in Liberia. Laboratory bred B (Ph.) globsosus were found to be highly susceptible to miracidia of S. haematobium from Liberia patients. B. forskalii is not infected in Liberia though laboratory infection of the local species has been achieved.

For S. mansoni, Biomphalaria pfeifferi is the only known established host.

1.32. Vector Distribution

Gibson (1977): In 1960, Walter sampled 330 sites near Beisalah, Gbarnga, Cuttington, and Joendee. B. globsosus was found commonly (at 42 sites); B. pfeifferi was rare. These relations were confirmed during a 1961 field trip covering 40 different stations (3 in the Suakoko-Gbarnga area, the remaining 37 in Zonzor, Voinjama, and Kolahun). In this latter survey, snail infection rates were found to be very low: only 1 out of 255 Bulinids collected shed schistosome cercariae.

Sodeman (1973) examined 177 sites along 71 miles of roadside in central Liberia. B.globsosus and/or B. pfeifferi were found in 40/177 (22.3% of the sites in about equal prevalence. Fifteen of the 177 sites (8.5%) contained infected snails, with S. mansoni infected sites outnumbering those infected with S. haematobium by a ratio of 3 to 2. Interestingly, these snail infection figures were commensurate with human infection figures from nearby areas.

1.3.3 Environmental Factors Influencing Distribution

Vogel (1958, 1959) found in his 12 site snail survey that depending on place and season, the rate of S. haematobium infection in snails varied between 2.9% and 59.5%.

Sodeman (1973) observed that the only natural water sources free of snails were seepage wells (shallow pits dug at the base of a hillside to permit collection of ground water) Sodeman suggested that the wells were snail-free because they lacked any significant connection with natural water courses.

Gibson et al. (1977), reporting on Walter's 1960 study, noted that the peak snail population was reached early in the year, at the end of the dry season. It was also noted that Biomphalaria thrived at 25°C-31°C and that disturbing canal water levels did lower the Bulinus snail populations.

LB 1.4 Diagnostic Procedures and Techniques

No country-specific information found.

LB 1.5. Therapeutic Trails

1.5.1. Studies on New Drugs

No country-specific information found

1.5.2. Mass Treatments

Haas et al. (1976) described a treatment program for 40 patients, 50-50 years of age, who were infected with S. haematobium. Treatment consisted of 10 mg/kg body weight of the drug metrifonate, given orally three times a day at two week intervals. Twenty-seven of the 40 treated cases no longer voided eggs after 1 dose, while 37 stopped passing

eggs after the second dose.

Side effects (nauseau, abdominal pain, and rare vomitting) were mild. Statistically, the drug did not influence transaminase, SGOT, SGPT, or LDH. There was no change in eosinophil levels. Some patients (7) experienced a transient effect on EGG curves (changes in T-wave in V 1-4).

1.5.3. Problems Encountered

No country-specific information found.

1.6 Control Measures Against Human Infection

No country-specific information found.

1.7 Vector or Intermediate Host Control

No country-specific information found.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

No country-specific information found.

1.10 Clinical Studies and Observations

No country-specific information found.

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LB 2.0 ONCHOCERCAISIS IN LIBERIA

2.2 Epidemiology of Onchocerciasis

2.2.1 Geographical Distribution

Onchocerciasis is widely distributed in Liberia. The disease is found throughout the savannah and rain forest bioclimatic zones. Epidemiological surveys have shown that the disease is prevalent in all nine counties, though endemicity and intensity vary from one region to another. The western part of the country is the most affected area.

The southwestern Salala district, southeastern Gibi district (Bong County), Gbarnga district, Saniquelle district and Tanipa district in Nimba County are onchocercal districts. The disease is also found along the Grand Cess River area and in the vicinity of Nyaake on the Cavalla River (Webbo district), in the lower St. John River, in the Marshall Territory (Bassa County), along the St. Paul (Todee district), the Mahem and the Lofa Rivers in Montserrado County.

The general distribution pattern, however, shows high endemicity in the western part of the country with a general decline towards hypoendemic conditions in the eastern region. Areas where the original tropical rain forest has been replaced by the savannah type of vegetation as a result of farming activities have the highest concentration of the disease.

2.2.2 Prevalence

The Harvard expedition of 1926 gave the first record of the occurence of onchocerciasis in Liberia (Frentzel-Beyme, 1973). Results obtained by Buck et al (Frentzel-Beyme, 1973) from screening 2,000 workers in the Firestone Plantation (who were immigrants from different regions of the country) showed that one-fifth (1/5) of the subjects were onchocercal nodule carriers and a third (1/3) of the 700 sampled had microfilariae. Prevalence rates were found to be highest among persons from the western part of the country. Microfilariae carriers were few among people from the coastal area. An examination of 600 patients of the Firestone Plantation Hospital at Cavalla in Maryland County (Eastern Liberia) revealed that 30% of the adult males had microfilariae while only 14% of the female sample had microfilariae. These results led to the conclusion that endemic transmission was possible in the northern part of Maryland County (Frentzel-Beyme (quoting Grant), 1973).

Parasitological studies done among the industrial workers from various parts of the hinterland of the country and among patients in the regional hospitals, showed that onchocerciasis is endemic and widespread throughout Liberia (Buck et al, 1955, Gratama, 1966).

(cited by Frentzel-Beyme, 1975). The same impression was gained by Frentzel-Beyme from his parasitological screening of approximately 800 workers at an iron mine in Central Liberia although there were marked differences in the prevalence of infection from one group to another.

An epidemiological survey which covered 121 communities and a population of 10,885 (9,587 from 116 rural communities and 1,298 from 5 commercial enterprises) was conducted from 1968 to 1971 in order to assess the prevalence of onchocerciasis in the country. About 1% of the rural population was covered in this study. Parasitological examinations were done on the 10,885 subjects and 38% of the population were found to be carriers of Onchocerca volvulus microfilariae. 6% of the sample had nodules but without microfilariae and 27% of the entire population had one or more onchocercal nodules. All nine counties, namely: Bong, Grand Bassa, Grand Campe, Grand Gedeh, Lofa, Maryland, Mantserrando, Nimba and Sinoe, have the disease. The commercial enterprises included in the study were the Bong Mining Company, the Firestone Plantation Company, the Maryland Logging Corporation and the African Fruit Company.

A comparison of microfilariae rates in the population classified according to different percentages

of prevalence rates. (0-10% = sporadic cases; 11-32% = low endemicity; 33-49% and 50-65% = medium endemicities; more than 66% = high endemicity, in all adults over 15 years of age infected with O. volvulus), showed that more than 66% of all persons over 15 years of age were infected with Onchocerca volvulus microfilariae. The infection rate was high in persons over 30 years old (50%) and in areas with high endemicity, the average age was 25 (Frentzel-Beyme, 1975, p. 77).

A study done on 1,252 individuals out of a total population of about 15,000 in Bong County, showed that 783 (63%) of the population sample were microfilariae carriers. The prevalence rate (mf and oc) was 68%. Sex-specific rates were significantly higher in males than in females. No microfilariae were found in the 110 1-4 year olds.

Microfilariae carrier rates of between 25% and 60% were found among the 10 years old and over age group and the 5-9 year olds had microfilariae in their hips and calves. The average rate was 43.5% and the combined microfilariae carrier rate for both sexes in the 15-29 years age group was 77%. The overall rate in persons older than 29 years was 92.4% (Frentzel-Beyme, 1973). More than 50% of the population had detectable larvae in the gluteael skin between the age of 16 and 18 years.

From January 1 to September 30, 1976, 1,082 cases of onchocerciasis were reported in Liberia (Gibson et al, 1977). A report from Phebe Hospital (Bong County) showed that 267 (33.2%) skin snips obtained from a population sample of 803 had microfilariae (1973 report). The 1974 report showed positive onchocerciasis skin snips. From January to May, 1976, 233 (49%) positive skin snips were reported; 473 persons were examined (Gibson et al, 1977).

The 1976 parasitological statistical report of the C. B. Dunbar Clinic at Gbarnga (Bong County) showed that 181 (36.7%) of the 492 skin snips examined for onchocercal microfilaria were positive (Gibson et al, 1977, tables 1 - 5). The positivity range for the Phebe Hospital and the C. B. Dunbar Clinic from 1973 to 1976 was 33% to 51%. Skin snips done on 71 persons at Palala revealed that 5.6% of the subjects had microfilariae.

The initial evaluation of eye implications and the importance of infection as a cause of blindness in Liberia was first given by Neuman and Gunders in 1963 (Frentzel-Beyme, 1973). An epidemiological evaluation of all eye patients of the Government Hospital in Monrovia, for onchocercal lesions led to the identification of two foci in the northwestern part of the country (in Bopolu and Voinjama district).

A population of 674, consisting of 344 adult males and 330 females, in Bong Range was examined for microfilariae in the anterior chambers of the eyes (MfAC). Results showed that 8.75% (59) had intraocular larvae (36 males and 23 females). The prevalence of bilateral blindness among the 2,285 residents of Bong was 1.18%. 27 adults of the 789 persons examined for visual ability had visions of less than 3/60 in both eyes and 16 were blind in one eye. The respective rates among the adults were 3.4% for bilateral blindness and 2% for unilateral loss of vision. The average age for bilateral blindness was 53 years in females and 55 years in males with a range from 20 to 75 years (Frentzel-Beyme, 1973).

The rate of blindness of 1.18% found in Bong Range communities was more than twice that observed in onchocerciasis-free regions of the country. In most of the cases, blindness appeared to be related with onchocercal infection. The average age for completely blind individuals was 54 years. Among the unilaterally blind, the average age was 48 years (blindness in this group was less related with onchocerciasis). Bilaterally impaired vision was found in 8.3% of 1,131 subjects.

Incidences of blindness among 789 adults of Bong Range population were:

(1) Partial visual impairment (6/60) = 54 persons (6.8%),

(2) Social blindness (greater than 1/60 - 3/30) = 27 persons (3.4%), and

(3) Total blindness and virtual blindness (less than 1/60) = 22 persons (2.8%). 14 persons had unilateral defects of vision (Frentzel-Beyme, 1973).

In another epidemiological survey conducted from 1969-1971 (Frentzel-Beyme, 1975) 121 communities with a population sample was 3.24%. A very high proportion of the population with visual defects had onchocerciasis and the disease was responsible for 25% of the blind individuals. Examination of visual acuity indicated that 125 persons out of the 9, 631 (6,579 of whom were above 14 years of age) subjects had visions of 1/60 to 2/60 in both eyes (Frentzel-Beyme, 1975). Gibson et al (1977) report rates (exclusively for adults) of 1.9% for virtual blindness, 5.3% for economical blindness, and 10% for impaired vision of all degrees (Gibson et al, March, 1977).

2.2.3 Intensity

The intensity of onchocerciasis in the affected population varies in accordance with the infection rates --especially in those areas which provide suitable breeding sites for female S. damnosum. Repeated infections are observed in hyperendemic areas where more than 80% of the adult male population over 25 yers of age carry

microfilariae (mf) in the skin. The intensity of infection rates which are dependent on the frequency of the infected female S. damnosum biting activity as well as the population's degree of exposure to areas harbouring the vector. Although prevalence rates for the studied population as a whole indicate a high degree of endemicity, regional evaluations show that transmission is focal and hence, the intensity of the disease is also localized in areas with high transmission and infection rates. Quantitative results from the skin biopsies classification showed a high microfilariae density in persons living in hyperendemic zones and increased with increased age. There was a high average yield per biopsy in individuals living under endemic conditions and therefore under constant exposure to the biting of female S. damnosum (Frentzel Beyme, 1975). Kershaw, Duke, and Budden (l.c.) (cited by Gratama, 1966), found that the intensity of infection increased in relation to the distribution of the microfilariae in different parts of the body.

2.2.4 Incidence of onchocerciasis

Incidences of onchocerciasis are high in hyperendemic areas where there is frequent reinfection of patients with O. volvulus. Gratama (1966) in his study in southeastern Liberia found that the incidence of onchocerciasis infection, as judged by the result of

the skin snips and/or the presence of nodules was 29.4% for males and 14.4% for females. (Gratama, 1966, p. 103). Data for this study were collected from May, 1963 to May, 1964. The population sample was 625 (279 males and 346 female patients over 15 years old in the Firestone Cavalla Plantation hospital). Skin snips were taken from 88% of the 279 male and 83.8% of the 346 female patients. Burch, Qualls and Greenville (1955) (cited by Gratama, 1966) found that 19.4% of the 2,423 plantation workers in the Harbel area of Liberia were nodule carriers (Gratama, 1966). The incidence among adult males over 15 years of age on the Cavalla plantation was 9.2% (most of these people were younger than 45 years old). The incidence of skin atrophy was found to increase among patients with positive skin snips and increased number of nodules (Gratama, 1966, Tables 9.3 and 9.4). Increased incidence rates were therefore quite pronounced in males and in older patients.

2.2.5 Population most affected

Studies done in different parts of Liberia clearly show that the male and older segments of the population are the most affected groups. According to the five classes in Frentzel-Beyme's classification (Frentzel-Beyme, 1975), the rates for males in Class I (prevalence rate 0 - 10%) was 16% as compared to 7% among females

of the same age group. Microfilariae densities in females were also lower than in males (Frentzel-Beyme, 1975, p.77).

The age specific studies indicate that persons 5 years of age and over suffer most from onchocerciasis. Microfilaria densities and carrier rates are high in males and increase with age. Increased rates in females are observed after ages 17 - 20.(Frentzel-Beyme, 1975).

It should be pointed out however that in hyper-endemic areas, children younger than 10 years of age are found to be infected with O. volvulus parasites.

Blindness is found mostly among the older population groups (usually those above 40 years old) although the young population heavily infected with the parasite may have high incidences of blindness--especially where head nodules are observed most frequently.

2.3 Vector Bionomics

2.3.1 Species of the vector transmitting onchocerciasis

Onchocerciasis in Liberia, as it is in other parts of West Africa, is transmitted by species of the black fly Simulium damnosum complex. Five forms of Simulium damnosum complex species have been identified in Liberia and Guinea, four of which were exclusively found in Liberia (Garms & Vajime, 1975). The five forms of S. damnosum identified by Garms and Vajime through the analysis of chromosomal materials collected from Liberia

and Guinea are:

(1) S. yahense (Vajime and Dunbar)

(2) S. santipauli (Vajime & Dunbar)

(3) S. damnosum (Theohald)

(4) S. soubrense (Vajime & Dunbar)

(5) S. sirbanum (Vajime & Dunbar)

Simulium sirbanum was found in the northern Guinea Savannah zone and not in Liberia. This form of the vector appeared to be a pure savannah species confined to the savannah zone.

2.3.2 Distribution of Simulium damnosum species

Simulium santipauli (Vajime and Dunbar, 1969) (=S. damnosum "Bandama" form, Dunbar, 1969) was identified from 13 breeding sites all of which were located in large rivers of the rain forest zone (Mano, Lofa, St. Paul, Farmington, Grand Cess, Cavalla and Makona Rivers). Larvae of this species were always associated with those of S. kenyae and sometimes with a few of S. schoutedeni or S. unicornutum. S. yahense (S. damnosum "Yah" form, Vajime, 1973) was widely distributed in Liberia (42 sites). Most of the species' breeding sites were small, often heavily shadowed streams or narrow rivers. This species was not found in large rivers. S. yahense was always associated with a large number of other flies. In the rain forest zone, it was in association with S. alcocki, S. garmsi, S. djallonense, S. schoutedeni, S. kenyae, S. unicornutum, S. loutetense

and S. liberiense.

S. soubrense (= S. damnosum "Soubre" form, Vajime, 1973) was found in the forest zone on the Cestos River. It bred in large or medium size rivers and was found in association with S. garmsi, S. schoutedeni, S. kenyae, S. unicornutum and S. damnosum s.s. in the forest zone; and S. schoutedeni, S. adersi, S. unicornutum, S. cervicornutum and S. tridens in the savannah region.

S. damnosum s.s. (= S. damnosum "Nile" form, Dunbar, 1969) was found in the forest zone on the St. John and Cestos Rivers. The species bred in large rivers and in dam spillways of irrigation systems. Its association in the forest zone were S. kenyae, S. soubrense, and S. unicornutum; while in the savannah zone the species associated with S. adersi, S. schoutedeni, S. unicornutum, S. griseicolle, S. tridens, S. bovis and S. sirbanum; and in irrigation systems with S. alcocki, S. garmsi, S. schoutedeni, S. unicornutum, S. cervicornutum, S. adersi, S. hargreavesi and S. sirbanum.

It may be of interest to mention that species of S. yahense and S. sanctipauli never occured together, but were separated by their specific ecological requirements. Larvae of S. sanctipauli were found in large rivers while those of S. yahense inhabited the small watercourses, completely shadowed and much cooler than the rivers (Garms, 1973).

The ecological requirements of S. damnosum species were quite evident when these associations with other black flies are compared. Comparison of the distribution of various species of S. damnosum complex with the areas in which onchocerciasis is endemic, suggested that all species of the vector participated in the transmission of O. volvulus. However, transmission potential of the fly population is not the same in all areas, e.g. the probability of transmitting O. volvulus in the forest zone could be reduced by zoophily as indicated by species of S. sanctipauli which were found to carry effective filarial larvae of nonhuman origin (Garms, 1973).

In contrast, however, the small streams in the savannah zone were generally found to be free of species of S. damnosum complex. These areas were densely populated by S. hargreavesi, which is probably a more competitive species than S. damnosum (S.L.) under the savannah bioclimatic conditions.

2.3.3 Environmental factors influencing vector distribution

The environmental conditions have a very significant influence on the distribution and activity of S. damnosum. The availability of fast running watercourses with adequate supply of organic matter and oxygen are essential for the breeding and development of S. damnosum

species. Therefore, fast flowing rivers with a current speed of not below 0.5 m/sec or above 2 m/sec and adequate vegetations for supporting the pre-imaginal forms of S. damnosum are necessary conditions for the survival of the species. (The tolerated speeds are between m/sec and 1.2 m/sec.) Temperature fluctuations are equally important and so are the seasonal variations. The daily activity of S. damnosum females which are the vectors for onchocerciasis and are also haematophagous as well as zoophilic (anthropophilic) may be slowed down or stopped by temperatures below 17°C or above 30°C (WHO, OCP//3.1, Onchocerciasis Control in the Volta River Basin Area, Geneva, 1973).

Seasonal changes are indeed very important as far as the activity of the vector is concerned. Three main types of seasonal variations of S. damnosum population have been observed in the Volta River Basin Area although similar observations have not been made in Liberia as such. But due to the fact that both the savannah and rain forest species of S. damnosum are found in Liberia, it is likely that the same seasonal changes exist. The three seasonal variations identified in the Volta River Basin Area are (1) synchronic variation, (2) inverse variation and (3) bimodal variation. During the synchronic variation, the abundance of the vector is positively correlated with the water flow, while S. damnosum mostly occurs in the dry season during

the inverse variation. During the bimodal seasonal changes, the vector is only abundant in those periods of maximum and minimum river flows. Other meteorological factors such as strong winds, rainfall, etc., which are unfavorable for the vector's activity play a significant role in the distribution of S. damnosum species, both the savannah and rain forest type. (WHO: Onchocerciasis Control in the Volta River Basin Area, Annex III-1, Geneva, 1973).

2.3.4 Breeding site

S. damnosum complex species breed in fast flowing well shaded and well aerated river waters. There are significant variations, however, among the forms identified so far. In Liberia, Garms and Vajime found that S. yahense ("Yah") bred in small, heavily shadowed streams or narrow rivers and was not found breeding in large rivers. S. sanctipauli ("Bandama") was found breeding in large rivers of the rain forest zone while S. soubrense ("Soubre") bred in large or medium size rivers in the rain forest and savannah zones. S. damnosum's ("Nile") breeding site were in large rivers, and in dam spillways of irrigation systems (in both the rain forest and savannah bioclimatic zones).

The rivers' current speeds and temperature fluctuations of the water are essential factors for the survival of S. damnosum larvae. Current speeds of

0.5 to 2 m/sec are favorable for larvae of S. damnosum which occupy the upper 50 cm of the rivers' water surface (the eggs hatch in 36-48 hours after laying). The larvae which feed by filtering organic and other particles in the water current need adequate support and inhabit only those parts of the watercourse with high contents of suspended nutritive particles. (WHO: Onchocerciasis Control Program in the Volta River Basin Area, OCP/73.1, Geneva, 1973).

Other conditions equally important for the breeding of the vector include the availability of mammalian blood, female S. damnosum flies in the breeding sites and adequate supportive surfaces such as rocks, vegetation, etc., for the attachment of the larvae (Garms & Vajime, 1975).

2.4 Diagnostic Procedure

2.4.1 General Diagnostic Methods

Identification of onchocercal nodules by palpation, examination of microfilariae in skin snips and in the urine, the use of the Mazzotti test (25 mg diethylcarbamazine, a microfilariae drug) are among the general methods used in the diagnosis of onchocerciasis in Liberia. However, taking skin snips for microfilariae examinations is the most common diagnostic technique used in the studies done in Liberia. (Gratama, 1966)

2.4.2 Other (new) Diagnostic Techniques

Gratama (1966) used a differential diagnostic technique in studying the role of Onchocerca volvulus and Wuchereria bancrofti in the pathogenesis of hydrocele and elephantiasis (Gratama, 1966). As a result of his study, Gratama concluded that measuring the relative position of the nerve ring was the most reliable way of differentiating between microfilariae bancrofti and microfilariae volvulus in hydrocele fluid when there is any doubt regarding their identity. Other points of differentiation in order of reliability were: (1) the shape of the tail end of the microfilariae, (2) the number of tail nuclei in single file and (3) the length of the nuclei-free anterior end, expressed as a percentage of the total body length. These three criteria are only reliable when no distortion of the microfilariae has occured during the preparation of the smears. Shrinkage can be avoided by adding a 5% formaldehyde solution to the hydrocele fluid and then waiting for 12 - 24 hours before centrifugation and preparation of the smears. A tentative diagnostic method was established by Frentzel-Beyme (1975) for screening 322 cases of both bilateral and unilateral blindness. Results showed that atrophy of the optic nerve was responsible for 6% of the cases. The diagnosis could only be made when proper examination of the fundus was achieved and only if the anterior

segment lesion did not prevent funduscopy. Unspecified leukoma of the cornea combined with staphyloma, pannus, traumatic scars and causes other than onchocercal sclerosing keratitis were detected by using this technique.

Positive diagnosis of onchocerciasis is however, made by seeing microfilariae in the anterior chamber of the eye, in the skin snips and in the urine (microfilariae) as well as the demonstration of adult worms in subcutaneous nodules (Scheie et al, 1974).

2.5 Therapeutic Trails

2.5.1 Clinical Trials

No extensive studies have been done in Liberia in regard to clinical trials of new drugs for the treatment of onchocerciasis. Drugs used to treat the disease are suranum and diethylcarbamizine (DEC) which are commonly used in other parts of West Africa for the same purpose. (Gratama, 1966)

2.5.2 Field Trials

No country specific data found.

2.5.3 Problems Encountered

No country specific information found.

2.6 Control Measures Against Human Infection

2.6.1 Chemoprophylaxis

No country specific information found.

2.6.2 Other Protective Methods

No country specific information found.

2.6.3 Problems Encountered

No country specific information found.

2.7 Vector or Intermediate Host Control Program

2.7.1 Eradication of Vector by Mechanical means

No country specific information found.

2.7.2 Chemical Control (use of insecticides, etc.)

No country specific information found.

2.7.3 Biological Control of the Vector

No country specific information found.

2.7.4 Other Control Methods

No country specific information found.

2.7.5 Problems

No country specific information found.

2.8 Disease Impact

2.8.1 Disease Impact on Population Distribution

The impact of onchocerciasis on the population is quite significant in that there is a constant shift from hyperendemic areas to those parts least affected by the disease. As a result of this population movement, some areas of the country are densely populated while others are very sparsely so. Seasonal migrations in the onchocercal rural areas are observed in accordance with the peak transmission levels of the disease and

the young population is constantly moving to towns where conditions are better in terms of job opportunities and infrequency of infection by onchocerciasis. (WHO: OCP/734)

2.8.2 Impact on Economy

No economic analysis relevant to the impact of onchocerciasis was given in literature reviewed.

2.9 Laboratory Studies

2.9.1 Laboratory Studies Done on the Vector

There are no extensive laboratory studies done in connection with the vector transmitting the disease. Some of the most detailed studies are those done by Garms and Vajime in 1975, in which the two investigators identified several forms of S. damnosum through the analysis of chromosomal materials collected from Liberia and Guinea. Garms and Vajime observed that larvae of S. yahense ("Yah") were characterized by large and steep abdominal tubercles (see Garms and Vajime, 1975, Fig. 2B, p. 378).

2.9.2 Laboratory Studies on Onchocerca volvulus

Gratama's study on the role of Onchocerca volvulus and Wuchereria bancrofti in the pathogenesis of hydrocele and elephantiasis is probably the only detailed information in regard to O. volvulus parasite in Liberia (Gratama, 1966). According to the results obtained from this study, O. volvulus were found to be

more or less extended, sheathless, and with oval and longitudinally arranged small nuclei and a transversely striated cuticle.

The anterior end of O. volvulus microfilariae has a slight widening just after the bending of the head, the first two nuclei are separate and isolated from the rest of the nuclear column and the nuclei-free zone is about 10 microns long, and the head is slightly angulated and rigid. There is a nonnucleated area of about 5% of the total body length in the posterior end. The tail end is often curved at a wide angle; the body has a uniform width except the caudal end where it narrows, the terminal nucleus is frequently elongated and triangularly shaped (Sharp (1926) cited by Gratama, 1966). The number of tail nuclei arranged in single file averaged 5.5. These morphological differences were used by Gratama in differential diagnosis of O. volvulus microfilariae and W. bancrofti mf. in hydrocele patients in the southeastern territories of Liberia (Gratama, 1966).

2.10 Clinical Studies and Observations

The general clinical manifestations of onchocerciasis include oedema of the skin, lymphoedema, lichenoid changes, depigmentation, atrophy of the skin (in onchocercal dermatitis), punctate keratitis, sclerozing keratitis, iridocyclitis (uveitis, plastic inflammation,

secondary glaucoma), choroidoretinal lesions, and post-neuritic optic atrophy in ocular onchocerciasis. (Gratama, 1966)

The pathogenesis of onchocerciasis is not completely understood. However, most investigators consider cutaneous symptoms of onchocerciasis as caused by antigens produced by microfilariae after previous sensitization significant weight loss in heavily infected persons (Buck et al, 1971).

Onchocercal punctate keratitis is found in all ages in hypoendemic communities, but no permanent ocular lesions are observed. They develop only in adults and are rarely gross. In mesoendemic areas (40-69% prevalence rates), punctate keratitis is common in young persons but less common in older individuals. Permanent lesions are observed in young adults and become more common and serious in older persons. Blindness and impaired vision (both anterior and posterior chambers) are also seen among patients for mesoendemic communities. Heavy invasion of the eye by microfilariae is common in early childhood and permanent lesions may develop in youth resulting in impaired vision and blindness. The intensity of microfilarial infection in these same hyperendemic areas (prevalence rate greater than 70%) tends to decrease in the older population (WHO: Oncho. Symptoms, pathology, diagnosis, 1974).

There is therefore a dermatological and an ophthalmalogical component to onchocerciasis caused by an allergic reaction due to disintegrating dead microfilariae (Scheie et al, 1971).

Ocular involvement may consist of permanent swelling of the upper lids due to edema and lipomatous changes (Scheie et al, 1971). However, the major cause of blindness in areas heavily infested with onchocerciasis is exudative fibrinous iridocyclitis which leads to occlusion of the pupil, frequent adhesions at the angle of the anterior chamber or posterior corneal face and a mass of tissue in the hypopyon position. In the acute stage the mass is soft and yellow but becomes tough, white and fibrinous, thus distorting and immobilizing the pupil, usually in a downward pear shape (Sheie et al, 1971, p. 699). Two distinct chorioretinal lesions have been described: (1) posterior uveitis secondary to the death of O. volvulus in the choroid, which is the first and most common and (2) posterior degenerative lesion that looks like a central areolar circumscribed chorioretinal atrophy but not associated with the presence of the parasite in the posterior segment. This type of lesion is found among patients from the savannah regions.

Motile microfilariae may be seen in the anterior chamber of the eye or attached to the iris stroma and to descemet's membrane.

LB 2.0 ONCHOCERCIASIS IN LIBERIA

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LB 3.0 MALARIA IN LIBERIA

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975): One hundred percent of the Liberian population lives in malarious areas.

Swamy et al. (1976): Malaria was reported from Kpain in Nimbia county in 1954 - 1957, 1958 and 1961; from Nimbia, Bong Grand Gedeh, Sinoe, Lofa and Grand Bassa counties in 1963 and 1965 - 1968; and from Monrovia and its environs (Sinkor, Bushrod Island, Bentol, Millsburg, Harrisburg, Clay-Ashland, Arthington, Careysburg, New Georgia, Paynesville and Brewersville) in 1962, 1968, 1972, 1974, 1975 and 1976.

Gibson et al. (1977): Malaria was studied in several sites in Bong County, Bentol and other rural areas.

3.2.2 Prevalence

Roberts et al. (1972): Malaria is endemic everywhere in Liberia and is considered the country's most serious disease problem. In 1960 it was estimated that everyone in Liberia had malaria at some time.

Jeffery and Gibson (1966): In a study of malaria in Kpain, Liberia it was found that 231 patients, ages 5 - 19 years, had positive blood films.

WHO (1975): The 1974 parasite rate in areas of Liberia in which control measures were operant was 9 - 25%. In areas without contro measures, the parasite rate was 41 - 87%. Malaria mortality for that year was 86.108 per 100,000.

Swamy et al. (1976): In 1963 in Nimbia, Bong, Grand Gedeh, Sinoe, Lofa and Grand Bassa counties, which were covered by the Malaria Pre-Eradication Project epidemiological survey, malaria was

found to be hyperendemic with an overall spleen rate of 59 - 81.5% and a spleen rate for children, 2 - 9 years old, of 68.4 90.6%. From 1965 to 1968 in the same area, 6,000 cases of malaria were treated. In discussion of the Malaria Control Program, which began in 1962 and comprised primarily anti-larval measures in Monrovia per se, but not in neighboring Sinkor or Bushrod Island, the 1968 overall spleen rate was 20%, ranging from 13.1% - 63%. It was highest on Bushrod Island and lowest in Monrovia proper. The 1976 malaria endemicity for greater Monrovia was mesoendemic with spleen rates for children, 2 - 9 years old, of 9.7% in general, in Monrovia, 12.8% in Sinkor, and 11% on Bushrod Island. The overall parasite rates in greater Monrovia are presented below.

Overall Parasite Rates (%) In Monrovia

Year	Overall	Monrovia	Sinkor	Bushrod Island
1962	10.9	--	--	--
1972	12.3	--	--	--
1974	26.0	--	--	--
1976	31.8	22.3	45.0	28.5

Malaria was hyperendemic in 1975 in the area within a 25 mile radius outside of Monrovia. For this area the overall spleen rate was 29.8% that year and the spleen rate for children, 2 - 9 years old, was 33%. The 1975 parasite rate was 45.9%. The highest rate was found in children 2 - 9 years old in Bentol where it was 76.1%; and the lowest was in Brewerville at 27.3%. In the comparison of the spleen rates and the parsite rates before and six months after chemoprophylaxis in Bentol and in three towns, Millsburg, Harrisburg and Clay-Ashland , which received no chemoprophylaxis, Swamy presents the following data:

Spleen Rate (%), 2 - 9 years old, 1975

	before	after chemoprophylaxis
Bentol	73.4	13.7
3 towns without chemoprophylaxis	39.2	44.1

Parasite Rate (%), 2 - 9 years old, 1975

	before	after chemoprophylaxis
Bentol	76.1	37.9
3 towns without chemoprophylaxis	59.5	56.6

Gibson et al. (1977): Malaria was described as the leading cause of mortality and morbidity in Liberia. These authors report that the parasite rate in children in rural areas may range from 80 - 100%. The parasite rate for 1961 was 18.5%. In 1963 in the six counties of Nimbia, Bong, Grand Gedeh, Sinoe, Lofa and Grand Bassa, the parasite rate ranged from 57 - 88%. The Annual Report of the National Public Health Service for 1969 reports that 73.6% of 743 blood samples from employees and their families were positive for malaria.

The malaria situation was studied in two different villages in Gbarnga District in Bong County. These were Palala, located in a swamp rice area, and Gbatala, which is not located in a swamp rice area. Malaria is mesoendemic in both villages. Prevalence data is presented below. Additional information regarding malaria as described in this two village study can be found in the Volume III Part B Section I.

Prevalences

2 Villages in Gbarnga District, Bong County, 1977

	Palala	Gbatala
Spleen rate	21.0%	14.0%
Parasite rate	55.0%	48.0%
Prevalence	54.9%	48.25%

3.2.3 Intensity

Jeffery and Gibson (1966): In a malaria study in Kpain, Liberia, 18 out of 231 patients, ages 5 - 19 years, had parasite densities greater than 1,000 per cubic millimeter of blood.

Swamy et al. (1976): In a splenometric survey of 14 townships 639 out of 2,140 people had palpable spleens. The overall average enlarged spleen was 2, while the average enlarged spleen in the 2 - 9 year old group was 2.1.

3.2.4 Incidence

APHA, Health Sector Assessment, Liberia (1977): The incidence of malaria around Monrovia has been reduced by control programs.

3.2.5 Population Most Affected

Roberts et al. (1972): The infant mortality due to malaria was 50%.

APHA, Health Sector Assessment, Liberia (1977): Eighty percent of the children in the interior of Liberia had positive blood smears.

Gibson et al. (1977): In Palala, which is in the swamp rice area, highest rate of infection can be found in the 10 - 19 years and the 30 -39 years age groups. In Gbatala, which is not in a swamp rice area, the rate of infection is highest in the 2 - 9 years age group and declines after that. The infant parasite rates found in the two villages is presented below.

	Infant Parasite Rates	
Palala	-----	66.0%
Gbatala	-----	25.0%

Additional data about age and sex distribution of malaria in these two villages is presented in the accompanying tables.

3.3 Vector or Intermediate Host Bionomics

3.3.1 Species Transmitting the Disease

Swamy et al. (1976): In Kpain, Nimbia county, during the period 1954 - 1957, *Anopheles funestus* comprised 57% of the vector population; *A. gambiae*, 32%; and *A. hancocki*, 10%. By 1958 following insecticide spraying with Dieldrin, *A. gambiae* ranked as the most prominent at 98% while *A. funestus* was only 1.5%. In 1965 *A. gambiae* was the only infected species of the vector and its sporozoite rate was 7.1%.

Gibson et al. (1977): Vectors collected in Monrovia were *Anopheles gambiae* - the predominant species, *A. funestus*, *A. hancocki* and *A. coustani*.

3.3.2 Vector Distribution

Swamy et al. (1976): The average room density for *A. gambiae* in in Kpain in 1961 was 0.08 - 0.10. Within the 25 mile radius around Monrovia the most infective species in 1975 was *A. gambiae*, particularly in New Georgia, Arthington and Careysburg, where the overall average room density was 1.09. The maximum density per room in Arthington was 12.3; in Careysburg, 3.8 and 3.0 in Bentol. In greater Monrovia in 1976 the average room density for *A. gambiae* in areas treated with a larvicide was 0.1. In areas of greater Monrovia that were not treated the average room density was 1.59.

Gibson et al. (1977): The most prominent vector in Monrovia as of 1977 is A. gambiae, but A. funestus, A. hancocki and A. coustani are also effective vectors.

3.3.3 Environmental Factors Influencing Distribution

Swamy et al. (1976): Rock pools and river bed pools left in drying rivers are common breeding sites for A. gambiae in Liberia. These authors also report finding A. aegypti breeding in a drum of water in Harrisburg.

Gibson et al. (1977): In both Palala and Gbatala 50% of the population is infected during the dry season.

3.4 Diagnostic Procedures or Techniques

3.4.1 General Diagnostic Methods

Wintrob (1973): This author's criteria for diagnosing cerebral malaria is a confirmed parasitemia and central nervous system dysfunction which is not due to severe hyperpyrexia, anemia, or metabolic abnormalities.

Kingston (1971): At Firestone Hospital this author based his diagnosis of cerebral malaria on a high density of P. falciparum parasitemia, presence of continuous convulsions, coma, or severe neurological abnormalities and exclusion of other causes of encephalitis. In order to make a definitive diagnosis, those disorders which must be differentiated from cerebral malaria because of similar clinical manifestations are hypoglycemia, sickle cell crisis, septicemia, meningitis, electrolyte imbalance, tetanus and viral or pertussis encephalitis.

3.4.2 New Diagnostic Techniques

No country-specific data found.

3.5 Therapeutic Trials

3.5.1 Studies on New Drugs

Kingston (1971): Urea in invert sugar when used in the treatment

of cerebral malaria in ten children at Firestone Hospital was effective in relieving the concomitant neuronal dysfunction. Urea does this by reducing cerebral edema via osmotic diffusion from brain tissue and cerebral spinal fluid. It also induces vascular distension and a decrease in blood viscosity which serves to unplug blocked vessels; and reverses agglutination by altering the surface properties of erythrocytes. The author recommends urea as an alternative or a supplement to corticosteroids, especially dexamethasone, which are successful in treati cerebral edema and inflammation induced by protein leakage from capillaries.

3.5.2 Mass Treatment

Jeffery and Gibson (1966): A claim of resistance of *P. falciparum* to chloroquine in Kpain reached WHO in September, 1974. A study conducted in February and March, 1975 substantiated this claim but a third study done in May and June of 1965 found normal sensitivity in all cases. Additional surveys were undertaken. The results of these surveys were that a normal rate of clearance of *P. falciparum* parasitemia (i.e. 2 - 3 days after beginning therapy) was observed indicating normal sensitivity of the parasite to chloroquine. The surveys also observed that of those patients continuously examined, 70% were cleared of parasitemia by the second day after therapy began and virtually all including those cases of parasitemia greater than 1,000 per cubic millimeter of blood were cleared by the third day.

3.5.3 Problems Encountered

See 3.5.2 for a discussion of possible resistance.

3.6 Control Measures Against Human Infection

3.6.1 Chemoprophylactic Measures

Swamy et al. (1976): A chemoprophylactic program was initiated

In Bentol in 1975 and provided for the distribution of chloroquine in doses of 5 mgs./kgs. of body weight per week to the whole population.

3.6.2 Other Protective Measures

No country-specific data found.

3.6.3 Problems Encountered

No country-specific data found.

3.7 Vector or Intermediate Host Control

WHO (1975): Only 8% of the population of Liberia had the benefit of antimosquito efforts in 1974.

Swamy et al. (1976): Liberia has had malarial control programs in operation almost continuously since 1951. In that year the Planned Malaria Control Program began and was based at Kpain. In 1961 this program was disbanded and moved to Monrovia. The Malaria Control Program in Monrovia began in 1962 and provided primarily larvicidal measures. Meanwhile the Malaria Pre-Eradication Project began in 1963 and covered Nimbia, Bong, Grand Gedeh, Sinoe, Lofa and Grand Bassa counties.

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.1 Eradication by Chemical Means

Swamy et al. (1976): Dieldrin was used in the Planned Malaria Control Program from 1951 until 1957 when vector resistance developed. Thereafter, DDT was used yearly until 1961. The larvicides used by the Malaria Control Program in Monrovia were Malarial, Abate and Fenthion (Baytex).

3.7.3 Eradication by Biological Methods

Swamy et al. (1976): Guppy fish (Lebestis reticulatis) are being tried in some places as they are larvivorous fish.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

WHO (1975): Vector resistance to Dieldrin was reported in 1974.

Swamy et al. (1976): Dieldrin and BHC were used as insecticides from 1951 until 1957 in Bong and Nimbia counties at which time vector resistance limited their effectiveness.

3.8 Disease Impact

No country-specific data found.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

Swamy et al. (1976): The sporozoite rate in *A. gambiae* in 1965 was 7.1%, while in 1975 it was 4%.

3.9.2 Laboratory Studies on the Parasite

Jeffery and Gibson (1966): In 231 subjects, ages 5 - 19 years, with positive blood films in Kpain the parasite formula was found to be as presented below.

Parasite Formula (%)

231 Subjects (5 - 19 years old), Kpain, 1966

P. falciparum	93.0%
P. malariae	5.6
Mixed Infection - *P. f.* + *P.m.*	4.0
Gametocytes only	.4

WHO (1975): The overall relative prevalence of *P. falciparum* in areas which had antimalarial efforts in 1974 was 90%.

Swamy et al. (1976): The parasite formulas observed over several years in several locales relative to the various malaria control efforts throughout Liberia are presented below.

Parasite Formulas (%)

	P. falciparum	P. malarie	P. ovale
1961, Kpain	85.0%	12.5%	2.5%
1972, Monrovia	97.5%	1.6	0.7
1974, Monrovia	93.5	4.2	2.1
1975, 25 mile radius (outside Monrovia)	85.7	9.3	4.8
1975, Bentol	95.5	3.2	1.3
1976, Monrovia	96.2	3.4	0.4

Gibson et al. (1977): The distribution of parasites in the two villages studied by these authors in 1977 is presented below.

Parasite Distribution

71 Subjects (15% of total population), Palala, 1977

	P. falciparum	P. malariae	P. ovale
No. of + cases	28	8	3
% of subjects	39	11	4
% of malaria parasites	71.8	20.5	7.7

Parasite Distribution

172 Subjects (25% of total population), Gbatala, 1977

	P. falciparum	*P. malariae*	*P. ovale*
No. of + cases	51	30	2
% of subjects	30	17	1
% of malaria parasites	61.4	36.2	2.4

Additional data about the age and sex distribution of Plasmodia parasitemia in these two villages can be found in the accompanying tables.

3.10 Clinical Studies and Observations

Barrett-Connor (1972): Surgery was implicated in the re-activation of malaria based upon a case study. Two weeks after a cholecystectomy for cholelithiasis, a 53 year old male in La Jolla, California developed symptoms of malaria, i.e. late-afternoon headache, myalgia, chills and fever (105°F) followed by diaphoresis. This episode recurred twice, three and five nights later. Blood-smear diagnosis identified *Plasmodium ovale* and the patient was cured with a chloroquine-primaquine regimen. The patient had worked in Liberia for five years until 1966. He had spent three years in Vietnam. He took amodiaquine as chemoprophylaxis while traveling and never experienced a malaria attack. This attack occurred six weeks after he had discontinued chemoprophylaxis. The author concludes that since *P. ovale* is rare in Vietnam and prevalent in Liberia, that the latter was the

site of infection; that this was a long latent period for an ovale infection and that the trauma of surgery re-activated this latent infection.

Wintrob (1973): Although cerebral malaria has its own clinical and pathological manifestations, it is actually a disease process localized in the brain and occurs along with other forms of infection and not a specific disease entity in itself. The pathological changes observed in cerebral malaria include cherry red brain substance produced by prominent blood vessels petechiae in the white matter; capillary occlusion by parasitized red blood cells, free parasites, malaria pigments and cell debris; evidence of vaso - spasm, eg. capillaries filled only with plasma, and malarial granuloma, ring-like hemorrhages indicating dissolution of brain substance with microglial proliferation. These neuronal and perivascular changes are seen inconsistently and appear in only 50 - 60% of the cases. They are not related to the severity of clinical findings. Changes in the electroencephalograph pattern are bilaterally symmetrical slow wave activity indicative of cerebral irritation and may not be clearly associated with the clinical picture. The prominent pathological feature is cerebral anoxia caused by thrombosis by pigments, infected red blood cells and endothelial proliferation; decreased oxygen carrying capacity and/or decreased cellular respiration which may be caused by cytotoxic

poisoning.

The psychological manifestations occur concurrently with the febrile period of malaria. These present as paranoid agitation with confusion, insomnia, restlessness and irritability, combativeness, delusion and hallucinations of withcraft, spirit possession, sexual assault and threats of death. A mental status exam reveals manifestations of organic dysfunction such as minor defects in recent memory and decreased concentration. Psychological testing supports this by indicating a generalized loss of intellectual skills and impairment of visual-motor integration. Wintrob concluded that acute anxiety can exacerbate malaria infections and that in patients with impaired capacity to cope with life stress, decompensation due to an acute infection occurs more rapidly and to a greater extent than in those with adequate coping abilities.

Gibson et al. (1977): The most severe form of malaria is caused by *P. falciparum* which may be fatal in its acute stage especially if complicated by cerebral or "algid" malaria. *P. vivax* and *P. ovale* produce syndromes of less severity. Infections by all three of these parasites are generally self-limiting.

P. malariae produces the most persistent infection often lasting throughout life but the clinical manifestations are the least severe of all. The four major factors that determine the severity of malaria infections are the rate of asexual multiplication in

the body, the amount of hemolysis, the immune status of the host and the extent of capillary blockage as seen in *P. falciparum* malaria.

TABLE 1 PALALA AGE AND SEX DISTRIBUTION OF MALARIA

AGE	MALARIA SP. P.F. M	P.F. F	P.M. M	P.M. F	P. O. M	P. O. F	TOTAL MALARIA CASES	TOTAL IN AGE GROUP	PERCENT INFECTED	REMARKS
2 yrs.	1	0	1	1	0	0	3	5 (3 males, 2 females)	60% (66.6% males, 50% females)	
2-9 yrs.	7	5	1	2	1	0	16	27 (13 males, 14 females)	59% (69.2% males, 50% females)	
10-14 yrs.	4	1	0	0	0	1	6	9 (6 males, 3 females)	66.6% (66.6% males, 66.6% females)	
15-19 yrs.	2	4	0	0	0	0	6	9 (2 males, 7 females)	66.6% (100% males, 57% females)	
20-24 yrs.	0	1	0	0	0	0	1	4 (1 male, 3 females)	25% (0% males, 33% females)	
25-29 yrs.	0	0	0	0	0	0	0	4 (1 male, 3 females)	0% (0% males, 0% females)	Small Numbers
30-39 yrs.	1	2	0	2	0	0	5	7 (2 males, 5 females)	71% (50% males, 80% females)	Small Numbers
40-49 yrs.	0	0	0	0	0	1	1	3 (2 males, 1 female)	33% (0% males, 100% females)	Small Numbers
50-59 yrs.	0	0	0	1	0	0	1	3 (1 male, 2 females)	33% (0%, 50% females)	Small Numbers
60 yrs.	0	0	0	0	0	0	0	0	0%	
T O T A L	15	13	2	6	1	2	39	71	54.9%	

NOTE: 2 infants 1 yr infected, indicating dry season transmission.

TABLE 2 GUATALA AGE AND SEX DISTRIBUTION OF MALARIA

AGE	MALARIA SP. P.F. M	P.F. F	P. M. M	P. M. F	P.) M	P.) F	TOTAL MALARIA CASES	TOTAL IN AGE GROUP	PERCENT INFECTED	REMARKS
< 2 yrs.	5	3	1	2	0	0	11	19 (10 males, 9 females)	57.8% (60% M, 55.5% F)	
2-9 yrs.	7	17	4	4	0	2	34	52 (20 males, 32 females)	65.3% (55% M, 71.8% F)	
10-14 yrs.	3	4	0	3	0	0	10	20 (6 males, 14 females)	50% (50% M, 50% F)	
15-19 yrs.	0	4	1	3	0	0	8	17 (3 males, 14 females)	47% (33% M, 50% F)	
20-24 yrs.	0	4	0	5	0	0	9	15 all females	60% (0% M, 60% F)	
25-29 yrs.	1	1	0	3	0	0	5	15 (2 males, 13 females)	33% (50% M, 31% F)	Number of males in sample small Figure probably not significant
30-39 yrs.	0	0	0	1	0	0	1	13 (7 males, 6 females)	7.6% (0.7% M, 16.6% F)	Infection rate low in age group
40-49 yrs.	0	1	2	0	0	0	3	8 (7 males, 1 female)	37.5% (28.5% M, 100% F)	Number of females too low to be significant
50-59 yrs.	1	0	0	0	0	0	1	6 (5 males, 1 female)	16.6% (20% M, 0% F)	Number of females too low to be significant
≤ 60 yrs.	0	0	0	0	0	0	0	6 (5 males, 1 female)	0% (0% M, 0% F)	Number of females too low to be significant
UNKNOWN	1	0	0	0	0	0	1	1 male	100% (100% M, 0% F)	Number too low to be significant
TOTAL	18	34	9	21	0	2	83	172	48.25% (39.3% M, 53.7% F)	

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LB 4.0 TRYPANOSOMIASIS IN LIBERIA

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Foci of trypanosomiasis are found in northeast Liberia and in the Central province.

Gibson et al. (1977): Trypanosomiasis was limited to northern Liberia in the mid 1960's with cases reported from Suakoko, Bong county and Harper.

4.2.2 Prevalence

Gibson et al. (1977): Trypanosomiasis is endemic but not widespread and is not now a major health problem. During the period of 1967 - 1977, Phebe Hospital, located in Suakoko in Bong county, reported 13 new cases of trypanosomiasis and three deaths due to the disease. Sekou Toure Hospital reported five slides positive for trypanosomiasis in May, 1976.

APHA Health Sector Assessment: The prevalence of trypanosomiasis is low but there is great potential for an increase in prevalence because Liberia lies in an endemic area (Volta, Niger, & Gambia Rivers).

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

Gibson et al. (1977): The potential exists for an increase in the incidence of trypanosomiasis with an increase in swamp rice production.

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

4.3.1 Species Transmitting the Disease

Gibson et al. (1977): There are several species of tsetse fly which act as vectors for trypanosomiasis in Liberia. These were not defined by this source.

4.3.2 Vector Distribution

No country-specific data found.

4.3.3 Environmental Factors Influencing Distribution

Gibson et al. (1977): The tsetse fly breeds in inadequately cleared vegetation.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specific data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): It is primarily the imported cattle that are infected with *T. brucei* and other zoophilic *Trypanosomae* in Liberia.

Gibson et al. (1966): Two of the case of trypanosomia

reported by Phebe Hospital in Bong county were infected with *T. gambiense*. Another two cases seen in February, 1977 were suspected as being infected with *T. rhodesiense*.

4.10 Clinical Studies and Observations

No country-specific data found.

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LB 5.0 FILARIASIS IN LIBERIA

5.2 Epidemiology

5.2.1 Geographical Distribution

Gibson et al. (1977): Filariasis is known to occur in Liberia but does not seem to be a major health problem.

Sasa (1976): Earlier writers (Young, 1953; Burch and Greenville, 1955) found the prevalence of W. bancrofti highest on the coast, and much lower in the interior. Kuhlow and Zielke (1976) also found moderately high rates in Liberia's inland savannah area. Their results, nevertheless, confirmed that prevalence is low in the country's forest belt.

5.2.2 Prevalence

Sasa (1976): Diller (1947) reported that out of 955 persons examined in a night blood survey of 5 Liberian villages, 84 (8.8%) showed microfilariae. The villages involved were Shangri-La, Paradise, Idlewylde, Village E, and Freetown. All but one positive case were W. bancrofti; one was D. perstans. Daytime blood smears found 14 cases of W. bancrofti and 2 cases of D. perstans out of 2,134 Liberian individuals examined.

Poindexter (1950) reported the results of the U.S. Public Health Service Mission to Liberia, which studied filariasis in 3 provinces and 4 out of 5 counties in Liberia. Ten percent of the 3,437 night blood smears examined were positive for W. bancrofti. Prevalence varied greatly in different villages, from 0.8% in Sanaquella district of Central Province to 19.8% in Grand

Bassa County. A prevalence rate of only 0.76% was found in 42,750 day blood smears.

A similar discrepancy between night and day blood filarial rates was reported by Young (1953). He found 4.34% of night blood smears positive but only 0.43% of the day blood smears positive for microfilariae of W. bancrofti. Prevalence was highest (13.0%) along the coast.

Burch and Greenville (1955) found prevalence rates for W. bancrofti of 10.2% in 520 night blood smears and 3.0% in 1,395 day blood smears. Six persons had D. perstans; none had L. loa. Again, prevalence along the coast was higher than in the interior (13.5% as opposed to 6.1%).

Gratama (1969) studied the etiology of hydrocele in southeastern Liberia. Hydrocele was due to W. bancrofti alone in at least 14.5% of the 176 cases studied.

Brinkmann (1972) found a mean infection rate of 12.7% in 16 villages in Marshall Territory. The night blood of 871 persons was examined, and prevalence rates were found to vary from village to village. Prevalence rates increased moving away from the sea. Lymphadenitis, elephantiasis and hematochyluria were commonly found. Hydrocele was present in 14.7% of the males.

Moasch (1973) attempted to quantify the transmission intensity of W. bancrofti in different regions of Liberia. His calculations follow:

Region	Annual Per Person Mosquito Bites	No. Infective Bites Per Person Annually	No. of Infective Larvae Transmitted Per Person Annually
Rural 1	29,000	500	1,500
Rural 2	10,000	200	500
Suburban	5,500		15
Monrovia		Transmission not detectable	

Kuhlow and Zielke (1976) recently carried out a night blood survey in 82 localities around Liberia. A total of 8,072 people were examined for microfilariae of W. bancrofti, and 403 (5.0%) were found positive. Rates were lowest for the forest belt (2.0%), and high for the coastal zone (9.0%) and savannah area (11.4%).

5.2.3 Intensity

No country-specific information found.

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

Sasa (1976): Young (1953), in a night blood survey of 18 Liberian areas, found an overall infection rate for W. bancrofti of 4.34%. The rate was higher (6.00%) for adults, suggesting that children were less affected by the disease.

Brinkmann (1972) gave some sex-and-age-specific data for W. bancrofti infection in Marshall Territory. The infection rate (as well as hydrocele prevalence) was highest in the 40 to 49 years age group. In the 16

villages surveyed, prevalence ranged from 26 to 32% for adult males and from 8 to 12% in adult females.

5.3. Vector or Intermediate Host Bionomics

5.3.1 Species Transmitting the Disease

Brengues et al. (1966) pointed to Anopheles gambiae, Anopheles melas and Anopheles funestus as the vectors of W. bancrofti in Liberia.

Sasa (1976): Moasch (1973) confirmed A. gambiae and A. melas as vectors, but downplayed the importance of A. funestus. A. gambiae and A. melas were found to be highly susceptible to W. bancrofti. Gelfand (1955) found A. melas, which breeds in brackish water, to be more highly infected than A. gambiae; this was thought to explain why W. bancrofti was most prevalent in the coastal region.

5.3.2 Vector Distribution

No country-specific information found.

5.3.3. Environmental Factors Influencing Distribution

Brengues et al. (1966): Gelfand (1955) indicated that the filarial transmission season in Liberia is dependent on A. gambiae during the rainy season and on A. melas during the dry season and beginning of rains.

5.4 Diagnostic Procedures

5.4.1 General Diagnostic Methods

No country-specific information found.

5.4.2 New Diagnostic Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Directed Against Human Infection

No country-specific information found.

5.7 Vector Control Program

No country-specific information found.

5.8 Disease Impact

No country-specific information found.

5.9 Laboratory Studies

5.9.1 Laboratory Studies on the Vector

Sasa (1976): Gelfand (1955) fed 5 species of mosquitoes found in Liberia on a human infected with W. bancrofti. A. gambiae, A. melas and C. thallasius were easily infected and allowed for development of the larvae in 13 to 14 days. Fewer C. fatigans and A. aegypti became infected. Also development of the larvae was slower in these two species.

5.9.2 Laboratory Studies on the Parasite

Sasa (1976): see 5.9.1. for Gelfand's study on vector-parasite compatibility.

Poindexter (1950) reported, based on hourly microfilarial counts of 10 young adult carriers, that W. bancrofti microfilariae demonstrated a remarkable nocturnal periodicity. Brinkmann (1976) constructed a periodicity curve for the Liberian strain of W. bancrofti, using observations on 38 carriers and the Harmonic Wave curve of Sasa and Tanaka (1972). He applied the results to the data from a recent Liberian prevalence survey. Computed prevalence rates

were found to be little affected by periodicity, but median microfilarial density measurements appeared to vary considerably according to the time of survey.

5.10 Clinical Studies and Observations

No country-specific information found.

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Documentation on Studies of Five Major Endemic Diseases in Ten African States

Part B
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MA 1.0 SCHISTOSOMIASIS IN MALI

1.2 Epidemiology

1.2.1 Geographical Distribution

Ansari (1973): Published information on the epidemiology of schistosomiasis in Mali is extremely limited. Both S. haematobium and S. mansoni are widely distributed in the country, but relatively few foci have been documented. Most of the known foci are situated on the Niger River and its tributaries or in the west of the country along the Senegal River and its affluents.

1.2.2. Epidemiology

Ansari (1973): Gaud (1955) estimated the average country-wide infection rate to be 35%. Deschiens (1951) gave a higher figure of 47%. Regional information is mainly limited to a study by Gaud (1955), in which he recorded prevalence rates for S. haematobium from 10 communities. Two areas at Koulikoro gave the highest rate (85% - 1942 records); the lowest rate was 2% at Bougouni (Kolondieba). In the area of Kayes, Watson (1970) reported that 75% of the population was probably infected.

Dufek and Kalivoda (1973): From 1961-71, schistosomiasis was diagnosed in 85 patients returning to Czechoslovakia from Mali. All the patients were infected with S. mansoni and 16 had concurrent urinary schistosomiasis. The infection were acquired in a swimming pool in Bamako (southern Mali) or in the Niger River near Bamako.

1.2.3. Intensity

No country-specific information found.

1.2.4. Incidence

No country-specific information found.

1.2.5 Population Most Affected

No country-specific information found.

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari (1973):

Both B. (B.) forskalii and Biomphalaria have been frequently recorded, but their respective roles in transmission are unclear. Ansari suggested that B. (B). truncatus may be responsible for the transmission in Mali of S. haematobium.

1.3.2 Vector Distribution

No country-specific information found.

1.3.3. Environmental Factors Influencing Distribution

No country-specific information found.

1.4 Diagnostic Procedures or Techniques

No country-specific information found.

1.5 Therapeutic Trials

No country-specific information found.

1.6 Control Measures Against Human Infection

No country-specific information found.

1.7 Vector or Intermediate Host Control

No country-specific information found.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

No country-specific information found.

1.10 Clinical Studies and Observations

No country-specific information found.

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MA 2.0 ONCHOCERCIASIS IN MALI

2.2 Epidemiology of Onchocerciasis

2.2.1 Geographysical Distribution

There are two principal foci of onchocerciasis in Mali (Imperato, 1971): in the Southern part of the country in Sikasso region and in the West in Kayes region. However, the disease is also found in basin of the Niger and Bani River in which the regions of Sikasso and Bamako lie and in the Senegal River basin within which the Kayes region lies. Basins of the tributaries of the Niger River, Fie, Sankarani, La Faya etc., the Baoule; the Bagoe, and Banifing (as far as their confluence) and tributaries of the Bani (but not the Bani itself) are onchocercal areas (WHO; OCP 173.1 Annex V-2, 1973) and so are the arrondissements of Narena, Central, and Beleko in Kangaba Cercle, Baleko, Mena and Fana in Dioila district; and Sikasso-Kadiolo and La Faya in Sikasso-Kadiola Cercle; and Zantiebou-dougou in Yanfolila district.

2.2.2 Prevalence

Imperato (1971) conducted a clinical survey for onchocerciasis along the affluents of the Senegal River in Kayes region. Results showed that the highest cyst rates were in the riverine area of Bafoulabe. A survey of 202 communities with and estimated population of 76,895 revealed that the disease is prevalent in Baleko, Mena, Fana, and La Faya areas (WHO: OCP/73.1 Annex iv-2) Skin snips taken on 168

persons in the village of Sinkoro, showed that 89% of the cases was positive. Positive skin snips at Ouolokoro was 73% and 69% at Kogni. More than one half of those examined (64%) at Djila showed positive skin snips. (WHO: OCP/73.1, Annex IV-2).

The prevalence of blindness is also high in these same areas. Imperato (1971) found that the total prevalence rate for blindness in the villages of Kenieba, Kita and Bafaulabe was 1.6%. The WHO, Onchocerciasis Control Programme Survey showed that the frequency of blindness was more than 4% even though the corresponding prevalence rates were less than 70% (WHO; Document OCP/73.1. Geneva, 1973).

2.2.3 Intensity

High intensities of infection are found in areas with heavy infection and transmission rates. Rougemont et al (WHO/ONCHO/75.118) found that intensity rates were high in the village of Sanamba in Bamako region.

2.2.4 Incidence

Clinical surveys conducted by Imperato et al (1971) in the regions of Sikasso and Kayes showed that incidence rates for individual villages were as high as 65%. The number of new cases recorded in the six regions within the two year period (1968 and 1969) indicated that the highest attack rates in the country were in the regions of Sikasso, Kayes and Bamako. Incidence rates recorded in 1968 and 1969 were 34.4 at Sikasso, 28.6 at Bamako, 21.6 at Kayes, 12.6 at

Mopti, 2.6 at Segou and 0.2 at Gao respectively. Attack rates/1000 population/year were 1.2 at Sikasso, 1.1 at Kayes and 0.7 at Bamako. The rates at Mopti, Segou and Gau were 0.3, 0.1 and 0.02 respectively.

2.2.5 Population Most Affected

Infections are more intense in males than in females of corresponding age-groups (WHO, Document OCP/73.1, Geneva, 1973). Rougemont et al (WHO/ONCHO/75.118) found that intensities of infection in the village of Sanamba in Bamako region were high in adult males than in females of the same age, e.g. in the 10-14 age group 77.8% of the cases were positive as compared to 45.5% in females of the same age-group, and the intensities in the same age-group were 7.7 in male and 4.5 in females. In the 45-54 age group the intensity rates were 27.6 in males and 21.2 in females. (Rougemont et al, WHO.ONCHO/75.118, table I).

2.3 Vector Bionomics

2.3.1 Species Of The Vector Transmitting Onchocerciasis

Onchocerciasis in Mali is transmitted by the bite of an infected female blackfly of the species Simulium damnosum. Both man and the fly are essential elements in the life cycle of the parasite, O. Volvulus.

Of the eight species now known in the Volta River basin area (Vajime, WHO. Document OCP/SAP/76.1), three are strongly believed to be good vectors of onchocerciasis. These are:

1. Simulium damnosum ("Nile" form).
2. Simulium Sirbanum ("Sirba" form).
3. Simulium Squamosum ("Bille" form).

The vectoral capacities of Simulium Yahense ("Yah" form), S. Sanctipauli("Bamdama" form), and S. Soubrense("Soubre" form) must be determined.

2.3.2 Distribution Of the Simulium Damnosum Complex

Species of S. damnosum complex have definite ecological preferences. The "Bille," "Yah," "Soubre", Bandama" and "Nile" forms predominate in the forest area while the savanna bioclimatic zone is predominated by the "Dieguera" and the "Sirba" forms (EHO: OCP/SAP/76.1 P. 7). The larval population of S. Sirbanum have been at Sotuba dam (Mali) unmixed with those of the other species (OCP/SAP/76.1) and the species has been found to show strong prevalence for extreme savanna conditions.

The distribution of the S. damnosum species group is related to the two main climatic regions. i.e. the forest and the savanna zones. S. damnosum and S. Sirbanum are the dominant species. S. damnosum extends as far north as Koni and Bandiagara, but its high density is in forested area is not observed in north where S. Sirbanum shows a persistent affinity for the dry areas and clearly predominates the dry Northern Savanna Zone.

2.3.3 Environmental Factors Influencing the Distribution

The distribution of S. damnosum complex is influenced by:

1. Ecological conditions
2. Meteorological conditions
3. Hydrological conditions
4. The physico-chemical properties of the water in which breeding takes place.

Each species of S. damnosum shows definite ecological preferences and each form is districted to its ecological requirements, i.e., the forest type of S. damnosum complex is to a large extent confined to that particular biogeographical zone while the savanna type does poorly in the rain forest area. (WHO: OCP/SAP/76.1).

Plant cover makes the movement of the flies possible by protecting females from solar radiation, thus, forests and gallery forests suffice for dispersion to take place. (WHO:OCP/73.1 Annex III-1). A high degree of cloudiness and humidity make dispersion possible because the cloud cover protects the females against the sun rays. (WHO: OCP/73.1 Annex III-1).

Seasonal variations are important factors in that the eggs, larvae and nymphs are unable to survive drought lasting several months. (Hughes 1952; Edwards, 1956; Marr & Lewis, 1964; Marr 1965. Quoted by WHO: in document OCP/73.1 Annex III-1).

Three main seasonal variations have been recognized in the Volta River Basin Area:

1. Synchronic variation
2. Inverse type of variation
3. Bimodal variation

The synchronic variation is caracterized by large water courses in the rain forest zone. The population density of female S. damnosum fluctuates according to the water level in the river where breeding takes place. (WHO: OCP/73.1. Annex III-1).

The inverse type of variation is found in the savanna region. Breeding of S. damnosum in this zone takes place only at low water levels. (WHO: OCP/73.1. Annex III-1).

In bimodal variation, the pre-imaginal breeding place exist during the dry seasons at low water on rocky shelves of low water channels and at high water levels on submerged vegetation of mean level bed. (WHO: OCP/73.1. Annex III-1).

The biting activities of S. damnosum flies are slowed down or completely stopped at temperatures between 17-18°c and 30°c. (WHO: OCP/73.1, Annex III-1).

There are numerous predators of the pre-imaginal stage of S. damnosum. Fish and larva of other insects are among the well known natural predator. S. damnosum larvae and adults are parasitized by a variety of organisms such as: Microsporidia, Flagellata, Ciliata, fungus, Hymenoptera etc.

2.4 Diagnostic Procedures Or Techniques

2.4.1 General Diagnostic Procedures

The recognition of onchocerciasis in mass examinations is based on two main diagnostic criteria namely: (1) dectection of typical onchocercal nodules by inspection and palpation and (2) demonstration of microfilariae of O. Volvu-

lus in routinely taken skin biopsies.(WHO: OCP/73.1). There are a number of other techniques being used in the diagnosis of onchocerciasis:

(1) Quantitative and qualitative analysis of miscrofilariae in skin snips.(WHO: onchocerciasis Symptomatology, pathology, diagnosis, 1974).

(2) Differential diagnosis for the differentiation of O. Volvulus microfilariae from those of other filariae e.g. W. bancrofti.(WHO: Onchocerciasis symptomatology pathology and diagnosis, 1974).

(3) The Mazzotti test (WHO:OCP/73.1, WHO: onchocerciasis Symptomatology, pathology diagnosis, 1974. The test is not recommended for routine tests in epidemiologocal studies. Because it yields a small proportion of both false positives and false negatives and its interpretation is subjective. (WHO: onchocerciasis, Symptomatology, pathology, diagnosis, 1974).

(4) Examination of microgilariae of O. volvulus in the urine.(WHO: OCP/73.1; WHO: Onchocerciasis Symptomalogy, pathology, diagnosis, Geneva, 1974).

(5) Demonstration of microfilariae of O. volvulus in the eye in ocular onchocercal involvement in heavily infected patients.(WHO: OCP/73.1; WHO: Onchocerciasis Symptoms, pathology, diagnosis Geneva, 1974).

2.4.2 New Diagnostic Techniques

Techniques are being developed and tried out as possible diagnostic tools. Among these are:

(1) The complement fixation test (Lartique, WHO/Oncho/66.50). This test is useful in individual cases when a decision is to be made regarding the suitability of a given type of treatment.

(2) Intradermal tests by the use of dietlylcarbamazine citrate (DEC). Fulsang and Anderson (WHO/Oncho/77.132) used this test as an alternative diagnostic technique in patients from the Cameroon rain forest area. The technique is valuable in the diagnosis of onchocerciasis in patients in whom the microfilariae densities are low. Further studies on this technique are needed regardless of its high sensitivity and few false negative result yields.

(3) The Enzyme linked Immunosorbent Assay (ELISA) has been considered as a possible diagnostic technique. The Minerva institute for Medical Research in Helsinki has been studying the technique and results are promising.(WHO: OCP/STAC/76.2).

(4) The membrane filtration technique. This technique was recently developed for the quantification of W. bancrofti microfilaraemia but was adapted and applied by Scheiber et al (WHO: Oncho/76.119) as a diagnostic tool in a prelimary study on 107 Onchocerciasis patients at Ogaro village, Dapango region, in Northern Togo.

(5) Funduscopy was used by Frentzel-Beyme (1975) as a tentative technique for the diagnosis of both bilateral and unilateral blindness in Libera.

The Diagnosis by using this technique could only be made when proper examination of the fundus was achieved and only if the anterior segment lesion did not prevent fundus copy.

Human onchocerciasis can, however, be diagnosed, with different degrees of certainly, on the basis of the presence of microfilariae of O. volvulus (in the skin in the anterior chamber of the eye); the presence of adult filariae, discernible only in cutaneous nodules; changes in the appearance of the skin, and clinical cutaneous signs, e.g. prunitus, prurigo, depigmentation, presbydermia, cutaneous nodules, lymphadenopathly etc); ophthalmological signs such as hypereosinophilia; and immunobiological signs, e.g. intradermal reactions, serological test etc Covazza: WHO/Oncho/66.48).

2.5 Therapeutic Trials

2.5.1 Studies on New Drugs

An agreement was established between WHO and OCCGE for chemotherapeutic trials with levamisole, diethylcarbamazine plus levamisole and nifurtimox to be carried out by the Parasitological Section of Centre Muraz, Bobo-Dioulasso, Upper Volta (WHO: ocp/STAC/76.1).

Duke (WHO/Oncho/67.62) found that Mel W. has almost the same macrofilaricidal ection as suramin. He also found that the antimonical preparations, TWSB and MSBE have different actions on O. volvulus that they have definite

microfilaricidal effects similar to those of DEC and that these prepatations have some action in blocking embryogenesis and kill adult worms at high concentrations (Duke, WHO/oncho 67.62). Single doses of Mel W at 7.1-10mg/kg of body weight were less effective againist adult O. Volvulus, but if higher doses were repeated annually, the miscrofilarice could be elinimated at the end of three years.

Diethylcarbamazine citrate (DEC) is very difficult to handle in the treatment of ocular onchocercal involvement, can reduce the number of microfilariae in the eye and skin and quitens lesions of the anterior segment when used in combination with a corticesteroid but has no effect on lesions of the posterior segment. The drug was found to be dangerous in treating patients with heavy ocular complications because of its severe adverse reactions on the optic nerve (WHO/oncho/76.2)

The addition of levanisole to DEC seemed to have no effect either on the microfilarial densities or incidence and intensity of side rections (WHO: OCP/STAC/76.2).

Metrifonate is the most promising new drug under investigation (WHO: OCP/73.1. Annex II-1). Limited studies have been done on other new drugs such as Nividazole, levamisole, dihydroemetine etc. Nividazole was found to be ineffective by some workers and of unacceptable toxicity by others (WHO: OCP/73.1, Annex II-1). At doses used in the treatment of ascariasis, levamisole showed no effect against

O. Volvulus and dihydroemetine was found to have no action on O. Volvulus as well.(WHO: OCP/73.1, Annex II-1). The use of melarsonyl potassium has been completely ruled out because of the high risk of death from arsenical encephalopathy that it entails.(WHO: OCP/73.1, Annex II-1).

Macro- and microfilaricidal drugs which have shown promising activity in various other forms of filariasis in experimental animals are being investigated against O. Volvolus. (WHO: OCP/73.1, Annex II-1). Among the potential macrofilaricides are metrifonate levamisole and nitrofurantoin. The same drugs have a microfilaricidal potentiality (WHO: OCP/73.1, Annex II-1). The use of suramin, levamisole and tetracycline for chemoprophylatic measures has been limited. Current experimental trials of new compounds has been limited to metrifonate.(See OCP/73.1 Annex II-1 section 4.2.1; WHO OCP/73.1, Annex V-5).

2.5.2 Mass Treatment

Mass campaigns for the treatment of onchoceriasis with suramin have been successful in Latin America. (Venezuela in particular). However, an attempt to use melarsonyl potassium in a mass campaign in Mali was stopped after a number of deaths occurred in the first 5,000 patients. (WHO: OCP/73.1. Annex II-1).

Mass treatment of onchocerciasis with the presently known macro- and microfilaricides has not been launched due to the risks of adverse reactions and the incomplete knowledge of the toxicity of these drugs. (WHO: OCP/73.1 Annex II-1).

2.5.3 Problems Encountered

The problems encountered in the development of new macro- and microfilacidal drugs have been:

(1) Lack of suitable laboratory animals.

(2) Lack of suitable laboratory facilities in the program area.

(3) Limited financial and manpower resources e.g., pharmacists, clinicians and entomologists.

(4) Incomplete knowledge on both the vector (*Simulium damnovum*) and the parasite, *O. Volvulus*. (See WHO: OCP/73.1 and OCP/73.1 Annex II-1, Annex V-5).

Individual treatment of onchocarciasis has been limited to two drugs (suramin & DEC) under careful clinical supervision due to the serious adverse reactions associated with these drugs. (WHO: OCP/73.1 Annex 1, Annex II-1).

Mass treatment has been discouraged due to the lack of complete statistical data on the epidemiological pattern of the disease in the population, unsuccessful vector control program, poorly known characteristics of the target population, the constant internal migration, emigration and the general lack of facilities, as well as the inadequacy of trained medical, para-medical and medical auxilliaries, e.g. there is one physician per 33-65 people in the capital but only 1 for 173,000 in the rural areas.(WHO: OCP/73.1 Annex VI-5).

2.6 Control Measures Against Human Infection

2.6.1 Chemoprophylactic Measures.

Chemoprophylaxis has been infeasible due to the difficulties associated with the administration of the available drugs, the incomplete knowledge on the toxicity and the serious adverse reactions of these compounds. An attempt to use melarsonyl potassium in a mass campaign was stopped because of the number of deaths that occurred in the first 5,000 patients undergoing chemoprophylactic treatment. (WHO: OCP/73.1 Annex II-1).

2.6.2. Other Protective Measures.

Wearing protective clothes such as long trousers, long sleeved shirts etc. and avoiding frequent contacts with the disease transmitting vector as well as the use of insect repellents are among the protective measures used in the endemic areas (WHO, document OCP/73.1) Movement of the people from the endemic areas to onchocercal free locations is another way in which the population at risk is trying to protect itself from the bites of S. damnosum, the disease transmitting agent. (WHO: OCP/73.1).

2.6.3. Problems Encountered.

Among the problems encountered in chemoprophylactic and other prophylactic measures are:

(1) The lack of suitable drugs with both macro and microfilarical effects.

(2) The serious side effects of the drugs currently used.

(3) The insufficient knowledge about the vector-parasite complex.

(4) The constant movement of the population in and out of the known endemic foci.

(5) The incompleteness of data about the characteristics of the target population.

(6) The type of activities of the population at risk is such that the adult groups, especially the males, is constantly exposed to the bites of the female S. damnosum.

(See WHO: OCP/73.1; WHO:OCP/73.1, Annexies II-1, I, V-5).

2.7 Vector or Intermediate Host Control

2.7.1. Eradication by Mechanical Means

Efforts are being made to control the vector, (S. damnosum) by destroying the breeding places and the natural habitats. Trapping of the field is also used as an alternative method. (WHO: OCP/73.1) Constructing dams upstream in order to slow down the water current and thus discourage the breeding of S. damnosum as well as changing the general ecological conditions of the areas known to be the most favorable natural habitat of the vector have been proposed. (WHO: OCP/73.1).

2.7.2 Eradication by Chemical Means

Insecticides such as DDT and its modified formulations, are being used in the efforts to eradicate S. damnosum species. Abate WDP 50% and Abate 500 EC, OMS-1825, Dimilin, Attosid, Redan and Fenitrothion are under preliminary trails. Evaluation of Chlorphoxim is at the most advanced state. (WHO: OCP/73.1).

So far the weekly applications of DDT have been the

most successful. Spraying by using aircrafts such as helicopters etc. is being carried out. (WHO: OCP/73.1; OCP/73.1 Annexes III-3, V-5).

Spraying of new formulations by helicopter has been carried out. (Phillipon et. al., 1973).

2.7.3 Eradication by Biological Methods

Known parasites and predators of S. damnosum have been thought of being used in controlling the vector at the larval and adult stages (WHO: OCP/73.1). This method has a very smally impact on the control of S. damnosum. (WHO: OCP/73.1 Annex III-1).

2.7.4. Other Measures

So far, no other alternative control measures have been developed besides those pointed out in section 2.7.1,2.7.2 and 2.7.3 above. On the other hand, studies on suitable and effective measures are being encouraged by WHO. (WHO: OCP/STAC/76.2).

2.7.5 Problems Encountered

Limiting factors in the control of S. damnosum include:

(1) Lack of biodegradable insecticides and larvicides (WHO:OCP/73.1, Annex III-3).

(2) The undesirable cummulative and toxic properties of such effective insecticides as DDT to the non-target fauna (WHO: OCP/73.1).

(3) The lack of staff and funds to maintain control programs for the required long period of time.

(WHO: OCP/73.1, Annex VI-2F).

(4) The incomplete knowledge about the vector -

parasite complex and their relationship to the human host. (WHO: OCP/73.1).

(5) The increasing evidence of the resistance and tolerance of the blackfly larvae to insecticides (WHO: OCP/73.1, Annex III-2).

(6) Reinvasion problem (WHO:OCP/76.2, Annex III-1).

(7) Long flight range of S. damnosum complicates reinvasion problem. (WHO: OCP/73.1).

2.8 Disease Impact

2.8.1 Impact on Population Distribution

Areas with high transmission and infection rates, have been abandoned. The population has moved to those areas where onchocerciasis is not a proplem. Internal population movement is not high. However, temporary emigration from endemic areas to Ivory Coast is noticeable, e.g., there is temporary emigration from the Yanfolila area to the Ivory Coast.(WHO: OCP/73.1 Annex VI-2.F). The Kadiolo administrative district is a densely populated zone with a population density of 14 per sq. km. for the whole "circle"but 381 per sq. km. actually occupied. (WHO: OCP/73.1 Annex VI-5). The Baoule valley downstream from Bougouni Ouassoulou valley over a width of 7 - 8 km and parts of the Bagoe valley are among the deserted or almost deserted zones. The population density in these regions is less than 5, ± 1 and 2 respectively (WHO: OCP/y3.1 Annex VI-5). Areas such as Boukoura, Faroko, etc. were abandoned due to onchoeriasis. (WHO: OCP/73.1 Annex VI-5). As a result of emigration, these are only about 73 men to every 100 women in the age group 25-30. About 10,000 sq. km. of land has been deserted.

(WHO:OCP/73.1, Annex VI-5)

2.8.2 Impact on Economy

Onchocerciasis has a very significant impact on the economy of the country. There is a decrease in productive capacity due to blindness and impaired vision caused by O. Voluvulus. (WHO: OCP/73.1 Annex VI-5) Moreover, population most affected is that in age of 15 and above and mainly males who constitute the major economic productive force.(WHO: OCP/73.1 Annex VI-5) The annual average income per person in the rural zone is U.S $24 and the cost of supporting 200 blinds is about U.S $48,000.(Annex VI-5) There is a decline in production due to onchocarciasis infection.

2.8.3 Amelionative Programs

WHO has launched an onchocerciasis control program in the identified endemic areas. The main object of the program is to reclaim the abandoned fertile valleys for re-settlement and farming and agricultural activities. The reclaimation of the valleys now deserted due to onchocerciasis will lead to a somewhat even population distribution and a decrease in emigration.(WHO: OCP/73.1 Annex VI-5). The local government is also cooperating in this economic development program in the rural onchocercal infested areas. (WHO: OCP/73.1).

A number of rural projects are in the course of implementation or study. These include the development of rice cultivation in the Sikasso region, establishment of a breeding ranch for N'Dama cattle in the Yanfolila region,

rice cultivation to the south of Segou, and Kenaf and cotton productions. The WHO Onchocerciasis Control Program is aimed at freeing such valley as the Boaule above Bougoumi, part of the Bugoe, the Ouassoulou and the Faya inferior (See Annex VI-2.F Fig. VI-2.F.1) from the constraints of the disease. In addition, development of integrated crop and livestock systems are being pushed ahead at the farm level.

The freed areas will be used for repopulation or resettlement programs as well. Such re-settlement programs will reduce the population density now experienced in some areas. Increased production and a decrease in emigration and internal migrations are also expected. (WHO: OCP/73.1 Annexes VI-2.F and VI-5).

2.8.4 Problems Encountered

Lack of financial and manpower resources, lack of infrastructures and facilities necessary for the implementation of the program are among the major problems encountered in the attempt to carry out the ameliorative programs in the affected areas. (WHO: OCP/73.1: DCP/73.1, Annex VI-5).

2.9 Laboratory Studies

2.9.1 Laboratory Studies on the Vector

Studies on the life cycle, the breeding and natural habitat, morphological characteristics and cytotaxonomical classifications have been carried out by such organizations as WHO, FED and OCCGE, as well as individual investigators. For example, Dunbar & Vajime (WHO/ONCHO/73.1, WHO/UBC/71.320)

recognized 17 cytological categories in two groups and believed that most of them, if not all, represent distinct species. Vajime (WHO: OCP/SAP/76.1) identified eight species. Philippon et. al. (WHO/VBC/76.619) found that the distribution, flight range, biting activity and the survival of the larval stages of S. damnosum are all influenced by the meteorological, climatological and hydrological conditions. These investigators also found out that the physico - chemical properties of the water are important for the immature stages of S. damnosum complex, e.g. the optimal PH values, the conductivity and the concentration of certain ions determine the breeding sites of a given species of the vector. Philippon et.al. (WHO/VBC/76.619, 1973). Thompson et al. (WHO/ONCHO/72.98) observed that S. damnosum can fly up to 40 to 60 km and that the emerged S. damnosum are phototaxes positive.

Two types of dispersion have been observed: radial dispersion in the rain forest and linear dispersion in the Savanna zone (WHO: OCP/73.1, Annex III-1). Seasonal migrations, extending distances of 90-100 km., in accordance with the Intertropical front (ITF) have been given as the explanation for the persistence of populations in regions with non-permanent breeding places. (WHO: OCP/73.1, Annex III-1). Eggs, larvae and nymphs of S. damnasum do not survive drought lasting several months. (Hughes, 1952; Edwards, 1967; Marr & Lewis, 1964; Marr, 1965. Cited by WHO: document OCP/73.1, Annex III-1). The daily biting

rhythm is slowed down or stopped at temperature below 17°C and 30°C. (WHO: OCP/73.1). Male S. damnosum feed exclusively on plant juices and only the females are haematophilic as well as zoophilic. (WHO: OCP/73.1).

2.9.2 Laboratory Studies on the Parasite

O. volvulus is not a uniform species. Important dissimilarities have been found between endemic areas in the forest and savanna zones (WHO:OCP/73.1). Male and female adult worms live mainly in the skin of the Ruma host where they form visible nodules. Female worms produce millions of embryos (microfilariae) during their life time which is up to 15 years (WHO: OCP/73.1)

2.10 Clinical Studies and Observation

The most important clinical manifestations of onchocerciasis are pruritic skin rashes, chronic skin manifestations e.g. "elephant skin", atrophy and depigmentation, hang groins and hernia, and different forms of eye lesions that may culminate in blindness. Heavily infected patients have microfilariae in their urine. Chronic weight losses have been observed among residents of hyperendemic areas. (WHO/OCP/73.1).

In the early stages of onchocerciasis, adult worms do not produce any detectable reactions and cannot be seen or palpated. (WHO: VCP/73.1). Eye lesions and blindness are the most serious consequences of onchocerciasis. Chronic sclerosing keratitis of the cornea is the most common of blindness in onchocerciasis.(WHO: OCP/73.1).

Besides the anterior eye lesions, microfilariae can also invade the deeper parts of the globe. Dead microfilariae in this area cause inflammatory reactions of the iris, ciliary body, retina and choroid. Ocular lesions are the most important and they occur more frequently in the savanna region than in the forest zone. (WHO: OCP/73.1, SASA, 1976).

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MA 3.0 MALARIA IN MALI

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975): One hundred percent of the population of Mali lived in malarious areas in which there were no antimalarial efforts made in 1974. More specific data about geographical distribution was not given by this source.

3.2.2 Prevalence

Plan Décennal (1966): Malaria ranked first among the principal causes of mortality for all age groups in 1963.

WHO (1975): In 1974 the parasite rate was 16-90% in areas without antimalarial efforts while malaria mortality was 90.400 per 100,000.

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

No country-specific data found.

3.2.5 Population Most Affected

No country-specific data found.

3.3 Vector Bionomics

No country-specific data found.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

3.5.1 Studies on New Drugs

Depinary et al.(1972): A single injection of sulfadoxine-pyrimethamine in combination was found to be as effective as quinine in ameliorating clinical symptoms of malaria and more effective with regard to ameliorating parasitemia.

3.5.2 Mass Treatment

No country-specific data found.

3.5.3 Problems Encountered

No country-specific data found.

3.6 Control Measures Against Human Infection

No country-specific data found.

3.7 Vector or Intermediate Host Control

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.2 Eradication by Chemical Means

Vector resistance reported below (see 3.7.5).

3.7.3 Eradication by Biological Means

No country-specific data found.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

WHO (1975): Vector resistance to Dieldrin was reported in 1974.

3.8 Disease Impact

No country-specific data found.

3.9 Laboratory Studies

No country-specific data found.

3.10 Clinical Studies and Observations

No country-specific data found.

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MA 4.0 TRYPANOSOMIASIS IN MALI

4.2 Epidemiology

4.2.1 Geographical Distribution

Imperato et al. (1976): Trypanosomiasis has been studied in the Senegal River Basin area of Mali.

4.2.2 Prevalence

WHO (1969): The prevalence of trypanosomiasis in in 1967 was 2,490 cases out of a total population of 4,745,000.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

WHO (1969): The incidence for 1967 was 259 new cases.

Imperato et al. (1976): The incidence of trypanosomiasis in Mali from 1960 to 1971 is presented below.

Trypanosomiasis in Mali, 1960 - 1971

Year	Population Examined	New Cases	Incidence/100,0
1960	653,257	1,205	184.5
1961	869,653	1,188	136.6
1962	734,617	892	121.4
1963	857,538	796	98.8
1964	901,949	538	59.6
1965	324,813	432	133.0
1966	519,195	49	94.4
1967	739,173	36	48.7
1968	313,689	70	22.3
1969	400,814	62	15.4
1970	423,040	109	25.7
1971	524,418	71	13.5

4.2.5 Population Most Affected

Imperato et al. (1976): In the Senegal River Basin of Mali, hunters who are usually the blacksmiths and herbalists of their villages contract the disease

more frequently than others.

4.3 Vector or Intermediate Host Bionomics

4.3.1 Species Transmitting the Disease

Imperato et al. (1976): Glossina palpalis and Glossina morsitans are the infecting species of tsetse flies in Mali.

4.3.2 Vector Distribution

Imperato et al. (1976): Glossina palpalis is found most frequently in riverine forest galleries around marshes and seasonal ponds, while Glossina moritans is found in uninhabited forests of the Senegal River Basin area.

4.3.3 Environmental Factors Influencing Distribution

Imperato et al. (1976): Tsetse flies are most active in the early morning, in the late afternoon and on moonlit nights when temperatures are relatively cooler.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

4.6 Control Measures Against Human Infection

4.6.1 Chemoprophylactic Measures

No country-specific data found.

4.6.2 Other Protective Measures

Imperato et al. (1976): Hunters, in contrast to other residents of their villages, wear long-sleeved tunics, hats and trousers when they go hunting.

4.6.3 Problems Encountered

No country-specific data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): All animals in Mali are susceptible to infection by *T. brucei* as well as other zoophilic *Trypanosomae*.

4.10 Clinical Studies and Observations

No country-specific data found.

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MA 5.0 FILARIASIS IN MALI

(The following information is drawn from Manabu Sasa, Human Filariasis, University Park Press, 1976)

5.2 Epidemiology

5.2.1 Geographical Distribution

Sasa (1976): Important foci of W. bancrofti infection were reported by Brengues et al (1968, 1969, Brengues and Coz (1972, 1973), and by Brengues (1973) from the regions of Niomo, Markala and Segou, in the flood zone of the Niger River. Low microfilarial rates were observed in the Sahara zone of Hombori and Douentza.

Brengues (1973) also reported the following information concerning elephantiasis: Elephantiasis is rare north of 14°N but is often found in the upper Senegal River basin (around Kayee and Yelimane), in the southern part of the Niger River flood zone, in the Bani River flood zone (Djenne, San and Tominian), in the southern Bamako region (near Bamako, Dioila, and Kangaba), in the upper Sourou valley (Koro), and in southern Mali (around Sikasso, Bougouni and Yorosso).

5.2.2 Prevalence

Sasa (1976): Brengues et al (1968, 1969), Brengues and Coz (1972, 1973) and Brengues (1973) found the following prevalence rates for filariasis in Mali:

	% Infection
a) Sahara zone of Hombori and Douentza	$\angle$ 5.0
b) Segou	
Boundo	26.5
Konodimini	27.0
N'Gara	11.9
c) Markala	
Domgoma	13.8
Douabougou	18.7
Dougouba	15.4
Sansanding	2.6
d) Niono	
Kanabougou	8.3
Kourouma	4.3
Molodo-Banbara	4.4
Niono "26"	2.0

In regard to elephantiasis, Brengues and Sales (1971) reported that in the hospital of "Point G" of Bamako, 6.0% (332 cases) of the 5,518 surgical operations performed from 1967 to 1970 were for hydrocele. Thirty-one cases (0.56%) were for elephantiasis. Similarly, in Gabriel Toure Hospital in Bamako, 13.1% (121 cases) of the 922 operations performed in 1971 were for hydrocele. There were 8 cases of elephantiasis treated in that hospital in 1971.

5.2.3 Intensity

No country-specific information found.

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

No country-specific information found.

5.3 Vector or Intermediate Hos Bionomics

No country-specific information found.

5.4 Diagnostic Procedures or Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Against Human Infection

No country-specific information found.

5.7 Vector or Intermediate Host Control

No country-specific information found.

5.7.5 Problems

No country-specific information found.

5.8 Disease Impact

No country-specific information found.

5.9 Laboratory Studies

No country-specific information found.

5.10 Clinical Studies and Observations

No country-specific information found.

R E F E R E N C E S

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Documentation on Studies of Five Major Endemic Diseases in Ten African States

Part B
National and Regional Disease Profiles
Section VI
Republic of Niger

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NG 1.0 SCHISTOSOMIASIS IN NIGER

1.2 Epidemiology

1.2.1 Geographical Distribution

Ansari (1973): S. mansoni has not been reported from Niger. The prevalence of S. haematobium infection is thought to be highest along the Niger River (Chamarin, 1965). Gaud (1955) reported S. haematobium in Zinder and Tanout. Deschiens (1951) noted foci at Tillabery, Niamery, Dasso, Birni-N'Konni, and N'Guigmi. Chamarin (1965) reported infection in the Magaria Cercle and among nomads.

1.2.2 Prevalence

Ansari (1973): Chamarin (1965) recorded a rate of 44.61% S. haematobium infection along the Niger River.

A few surveys have shown up to 90% infection rates in children along the Niger. Gaud (1955) reported S. haematobium prevalence rates of 40% and 60% in Sinder and adjacent areas, and a rate of 33% at Tanout.

Chamarin (1965) reported the results of several large surveys in which urine samples were examined for S. haematobium. In the Tillabery Cercle, 44.61% of 13,857 urine examinations showed S. haematobium eggs. In the Magaria Cercle 21.12% of 1008 samples were positive; at Tessahoua the rate was 25.04% of 1,1174 examinations. Urine samples taken from 1420 nomad people gave an infection rate of 11.26%.

1.2.3 Intensity

No country-specific information found

1.2.4 Incidence

No

1.2.5 Population Most Affected

Ansari (1973): Of the persons in the Tillabery Cercle reported by Chamarin (1965) to be to infected with S. haematobium, 68% were schoolchildren from 6 to 12 years of age.

Leszik and Wilson (1968): Of the 560 cases of S. haematobium infection seen in Dogondoutchi, 551 were males and only 9 were females. The 6-15 year old age-group was most affected.

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari (1973): B. (Ph.) globosvs, B. (B) forskalii, B. (B) Senegalensis, and other Bulinus species have been reported.

1.3.2 Vector Distribution

Ansari (1973): B. (Ph.) globosus has been reported near the Nigerian border east of Maradi. B (B) forskalii and Bulinus (B) spp. have been found South-east of Zinder. Wright (1959) reported B. (B.) senegalensis.

1.3.3 Environmental Factors Influencing Distribution

No country-specific information found.

1.4 Diagnostic Procedures or Techniques

No country-specific information found

1.5 Terapeutic Trials

No country-specific information found

1.6 Control Measures Against Human Infection

No country-specific information found

1.7 Vector or Intermediate Host Control

No country-specific information found

1.8 Disease Impact

No country-specific information found

1.9 Laboratory Studies

No country-specific information found

1.10 Clinical Studies and Observations

Battin et al. (1969) reported on two cases of vesical schistosomiasis, one coupled with malaria. The patients were a young boy and his sister; they had contracted the infections while visiting Niger. The boy presented with non-painful hematuria. An eosinophlia of 5% was observed. The diagnosis of S. haematobium was confirmed by the discovery of eggs in the boy's urine and by a positive serodiagnostic test. Ambilhar was used successfully for treatment, in two 8-day cycles of 25 mg/kg/day. The boy's sister presented with convulsions and hypertermia. Malaria was diagnosed and treatment was undertaken

with nivaquine. At the same time, S. haematobium eggs were found in the girl's urine. Ambilhar treatment was also undertaken, in a 2-cycle program similar to that given the boy. During the second Ambilhar cycle, the girl's electrocardiograms showed a progressive flattening of the S.T. wave in the left precordium.

Leszek and Wilson (1968) observed 3 cases of S. haematobium infection and gave the following information:

Symptoms and Clinical Observations:

1. lower abdominal pain
2. frequent micturition
3. terminal hematuria
4. weakness
5. edema of inferior extremities
6. abdominal protuberance
7. eosinophilia
8. increased sedimentation speed
9. anemia
10. ascitic fluid containing S. haematobium eggs and worms

Complications observed in 3 cases studied

1. ascitic fluid (3cases)
2. hepatosplenomegaly w/eggs in liver biopsy (2)
3. adult worms in abdominal puncture fluid (2)
4. eggs in rectal scraping (2)
5. symptoms of appendicitis, tumor in region of appendis (1)

All symptoms disappeared after treatment.

Wozniczka (1967) described three cases of urinary schistosomiasis with complications, as flows:

1. Mature forms of parasite detected in one patient's ascitic fluid
2. Vrolithiasis found in a 3 year old child
3. One case of habitual abortion found due to schistosomiasis.

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NG 2.0 ONCHOCERCIASIS IN NIGER

2.2 Epidemiology

2.2.1 Geographical Distribution

Onchocerciasis is mostly found in the southern part of Niger. The disease is endemic to the valleys of the Mekrou, Sirba, Goroubi and Kiamangou rivers, all of which are tributaries of the Niger River and are colonized by species of Simulium damnosum complex.

2.2.2 Prevalence

Prevalence studies and surveys have shown that onchocerciasis is endemic to almost all the communities in the southern portion of Niger. An epidemiological survey of approximately 59 communities with a population of about 20,400 revealed that onchocerciasis is prevalent in Foyer de Tamau, Torodi, around Mala, Ouro Diandio, Dissirire, Balsi, Kakou, Saoma, Terounde, Ouro Hesso, Ouro Seini and Ouromodi. The number of persons examined for O. volvulus microfilariae was 18,972 (93%) and 21.45% had microfilariae in the skin biopsies. It was estimated, on the basis of the results obtained from this study, that about 4,380 persons in the units surveyed had onchocerciasis. The percentage of persons with onchocercal nodules was high in the villages of Ouro Diandio, Dissirire, Ouro Sanda, Nanifono, Tiena Kinto, Moli Haussa and Moli Gouima.

Blindness was most prevalent in Kakou, Teroudie,

Ouro Diandio, Dissirire, Mala, Alfassi and Ouri Seini communities (WHO/OCP/73.1).

2.2.3 Intensity

There is no data specifically for Niger in regard to the intensity of onchocercal infection in the identified endemic areas. However, it is quite likely that the intensity of the disease will vary in accordance with the degree of infection, the transmission potential and the pathogenecity of the strains of O. volvulus. High intensities of infection, therefore, are (more than likely) to be found in heavy onchocerciasis transmission and infection areas where the perennial and seasonal biting activities of Simulium damnosum complex is high. (WHO: OCP/73.1; OCP/73.1 Annex IV-2)

2.2.4 Incidence

Incidence rates were not reported in any of the studies referred to here. But, based on the level of microfilariae circulating in the infected population in the given communities, the infective larvae transmitted by the vector, the population size of S. damnosum complex species and the seasonal as well as the perennial biting of the flies and the transmission potentials, it is most likely that the number of new cases of onchocerciasis is high in those areas where the environmental factors are conducive to the survival of the vector. Incidence rates will therefore tend to be high in communities found in

hyperendemic areas where a combination of factors favorable for the vector-parasite complex exist and where the degree of interaction between man and the vector population is high. (WHO: OPC/73.1; WHO: OCP/73.1 Annex IV-2)

2.2.5 Population Most Affected

The adult male population suffer most from onchocerca volvulus infection. Studies done by WHO Onchocerciasis Control Program in the Volta River Basin Area indicate that onchocercal nodules and microfilariae as well as blindness are more common in adult males than in females of the same age group. (WHO: OCP/73.1; OCP/73.1 Annex VI-5)

The adult population is generally more affected by the diseases in both sexes than the young population. These observable differences in the prevalence, intensity and incidence rates among the various age and sex groups are not due to any genetic factors or vector preference. The main factors contributing to these variations are the types of activities in which each group is engaged, since they determine the degree of interaction between the vector and the human host. The adult male group is more exposed to infected female S. damnosum during their high seasonal biting activities in the endemic areas. (WHO: OCP/73.1)

In those areas where women and children are in frequent contact with the infected flies, the incidences and intensities of infections are equally high and the differences in age and sex specific rates are insignificant.

In heavily infected areas with high transmission potentials and a high degree of infective biting activities of the vector and where the women carry their children on their backs or where children accompany their parents to the gardens, etc., the disease prevalence is considerably high in children. In such areas, head nodules are observed in children and the female population is usually heavily infected with O. volvulus parasites. Blindness in these areas is almost as high in the adult female population as it is in the adult males. Impaired vision is quite common in children (WHO: Onchocerciasis, symtoms, pathology, diagnosis, edited by Buck, 1974).

2.3 Vector or Intermediate Host Bionomics

2.3.1 Species of the Vector Transmitting Onchocerciasis

Onchocerciasis in Niger is transmitted by the same species of S. damnosum complex found throughout the rain forest and savannah biogeographic zones of West Africa. Several forms of S. damnosum have been identified in the Volta River basin area which includes the extreme southwest of Niger. Dunbar and Vajime (WHO/OCP/71.87; WHO/VBC/71.320) suggested that 17 cytotaxonomical categories may be recognized in two subgroups, and that they resent distinct species. The "Nile" subgroup includes the "Nile" forms, the "Bandama", the "Sirba", the "Soubre", the "Bille" and the "Yah".

Vajime (WHO/SAP/76.1) identified eight species of S. damnosum, namely: Simulium squamosum ("Bille" form), S. yahense ("Yah" form), S. soubrense ("Soubre" form), S. sanctipauli ("Bandama" form), S. damnosum ("Nile" form), S. dieguerense ("Dieguerense" form), S. sirbanum and S. sudanense. S. sudanense and S. dieguerense appear to be rare. S. squamosum, S. soubrense and S. damnosum are found in the area covered by WHO Onchocerciasis Control Program area. S. squamosum, S. damnosum and S. sirbanum are believed to be very potent vectors of onchocerciasis.

2.3.2 Vector Distribution

Species of S. damnosum complex are well represented both in the rain forest and in the savannah zones in the southern part of Niger. The vector flies are found all along the valleys of the Mekrou, Sirba, Goroubi and Diamangou rivers. These tributaries of the Niger River provide suitable ecological conditions for the breeding of S. damnosum. The forest zone is dominated by S. yahense, S. damnosum, S. squamosum, S. sanctipauli and S. soubrense. The savannah bioclimatic zone is inhabited by S. dieguerense, S. sirbanum and S. sudanense. However, S. damnosum, S. squamosum and S. soubrense have been found in the savannah as well even though these species are primarily found in the forest zone. S. sirbanum is clearly a colonizer of the dry areas.

S. quamosum, S. damnosum and S. sirbanum are considered to be potent vectors of onchocerciasis due to the correlation of known foci of the species with endemic areas of onchocerciasis.

Localized distribution and dispersion of the black flies in the forest and savannah areas has been collected, systematized and studies by Le Berre et al (1964, cited by Cuellar, 1972). In the forest areas, a broad random-type dispersion from breeding places predominates. In the savannah, most of the dispersion is linear through the riverine galleries (Cuellar, WHO/ONCHO/72.94).

2.3.3 Environmental Factors Influencing the Distribution

The distribution and activity of S. damnosum complex species are influenced by a considerable number of environmental factors. (WHO: OCP/73.1)

The forest and savannah forms of S. damnsosum have specific ecological requirements. All species of S. damnosum breed in large rivers with the exception of S. yahense which breed in creeks and small tributaries. S. surbanum breeds in the extreme savannah conditions.

Three types of seasonal variations of S. damnosum populations have been recognized: synchronic variation, inverse variation and bimodal variation. During the synchronic seasonal variation, the abundance of the vector is correlated with the water flow. S. damnosum occur mostly during the dry season in the inverse variation,

while the flies are abundant only in the periods of maximum and minimum river flows during the bimodal variation. The breeding sites of S. damnosum therefore correspond with the water level and the rate of flow of the river. Rapidly flowing, well aerated watercourses provide suitable breeding ground for S. damnosum. The conditions of the water (oxygen content, current velocity), the river bed (e.g. rocky, shallow), vegetation in the river and along the riverbanks and the availability of mammalian blood in the immediate surroundings are necessary conditions for the suitability of the breeding ground. (WHO: OCP/73.1)

Climatological conditions such as temperature and relative humidity, rainfall and altitute are also important factors for the general survival of the vector. In the dry savannah where there is a markedly pronounced wet and dry season with a great fall in the water level of the river and relative humidity, S. damnosum is mainly a wet season fly; but in the rain forest areas where there are no pronounced seasonal variations, the vector flies are abundant throughout the year. (WHO: OCP/73.1)

Studies conducted by Philippon et al (WHO/VBC/76.619) show that the physico-chemical properties of the water are important for the immature stages of S. damnosum complex. The breeding sites of each species is among

other things determined by the pH value, the conductivity and the concentration of certain ions, e.g. S. sanctipauli and S. yahense breed in an acid water with pH values below 7, and the larvae of these same species were found in waters with high potassium and sodium sulfate content. S. sirbanum, S. sudanense, S. damnosum, and S. squamosum, which include the forest, the savannah and the mountain areas breed in waters with neutral, weakly alkaline pH.

Meteorological conditions such as wind movement are also significant factors as far as the dispersion of the vector is concerned. The long flight ranges which have been observed by a number of investigators are influenced by the meteorological conditions and the conditions of the vector itself, e.g. parous or nulliparous and the degree of infectivity by O. volvulus larvae. (WHO: OCP/73.1)

The biting activities of S. damnosum are very much influenced by the climatic conditions. At temperatures below 17°C or above 30°C the vectors' daily biting rhythms may be slowed down or stopped (WHO/OCP/73.1). In the rain forest area where perennial transmission is observed, the biting of S. damnosum is consistent; but in the savannah region where seasonal transmission prevails, the activities of the fly are controlled by the seasonal fluctuations.

2.4 Diagnostic Techniques

2.4.1 General Diagnostic Techniques

The diagnosis of onchocerciasis is generally made by parasitological measures, immunologic measures or clinical manifestations. Examination of microfilariae in the skin snips, in the urine, and in the eye are the most common methods used in the diagnosis of onchocerciasis. The immunodiagnostic techniques are of little practical value because of their unreliability either in specificity or sensitivity or both (Sasa, 1976). The skin depigmentation and the presence of onchocercal nodules are clear indicators of onchocerciasis. However, the demonstration of microfilariae in nodules or skin snips is the most positive diagnostic method for onchocerciasis.

2.4.2 New Diagnostic Techniques

New diagnostic techniques are being developed and a few have been tried out by some investigators. The complement fixation test (Lartigue, WHO/ONCHO/66.50), the intradermal tests (Fulsang and Anderson, WHO/ONCHO/77.132), and the Enzyme Linked Immunosorbant Assay (ELISA) are among the new diagnostic methods under investigation. The membrane filtration technique developed for the quantification of W. bancrofti microfilaraemea has been adapted for use as a diagnostic technique for onchocerciasis (WHO/ONCHO/76.119).

2.5 Therapeutic Trials

2.5.1 Studies on New Drugs

There is a search for effective macro- and microfilarial drugs. Arsenical, antimonical and other compounds have been tried out as in the treatment of onchocerciasis (Sasa, 1976). New combinations of the known drugs such as diethylcarbamazine, suramin, Mel W, metrifonate, etc., whose macro- and microfilaricidal actions against O. volvulus are well established are being studied by WHO (SAP/76.1).

So far no single drug or new combination of those already known has been found to be effective for both the adult worms and the microfilariae.

2.5.3 Mass Treatment

The use of drugs whose actions against the adult O. volvulus and the microfilariae are known for large scale treatment of onchocerciasis has not been encouraged because of the pharmacological nature of these compounds. Using such drugs as suramin, Mel W, diethylcarbamazine, etc., in mass treatment of onchocerciasis has not been feasible due to their severe adverse effects on the patients. Hence, large scale field therapeutic campaigns against onchocerciasis awaits further investigation on the safety of the drugs currently used (WHO/OCP/73.1).

2.5.4 Problems Encountered

There are a number of problems faced in both the clinical and field trials with new drugs as well as the old ones.

The major problem is the lack of a suitable drug that can kill both the adult worms and the microfilariae at the same time and have minimum side effects on the patients. So far no drug has been found to have such a dual effect against O. volvulus. (WHO: OCP/73.1 Annex 11-1)

Other limiting factors include lack of suitable laboratory experimental animals, the constant reinfection by O. volvulus and the lack of complete knowledge on the S. damnosum vector-O. volvulus complexes. The therapeutic campaign against onchocerciasis is further complicated by the long life span of the parasite once it gets established in the human host. Administration of DEC, suramin and other drugs with effective actions against the adult worms and O. volvulus microfilariae for a long period of time, has been discouraged by WHO Expert Committee on Onchocerciasis until further studies prove their safety in mass treatment. (WHO: OCP/73.1)

2.6 Control Measures Against Human Infection

2.6.1 Chemoprophylactic measures

Efforts have been made in order to protect the population living in onchocerciasis endemic areas from being infected by the disease. Chemoprophylaxis has been

considered as the most practical protective measure, but so far no suitable drugs are available for mass use. Insect repellents have been used in some parts but results have not been appreciable. (WHO: OCP/73.1 Annex II-1)

2.6.2 Other Protective Measures

Avoiding the bites of S. damnosum by wearing protective clothes such as long trousers, etc., by minimizing the contact between the human host and the vector during the peak biting activity are some of the protective measures used against onchocercal infection. Denodulization and use of drugs such as DEC, suramin, etc., are being used to reduce the number of cases. (WHO: OCP/73.1)

2.6.3 Problems Encountered

Chemoprophylaxis as a preventive measure against onchocerciasis has not launched due to the lack of suitable drugs. To date there is no drug that is effective and safe enough for mass chemoprophylactic programs. (WHO: OCP/73.1)

The use of insect repellents has not achieved much due to the undesirable smell of the drug used for this purpose. The most protective measure is the complete avoidance of any contact between the population and the vector. This, however, is impracticable because of the activities of the population in endemic areas - especially the male adult population and the long dispersion and flight range of the vector. The main occupation in the onchocerciasis areas is farming and the related occupations,

all of which expose the population to the biting of S. damnosum. The host-vector interaction is, therefore, a major problem in terms of carrying out an effective preventive program in heavily infected areas. (WHO: OCP/73.1)

2.7 Vector Control Measures

2.7.1 Eradication by Mechanical Means

The World Health Organization (WHO), the Organization de Coordination et de Cooperation pour la Lutte Contre les Grandes Endemies (OCCGE), and the Fonds European de Developpment (FED) have launched a large scale onchocerciasis campaign in the Volta River Basin Area, Niger included. (OCCGE forms the core of the program) Among the mechanical means used in controlling the vector S. damnosum are the destruction of all known S. damnosum breeding sites along the rivers and tributaries, ecological manipulation in order to discourage both the breeding and the general habitation of the vector. (WHO: OCP/73.1)

2.7.2 Eradication by Chemical Means

Insecticides such as DDT, etc., and larvicides are being used in vector control programs. WHO and OCCGE are the main organizations involved in large scale campaigns against S. damnosum. Systematic application of insecticides and larvicides in identified natural habitats and breeding ground of the vector is being carried out.

Spraying by use of helicopter and other aircrafts is practiced in areas which cannot be reached by other means (WHO/OCP/73.1).

2.7.3 Eradication by Biological Means

The use of known predators of the adult S. damnosum and their larval form has been proposed (WHO/ONCHO/73.1). Such known predators as mirmithidae have been considered as possible means of controlling the S. damnosum complex species. (WHO: OCP/73.1)

2.7.4 Other Vector Control Measures

Insect trapping has been used as another method of reducing the vector population in endemic areas. (WHO: OCP/73.1 Annex V-2)

2.7.5 Problems Encountered

Some of the problems encountered in onchocerciasis control programs are: the toxic effects of the insecticides and larvicides used on the non-target organisms in the area, the lack of a suitable insecticide or larvicide which has no or very little toxic effects on the non-target organisms in the onchocercal areas, the long flight range of the vector which complicates the problem due to reinvasion of once freed areas, the high costs involved in maintaining the personnel and equipment in order to keep the program going and the lack of trained local entomologists to continue studying and identifying the

specific vectors of onchocerciasis in the areas concerned. (WHO: OCP/73.1)

Constructing dams upstream so as to slow down the currents of the rivers or streams, thus making the breeding of S. damnosum impossible, has not been a successful means because of the problems of spillways which provide excellent breeding sites for some of the species of S. damnosum complex. (WHO: OCP/73.1)

The vector control programs are further complicated by the host-vector relationship. The adult O. volvulus has a long life span in the human host (up to 20 years). In order to completely eradicate the disease the control program must be maintained for at least 15 to 20 years because of reinfection of the flies by the infected population would remain possible for that period. Movement of the population from one endemic area to another or to other areas where there is a potential for onchocerciasis transmission must be restricted. It is difficult to achieve such measures and thus the problems continue to be compounded. (WHO: OCP/73.1)

2.8 Impact of Onchocerciasis

2.8.1 Impact on Population Distribution

There is a constant population movement from areas heavily infected with O. volvulus to onchocerciasis free areas. This is more so among the young people who migrate from the rural areas to the towns and cities in search

of better job opportunities as well as getting away from the infected areas. This population shift has created some problems in urban centers, e.g. overpopulation; also, the fertile areas have been abandoned. (WHO: OCP/73.1; OCP/73.1 Annex VI-5)

2.8.2 Impact on the Economy

The economic implication of onchocerciasis is quite obvious. Economic blindness is a definite setback as far as economic production is concerned. As pointed out in 2.2.5, the male population is the most affected group (the average age for economic blindness in some areas is 40 years). Hence, there is a significant number of individuals who are out o work due to onchocercal ocular involvement. (WHO: OCP/73.1; OCP/73.1 Annex VI-5)

Onchocerciasis is also a public health problem. Large amounts of money are spent each year in purchasing drugs for the treatment of the disease. The control program aimed at eradicating the vector and the preventive measures designed to protect the population at risk from being infected by the parasites are equally expensive to maintain. (WHO: OCP/73.1 Annex VI - 5)

Persons with impaired vision or suffering from complete blindness are helpless and as such their responsibilities are to a large extent assumed by their immediate families or relatives. This places an unnecessary burden and economic hardship on the families or relatives concerned. As a whole, onchocerciasis causes

considerable economic strains both at the family and the national level. (WHO: OCP/73.1 Annex VI-5)

2.8.3 Ameliorative Programs

WHO has undertaken a large scale onchocerciasis eradication program in the endemic areas. After the eradication of the vector there are plans to develop the freed areas economically and to repopulate them. There are plans for economic development in terms of farming and other agricultural activities in those areas now abandoned as a result of heavy transmission and infection rates (WHO/OCP/73.1, Annex VI-2.G).

2.8.4 Problems Encountered

In order to reclaim the abandoned areas due to heavy infections by O. volvulus, such areas must be completely free from the vector transmitting the disease and therefore safe for the resettled population. Complete eradication of S. damnosum has been a major problem in that there are a number of factors involved, among which are the lack of suitable insecticides and larvicides, lack of qualified personnel, lack of funds and the problems of host-vector relationship, the vector-parasite relationship and the host-parasite relationship. In order to resettle the people and thus undertake an effective economic or land development program, there must be effective vector-parasite complex control measures. (WHO: OCP/73.1)

2.9 Laboratory Studies

2.9.1 Studies on the Vector

A number of studies have been done on S. damnosum, the vector responsible for onchocerciasis. Several forms of the vector have been identified as a result of morphological and cytological studies and new subgroups recognized (Dunbar and Vajime, WHO/ONCHO/71.87). 17 cytotogical categories in two subgroups have been recognized (Dunbar and Vajime, WHO/ONCHO/71.87). According to Vajime, eight species are now known in and around the Onchocerciasis Control Programme area (WHO/SAP/76.1). Thompson et al (WHO/ONCHO/72.96) found that the emerged S. damnosum settle in the light position at the top of the mesh sides of the cage, thus indicating positive phototaxis, and that at high temperatures and low relative humidity they died.

So far a self-perpetuating colony of any S. damnosum complex species or cytotype has not been achieved. This has been due to lack of stable hydrochemical conditions and the inability to induce the adults to feed on blood, mate and lay eggs in the captive environment. Larvae can be reared either in open systems where the water passes through once or in enclosed systems where water is cycled. Mating is one of the chief difficulties in developing a self-perpetuating colony for laboratory studies. (WHO: OCP/STAC/75.2)

2.9.2 Studies done on O. volvulus

Bain (WHO/ONCHO/68.70) has done some morphological studies on O. volvulus developmental stages. Results show that O. volvulus larvae has distinct morphological characteristics different from those of other microfilarial larvae, e.g. the microfilariae of O. volvulus have no sheath. Gratama (1966) also showed that O. volvulus microfilariae possess specific distinguishing morphological characteristics as compared to microfilariae of other filarial worms such as W. bancrofti (Gratama, 1966). Duke et al (1966) showed that the forest strain of O. volvulus can develop only in the forest forms of S. damnosum, and that the savannah strain could develop in the S. damnosum from the same bioclimatic region. Philippon and Bain (cited by Duke et al, 1975) found that when the Sudan savannah form of S. damnosum ingested large numbers of microfilariae, many of the parasites were eliminated at the microfilarial stage in the gut of the fly and only a few developed (Duke et al, 1975). The studies on morphology and developmental characteristics indicate that there are two strains of O. volvulus, the forest and the savannah strains, and that these form O. volvulus-S. damnosum complex, e.g. each strain develops in a specific species of S. damnosum and the two strains differ in the degree of infectivity (Garner et al, 1973). Also, there are antigenic differences between the adult worms and their microfilariae (Bryceson et al, 1975).

2.10 Clinical Studies and Observations

Besides the general clinical manifestations of onchocerciasis such as oedema, lichenoid changes, late depigmentation ("leopard skin"), skin atrophy and other conditions observed in onchocercal dermatitis, and hanging groins and other regional lymphadenopathies seen in lymphadenitis as well as puntate keratitis, sclerozing keratitis, mild uveitis plastic inflammation, choroidoretinal lesions and postneuritic optic atrophy (in ocular involvement). Studies have revealed that microfilariae are also found in organs other than the skin and the eyes (Onchocerciasis, symptoms, pathology, diagnosis, edited by Buck, 1974). Microfilariae of O. volvulus have been recovered from the blood vessels, the aorta, the liver, viginal smear, sputum, kidney, spleen, lymphatic system, cerabrospinal fluid, etc. (Onchocerciasis, symptoms, pathology, diagnosis, 1974. Tables 1 and 2, pp. 15 and 16). Systematic studies on chronic onchocerciasis patients have also shown that marked weight differences in the adult males and females were related to the intensity of infection (Rolland and Balay, quoted by WHO, Onchocerciasis, symptoms, pathology and diagnosis; edited by A.A. Buck, 1974). Duke et al found significant weight losses in heavily infected persons in Chad (Table 3, p. 16).

Hanging groins are more common in patients from the

African onchocerciasis regions than in Latin American ones. In hypoendemic areas onchocercal punctate keratitis is found in all age groups but permanent ocular lesions are uncommon and develop only in adults and are rarely gross. In mesoendemic communities, punctate keratitis is prevalent in young persons but less in the older age groups. Permanent lesions are observed in young adults and become progressively common and serious in older persons. Heavy invasion of the eye by microfilariae is common in childhood in hyperendemic regions. Permanent lesions are quite frequent in youth and blindness is commonly observed at the early age while head nodules are observed in children.

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NG 3.0 MALARIA IN NIGER

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975): In 1974, 88.6% of Niger's population lived in malarious areas. Of that population, 98.4% lived in malarious areas in which there were no antimalarial measures in effect. More specific data about geographical distribution was not given by this source.

3.2.2 Prevalence

WHO (1975): The 1974 spleen and parasite rates in areas of Niger that were without antimalarial measures were 12-83% and 5-80% respectively while the overall malaria mortality for that year was 44.150 per 100,000.

WHO (1976): The numbers of cases and deaths due to malaria during the months of June through October, 1974, are presented below.

MALARIA, NIGER, JUNE-OCT., 1974

1974	No. of Cases	No. of Deaths
June	13,318	11
July	18,490	21
Aug.	38,048	22
Sept.	43,632	33
Oct.	31,711	41

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

No country-specific data found.

3.2.5 Population Most Affected

No country-specific data found.

3.3 Vector or Intermediate Host Bionomics

3.3.1 Species Transmitting the Disease

No country-specific data found.

3.3.2 Vector Distribution

No country-specific data found.

3.3.3 Environmental Factors Influencing Distribution

Poulsen (1976): Malaria is most common during the rainy season which extends from April to October.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

No country-specific data found.

3.6 Control Measures Against Human Infection

3.6.1 Chemoprophylactic Measures

Poulsen (1976): The Government of Niger instituted

a chemoprophylactic program in which Nivaquine was distributed at no cost to children and expectant mothers. This program was poorly accepted, so the GON instituted the "Flavoquinization" program. In this program, paramedical personnel visited all the villages in their assigned service area every two weeks. At each visit they would sell the drug to the villagers below its cost to the GON and record the participants in the program. The people seemed to have more confidence in something they had to pay for and a significant decrease in patients seeking treatment for malaria was reported thereafter.

3.6.2. Other Protective Control Measures

No country-specific data found.

3.6.3 Problems Encountered

No country-specific data found.

3.7 Vector or Intermediate Host Control

WHO (1975): Only 1.6% of the population living in malarious areas in 1974 had the benefit of anti-mosquito control efforts.

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.2 Eradication by Chemical Means

No country-specific data found.

3.7.3 Eradication by Biological Methods

No country-specific data found.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

No country-specific data found.

3.8 Disease Impact

No country-specific data found.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

No country-specific data found.

3.9.2 Laboratory Studies on the Parasite

WHO (1975): The relative prevalence of *P. falciparum* in areas of the Niger which had antimalarial efforts as reported for 1974 was 82%.

3.10 Clinical Studies and Observations

No country-specific data found.

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NG 4.0 TRYPANOSOMIASIS IN NIGER

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Trypanosomiasis was reported in 1967 in the Say-Kirtachi-Tamou triangle.

4.2.2 Prevalence

WHO (1969): The prevalence of trypanosomiasis for 1967 was 27 patients out of a total population of 3,546,000.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

WHO (1969): The incidence of trypanosomiasis in 1967 was 22 new cases.

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

No country-specific data found.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specfic data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): All domestic animals are susceptible to infection by *T. brucei* as well as other zoophilic *Trypanosomae*.

4.10 Clinical Studies and Observations

No country-specific data found.

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NG 5.0 FILARIASIS IN NIGER

5.2 Epidemiology of the Disease

5.2.1 Geographical Distribution

No country-specific information found.

5.2.2 Prevalence

Sasa (1976): Pfister (1954), during examinations of 79 persons from the desert region of Say-Maradi, found 5 (6.3%) individuals infected with *W. bancrofti* and 1 (1.3%) with *D. perstans*.

Brengues et al. (1968) and Brengues (1973) found only 1 infected individual out of 205 persons examined at Tahoua. Similarly, only 3 out of 203 persons examined at Tera were infected with microfilariae.

5.2.3 Intensity

No country-specific information found.

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

No country-specific information found.

5.3 Vector or Intermediate Host Bionomics

No country-specific information found.

5.4 Diagnostic Procedures or Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Against Human Infection

No country-specific information found.

5.7 Vector or Intermediate Host Control

No country-specific information found.

5.8 Disease Impact

No country-specific information found.

5.9 Laboratory Studies

No country-specific information found.

5.10 Clinical Studies and Observations

No country-specific information found.

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Part B
National and Regional Disease Profiles

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SN 1.0 SCHISTOSOMIASIS IN SENEGAL

1.2 Epidemiology

1.2.1 Geographical Distribution

Ansari (1973): "S. haematobium is the species predominant in Senegal. It occurs in all parts of the country, with the possible exception of the Ferlo desert area (Lariviere and Diallo, 1967). The main endemic foci are located in the valleys of the various rivers, viz. the Senegal, the Faleme, the Saloum, the Gambia and the Casamance. Certain foci are situated in the north near the border with Mauritania."

1.2.2 Prevalence

Ansari (1973): "The range of prevalence according to Gaud (1955) is 2-40% with an estimated average of 15%. According to Deschiens (1952) the average prevalence is 8%, and according to Pfister (1957) it is 15%.

Infection rates vary in accordance with the region. At Dakar, the rate was 6% in 1923, and at nearby Medina it varied between 39% in 1923 and 8% in 1949. Rates in the Thies and Kaolack areas range from 7.5 to 75%, and in Basse-Casamance from 15 to 85% (Lariviere and Diallo, 1967).

Lariviere et al., (1958) examined numerous individuals in the Cercle of Thies and that of Kaolack. In the subdivision of Thies, the prevalence in three villages ranged between 7.4

and 26.9%. In the subdivision of Tivaouane (Cercle of Thies), of three villages, infection was observed only in Makha with a rate of 1.5%. In the subdivision of M-Bour, nine villages were surveyed with infection rates varying from 0 to 65%. A total of 806 faecal examinations proved negative for S. mansoni eggs.

From four villages in the subdivision of Fatick in the Cercle of Kaolack, a total of 997 children were examined; 3.9% were positive for S. mansoni and 23% of S. haematobium. In the subdivision of Foundiougne (Cercle of Kaolack), two villages in the region of Sine showed positive urines of 75.9 and 5.35% respectively.

In the Arrondissement of Khombole, Lariviere et al. (1960) noted 20% of 115 children positive at Keur Messia Diake, 7.3% of 109 at Mandanguil Ouoloff, 7% of 129 at Bousnak-Gotte, 4% of 107 at Niangue Dakar and Djite, and 3% of 123 at Parare and Dimbe.

Sardou (1962) reported an infection rate of 32.1% in 140 inhabitants of the village of Ngoye in the region of Diourbel.

Active transmission is also taking place around lac de Guiers in the north (3.12%); in the areas of Podor (15-20% infected), Matam (11.8%), and

Bakel (22%), on the River Niger; in Eastern Senegal (Tambacounda and Kedougou); and in Haute-Casamance (Kolda) (Lariviere and Diallo, 1967).

In Basse-Casamance, the villages of Balandine and Kartiack, north of the Casamance River, showed prevalence rates of 22 and 42% respectively. South of the river, the following rates were obtained in various villages: Nyassia 15%, Seleki 71%, M'Lomp 33%, Kodjinole 85%, and Kagnoute 82%."

AID, OMVS (1975): Urinary schistosomiasis is prevalent in the Senegal delta (allegedly 10% - sources 12 and 5) and in increasing rates all along the Senegal River Valley to the Mali border and beyond, where it may affect over 40% of the population.

Johnson (1977): The examination in 1973-1975 of 3,500 urine specimens from students at the institute in Dakar seen by referral revealed a 5.3 percent positive for schistosome flukes. A report by experts in 1960 of a study on students at the technical school indicated that 35 percent of the students were infected with schistosomes. Most of these students were from the southern portion of Senegal. Further to the north of the delta and on into Mali the incidence is estimated

to increase from 10 percent to 40 percent.

Gibson et al. (1977): A survey by Dr. Junod in Tambacounda showed a 34.9% prevalence rate for *S. haematobium* among schoolchildren. For the Bakel area, Watson gave a rate of 22%.

Warren and Hoffman (1976): (quoted abstracts) Lariviere, M., S. Diallo, and P. Rangue (1964)- "The author and his colleagues have already described *Schistosoma mansoni* infection in Senegal.

They now record the finding, in 1964, of *S. mansoni* eggs in the faeces of 3 out of 9 and 4 of 18 children, respectively, in 2 villages in the Kolda region, Upper Casamance. Later, they found 13 infected persons among 70 whose stools were examined in Kedougou in eastern Senegal, and in 1 of 21 and 3 of 10 children, respectively, in 2 village schools in the Etiolo and the Salemata-Gandjiri regions, which are situated in the Bassari area, near the Republic of Guinea."

Bereni, L., J. Bougarel, and A. Sy (1974)- "The authors have conducted a survey on the incidence of urinary schistosomiasis in school children in the town of St. Louis in Senegal. A preliminary study had provided an estimate of the incidence in the various areas from which the children came.

The lower Senegal river valley (St. Louis and the Delta) were almost free (3.5%), while the upper river, Eastern Senegal at 40.7% and Sine Saloum at 52.4%, were heavily infected."

1.2.3 Intensity

No country-specific information found

1.2.4 Incidence

No country-specific information found.

1.2.5 Population Most Affected

No country-specific information found.

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari (1973): For S. haematobium: B. (Ph.) jousseaumei, B. (B.) guernei. For S. mansoni: B. pfeifferi.

AID, OMVS (1975): B. truncatus is intermediate host for S. haematobium.

1.3.2 Vector Distribution

Ansari (1973): "Bulinus (Bulinus) sp. have been reported from a number of areas. Smithers (1956) collected B. (Ph.) jousseaumei at Kolda. Gretiliat (1963) noted that this species serves as an intermediate host in the upper Casamance region. Lariviere and Charnier (1957) found B. (B.) forskalii at Cap Vert. B. (B.) senegalensis is

apparently widely distributed; however, Gretillat (1961) failed to find this species infected in an extensive survey of the Tamba Counda area where infection is apparently carried exclusively by B. (B.) guernei, 2 to 8% of which were found to be positive."

1.3.3 Environmental Factors Influencing Distribution

AID, OMVS (1975): Bulinid snails require fresh water rich in organic material emanating from aquatic vegetation, temperatures varying broadly between 10°C and 30°C with optimum range between 18°C and 25°C. Transmission requires calm waters with low levels of salinity or preferably fresh water. ...The main stream of the Senegal River is the axis of the dispersion of the snails. However, the secondary streams feed a number of ponds where the predominance of fresh water favors the snail population. During the annual flood the amount of fresh water increases, resulting in a redistribution and intensification of the presence of Intermediate hosts throughout the area of prevalence. During the dry season it has been shown that the snail B. guernei can bury itself in the sand below the level of its usual habitat in search of moisture and thus survive long periods of drought.

1.4. Diagnostic Procedures or Techniques

1.4.1 General Diagnostic Methods

No country-specific information found.

1.4.2 New Diagnostic Techniques

Warren and Hoffman (1976): (quoted abstract) Bereni, L., J. Bourgarel, and A. Sy (1974)- "They investigated a method of increasing the positive results in urinary surveys by giving injections of Methergin (methylergometrine) and Gynergen (orgatamine). For example, of 327 subjects negative to straight examination, 54 (16.5%) were positive after Methergin injection, and similar results obtained with Gynergen. However, Gynergen produced unpleasant side-effects and was abandoned. Tables are given of the exact results of so-called re-activation."

1.5 Therapeutic Trials

1.5.1 Studies on New Drugs

No country-specific information found.

1.5.2 Mass Treatment

Warren and Hoffman (1976): (quoted abstracts) Diallo, S. and P. Druilhe (1973) - Among the different groups of drugs suggested and tried for the treatment of schistosomiasis have been the organophosphorus preparations. The authors have used metriphonate in the treatment of *Schistosoma haematobium* infection in children in two villages

in the district of Thies in Senegal.

Urine was collected during the period 10 a.m.-2 p.m. and examined both by centrifugation and by the egg count method of Bell. 7.5mg/kg of metriphonate was given in a single oral dose and repeated 3 weeks later. Urines were examined again 3 weeks after second dose, at 7 weeks and at 16 weeks.

115 children were treated. 13 had abdominal pains, 3 had diarrhoea, 9 had nausea without vomiting, and 6 suffered from giddiness. None of these side-effects was severe. 89 children were followed up fully and 48 appeared to be cured (54%). In those not cured, a reduction of 80% was noted in the number of eggs per 10 ml of urine.

The authors feel that, although these results are not as good as those obtained with niridazole, the convenience of single oral administration makes this treatment worthwhile for most campaigns.

Lariviere, M., P. Camerlynck, and M. Rey (1965)- "In Dakar (1-(5)-nitro-thiazolyl-(2)-oxo-tetrahydro-imidazol) (Ambilhar) was given to 16 patients aged 9-18 years with *Schistosoma mansoni* and to 24 children and adolescents with *S. haematobium* infections. The daily dosages used in the treatment

of the former ranged from 21.7 to 38.4 mgm./kgm. of body weight, and the total dosages from 3.5 to 10.5 mg.; the daily dosages for those with S. haematobium infections ranged from 19.2 to 55.5 mgm./kgm., with totals of from 3.5 to 15 gm. The daily dosage was divided into 2 subdoses, and the period of treatment was from 5 to 7 days. Examinations undertaken on these patients included rectal biopsies, electrocardiograms and search of the stools for eggs by Bell's method; all the patients, other than 12 of those with vesical schistosomiasis, were treated in hospital.

The therapeutic results were good. Of the 16 patients with S. mansoni infections only 2 continued to yield viable eggs 3 months after treatment, and these contained abnormal embryos. Of the 24 with S. haematobium infections none were passing viable eggs in the urine when reviewed after 3-7 months; though calcified eggs were seen in some of the urines haematuria had disappeared early in treatment. The optimum dosage of the drug with regard to both effectiveness and tolerance appeared to be 25 mgm./kgm. daily for 7 days. The side-effects were abdominal pains, 7 patients, and vomiting, 5 patients, but they were not severe. Some children accidentally given a double dosage suffered abdominal cramps with nausea and vomiting.

Electrocardiography of the 28 hospital patients revealed no changes in the tracing in half of them, but in the others there were some changes though these were not accompanied by symptoms."

Lariviere, M., P. Camerlynck, and M. Rey (1966) - "16 patients infected with *Schistosoma mansoni* in Senegal were successfully cleared of infection with doses of Ciba 32644-Ba at levels of 20 to 35 mg. per kg. body-weight per day for 7 days. Follow-up examinations showed clearance for 9 weeks. 24 patients with *S. haematobium* were treated with doses from 19 to 55 mg. per kg. per day and cleared of infection. Follow-up examinations varied in duration from 6 to 25 weeks and all were negative. The optimal dose, which was well tolerated, was 25 to 30 mg. per kg. daily for 7 days. In a few cases, gastro-intestinal disorders were found at higher doses. Some changes in the electrocardiogram, principally in the T waves, were observed, but were not accompanied by any clinical manifestations."

Sankale, M., R. Baylet, and M. Moulanier - "95% immediate success was obtained with niridazole treatment of *Schistosoma haematobium* infections in patients in Dakar, Senegal. Late failures seem rare, and they respond to retreatment. The daily dose recommended is 25 mg. per kg. body-

weight per day for seven days. Side effects are frequent but usually minor. More serious symptoms, particularly neuropsychiatric, may occur."

1.6 Control Measures Against Human Infection

No country-specific information found.

1.7 Vector or Intermediate Host Control

1.7.1 Eradication by Mechanical Means

No country-specific information found.

1.7.2 Eradication by Chemical Means

Warren and Hoffman (1976): (quoted abstract)

Gretillat, S. and A. Lacan (1964)-

"A length (13.5 kilometres) of the Casamance river, Senegal, was treated with 1,600 kgm. of dimethyldithiocarbamate of zinc (Ziram) applied as a water-dispersible powder. Effective killing of several snail species, including *Bulinus jousseaumei* and *Lymnaea natalensis*, is reported, and 3 species of fish also succumbed to concentrations of 2 p.p.m. while 4 other species were apparently unaffected. The method of application of the the molluscicide varied from a boat in the centre of the stream, but in fast-flowing condition it was best applied from the banks. Detailed results are given in 3 tables and discussed fully."

1.7.3 Eradication by Biological Means

No country-specific information found.

1.7.4 Other Control Measures

No country-specific information found.

1.7.5. Problems encountered

No country-specific information found.

1.8 Disease Impact

No country-specific information found.

1.9. Laboratory Studies

1.9.1 Laboratory Studies on the Vector

No country-specific information found.

1.9.2. Laboratory Studies on the Parasite

Warren and Hoffman (1976): (quoted abstract)

Fernex, M. and P. Fernex (1963)-

"...In mice killed 3 months after infection with *Schistosoma mansoni* the number of mast cells in the skin was 3 times that in control animals."

1.10 Clinical Studies and Observations

Warren and Hoffman (1976): (quoted abstracts)

Quenum, C., G. Serafino, and A. Diop (1964)-

In the routine histological examination of a spleen removed at autopsy from a Senegalese patient who had died after a severe burn the authors were surprised to see schistosome eggs. These eggs were found isolated, or in groups of

2 or 3, in the splenic parenchyma. There was no inflammatory or fibrous reaction. There are few reports of similar findings, and the authors discuss this aspect of the problem and also the relationship with schistosomal splenomegaly. The histological appearances are shown in photomicrographs.

Armengaud, M., et al. (1962):
With a view to making an independent assessment of the hepatosplenic complications attributed to schistosomiasis, the authors admitted 45 patients for investigation. 29 had *Schistosoma mansoni* (intestinal) infection; 16 had vesical schistosomiasis, the infecting parasite being *S. curassoni*, not *S. haematobium*. All 45, even those aged 6-10 years, showed abnormality of the liver; a simple but active cellular inflammation of the mesenchyma ("mesenchymatose cellulaire") in 24%, a moderate portal fibrosis in 24% and severe fibrosis in 50% and in child aged 8 years there was a definite cirrhosis. The lesions were more marked in *S. mansoni* infections. Eggs were found in the liver in 75% of patients with *S. mansoni*, and in only 7% of those with *S. curassoni*. During treatment, an increase in the size of the liver was noted in 56% of patients with vesical and in 92% of those with intestinal infection.

Splenomegaly, scarcely ever more than 2 fingers' breadth and never the classical "tropical splenomegaly," was found in 37.5% of those with vesical and 27% with intestinal infection. Enlargement of the spleen during treatment occurred in 68.7% and 43%, respectively.

The degree of involvement of liver and spleen did not depend on age. Frankly cirrhotic livers were seen in children under the age of 8 years, while older persons infected for 10 years or more had simple mesenchymal inflammation. The suggestion is made that it is the primary infection which determines the degree of liver involvement, and that super-infections do not have any further effect. Also the actual presence of eggs in the liver is not essential: the pathological findings in those with vesical infection conform with reaction to a remotely produced toxin. Eggs or adult worms which reach the liver, as those of S. mansoni do, act as foreign bodies and aggravate the sclerosing, fibrotic hepatitis, but do not play the determining role.

Out of the 45 patients, 16 had enlarged hearts, and during treatment 23 suffered a Loeffler reaction, with accentuation of eosinophilia, transitory infiltrations of the lungs and an appreciaciable increase or heart size. The authors

noted this phenomenon without pretending to explain it.

Brocard, H. et al. (1972) -
In a Senegalese patient aged 32 years, who had been in France only for a few weeks and in whom large mediastinal opacities were discovered on routine examination; clinical examination and further investigations permitted the discovery that the thoracic abnormalities were due to pseudo-aneurysmal dilatations of the branches of the pulmonary artery. Hemodynamic study confirmed the existence of pulmonary hypertension. Pulmonary biopsy showed peripheral vascular lesions of thrombosis with permeabillisation. Schistosomiasis was discovered and proved by parasitology, serology, endoscopy and urologic investigations.

From what is known of chronic cor pulmonale due to schistosomiasis, the finding of various clinical and laboratory abnormalities and the pathological appearance of pulmonary biopsy suggest that this pulmonary hypertension is due to multiple pulmonary emboli due to Schistosoma haematobium eggs.

The authors then recall the etiology, the pathology, the clinical, diagnostic and therapeutic findings in chronic cor pulmonale due to schistosomiasis.

Mensah, A. et al. (1972) -

The authors report 4 cases of genital schistosomiasis from Senegal. The first was a man aged 84 years with acute retention. Biopsy of the prostate showed numerous eggs of *Schistosoma haematobium*. He improved on niridazole (Ambilhar) treatment The second, a younger man aged 28 years, had haematuria, suprapubic pain, and a chronic urethral discharge. He had a cyst of the left epididymis, a hydrocele on the same side, and systoscopy demonstrated schistosomal bladder lesions. Surgical treatment of the cyst and hydrocele did not relieve his symptoms, and a biopsy of the prostate confirmed schistosomal prostatitis. Treatment with Ambilhar relieved the pains and urethral discharge.

The third patient was a woman aged 25 years who was operated on as an emergency for intra-peritoneal bleeding. There was chronic inflammation of the uterine adnexa with a cystic haemorrhagic mass. This was removed and histological examination showed that it was caused by *S. haematobium*. The fourth patient was a boy aged 14 years who developed uraemia with acute suppression of urine. He responded to ureteral drainage; his bladder was full of pus. He then developed an epididymoorchitis due to schistosomal infiltration.

In a lengthy discussion the authors suggest that as diagnosis is more difficult in genital schistosomiasis and depends on biopsy, it is likely that it is much more frequent than reported. They quote Gelfrand's figures of 57.9% prostatic involvement in men, and involvement of the female organs in up to 91%.

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SN 3.0 MALARIA IN SENEGAL

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1971): No area of Senegal [illegible] malaria throughout the entire year except Cap Vert in which there is a decreased risk during January through June.

Mays (1975): Malaria can be found all over Senegal especially in the Fleuve Region and in Ferlo.

WHO (1975): One hundred percent of the population of Senegal lives in malarious areas in which 70.2% of the population are without any antimalarial efforts.

APHA (1977): Malaria was studied in Bakel and much of the Senegal River valley.

3.2.2 Prevalence

Mays (1975): The malaria situation in Senegal has been classified as extreme in the magnitude of its severity. Prevalence rates were 56% in the Fleuve Region and 48% in Ferlo. Seventy-six percent of the population less tahn 30 years old was found to be positive for malaria. It was estimated that effort to increase agricultural productivity in Senegal by expanding bodies of water and constructing irrigation canals would increase vector breeding and change malaria endemicity from its present mesoendemic status to a hyperendemic one with a parasite index greater than 50% at all times.

WHO (1975): The parasite rate in areas of Senegal with antimalarial measures was 15 - 35% in 1974. In areas

without antimalarial measures the 1974 parasite rate was 25 - 85%. Malaria mortality was 91.533 per 100,000 that year.

APHA (1977): Records at the major health center in Senegal and its dispensaries indicate that malaria is a major disease problem.

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

APHA (1977): Incidence rates were reported highest in the rainy season which extends from June through September and low during the rest of the year because the vector breeding grounds dry up during the dry season.

3.2.5 Population Most Affected

Mays (1975): Of those 30 years old or less, 76% were found to be positive for malaria.

3.3 Vector or Intermediate Host Bionomics

3.3.1 Species Transmitting the Disease

Mays (1975): The predominant vector of malaria in Senegal was found to be *Anopheles gambiae melas*. *A. funestus* and *A. nili* were also competent vectors.

APHA (1977): *Anopheles gambiae* was found to be the the predominant vector in Senegal. It was reported th only 8 - 10 days are required for the mosquito life cycle in warm water.

3.3.2 Vector Distribution

No country-specific data found.

3.3.3 Environmental Factors Influencing Distribution

Mays (1975): *Anopheles* breed primarily during the rainy season, July - September, although there is some minimal breeding during the dry season. The construction of irrigation canals and the expansion of bodies of water in an effort to improve agricultural productivity would provide for an increase in vector breeding which would produce an increase in endemicity of the disease. Other factors may enhance the opportunity for an increase in vector breeding. For instance, water spillover caused by improper irrigation methods may produce pools for more foci for breeding. The soil studied in Senegal was noted to have good water retention properties which will also enhance mosquito breeding.

APHA (1977): It is during the rainy season, June through September, that the vector is most active and incidence rates are highest. During the rest of the year breeding grounds dry up and incidence rates decline.

Plans to increase agricultural productivity by irrigation presented the problem that mosquitoes transmitting the disease may be increased due to prolonged ponding of water in developing rice paddies. This should actually present no more serious a problem because irrigated fields don't need to be always unindated. The soil has good water retention properties. Irrigation intervals even during the

dry season are only seven to eight days during early growth and 15 days just prior to harvesting. Percolation and evaporation usually dries the fields in two days. Thus the land should be dry during most of the dry season so that the ponding necessary for mosquitoes is lacking. Yet, the authors observed periods of continued unindation longer than necessary. Farmers seem to have an incentive to save water and also to avoid work since continued unindation makes weeding, filling low spots and repairing leaky canals unneccessary. It was also noted that some marigots retain water all year, but it is hoped that surface disturbances by man and cattle will provide less favorable conditions for vector breeding.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

No country-specific data found.

3.6 Control Measures Against Human Infection

3.6.1 Chemoprophylactic Measures

WHO (1972): Chloroquine is available to the entire population throughout the country. Senegal has also launched a plan to provide 500,000 children under five years of age with chemoprophylaxis.

WHO (1973 (3)): Senegal is reported to have an impressive self-help plan for rural communities in conjunction with area health services. Under this plan chloroquine is available to the entire population.

APHA (1977): The Service de Lutte Antipaludique of the Ministry of Public Health and Social Affairs has attempted to administer a mass prophylaxis program with chloroquine. Unfortunately, it has been ineffective because of lack of adequate financial support and poor supervision. If efforts to improve agricultural productivity are instituted, development of suitable disease control programs is essential. Malaria prophylaxis for all residents of the area during the main three month transmission period, July - September, is recommended. The authors also proposed a project under the combined administration of the Service de Lutte Antipaludique and the Department of Parasitology of the University of Dakar. Under this plan, either chloroquine tablets distributed free weekly or bi-weekly or chloroquinized salt adjusted to the salt intake of the population could be utilized.

3.6.2 Other Protective Measures

APHA (1977): A proposal for a suitable disease control program suggested the use of radio communication between Bakel Health Center and each of its twelve outposts to facilitate primary medical care.

3.6.3 Problems Encountered

No country-specific data found.

3.7 Vector or Intermediate Host Control

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.2 Eradication by Chemical Means

WHO (1971): Antilarval operations were reported in several countries including Senegal.

WHO (1975): Of the population living in malarious areas of Senegal, only 12.5% have the benefit of antimosquito protective measures.

APHA (1977): Larvicide, pesticide and herbicide usage is very limited by the reluctance of farmers but it is anticipated that it will catch on.

3.7.3 Eradication by Biological Methods

No country specific data found.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

WHO (1975): Vector resistance to DDT and Dieldrin were reported in 1974.

3.8 Disease Impact

3.8.1 Impact on Population Distribution

No country-specific data found.

3.8.2 Impact on Economy

No country-specific data found.

3.8.3 Ameliorative Programs

Mays (1975): Any efforts to correct the impact of malaria on the population or economy of Senegal must recognize the irreversible nature of the problem and be prepared for continued work on a long-term basis.

3.8.4 Problems Encountered

APHA (1977): Malaria was described as a major obstacle to modern development in Bakel and much

of the Senegal River valley.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

No country-specific data found.

3.9.2 Laboratory Studies on the Parasite

Mays (1975): Most cases of malaria in Senegal are infected by *Plasmodium falciparum* but *P. vivax* and *P. malariae* have also been identified.

WHO (1975): The relative prevalence of *P. falciparum* in 1974 was 85%.

3.10 Clinical Studies and Observations

No country-specific data found.

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SN 4.0 TRYPANOSOMIASIS IN SENEGAL

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Trypanosomiasis was reported in Niayes (on petite cote) between 1965 - 1967.

Watson (1970): Severe trypanosomiasis was reported in the Senegal River valley, in eastern Senegal and in Faleme valley.

Mays (1975): Trypanosomiasis was described as no serious problem in the lower and middle Senegal River valley. Endemic areas in Senegal include Cap Vert area and inland to the village of Pout and from Rufisque to Lake Tamna. Endemic areas also include the area along Somone River in Gambia River basin in Casamance province and in Senegal Oriental near Tambacounda.

4.2.2 Prevalence

WHO (1969): The Niayes focus showed a recrudescence of trypanosomiasis between 1965 - 1967. The prevalence was 188 cases.

Mays (1975): The magnitude of the trypanosomiasis situation was described as moderate.

APHA (1977): No human trypanosomiasis was reported.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

WHO (1969): In Niayes, 16 new cases were reported in 1967 and 10 at Fann Hospital Center. The total incidence for 1967 was 35 new cases. The overall incidence

of trypanosomiasis in Senegal has steadily declined.

Raadt (1976): The incidence of trypanosomaisis in Senegal for the period from 1968 to 1974 is presented below.

Trypanosomiasis Incidence in Senegal

Year	No. of New Cases
1968	43
1969	16
1970	16
1971	--
1972	17
1973	10
1974	2

4.2.5 Population Most Affected

Watson (1970): Trypanosomiasis tends to be more common in those people who leave their village area to hunt, fish, or farm. Workers on dam construction sites are also especially vulnerable to infection by trypanosomiasis.

4.3 Vector or Intermediate Host Bionomics

4.3.1 Species Transmitting the Disease

Watson (1970): The main vector of human trypanosomias is the tsetse of genus Glossina. Two types are found. These are G. palpalis gambiense and G. tachinoides. G. gambiense is the primary vector and G. moristans submorsitans is also active in disease transmission.

4.3.2 Vector Distribution

Watson (1970): The distribution of G. gambiense re-

mains relatively constant throughout the year as does that of G. tachinoides. G. gambiense is found in forest galleries along water courses in the Senegal basin while G. morsitans submorsitans are found in open forests and wooded savannas and is not limited to the neighborhoods of water courses. This latter species is usually found farther north than the others and is widespread in the Faleme valley in East Senegal.

4.3.3 Environmental Factors Influencing Distribution

Watson (1970): Vectors are found in limited numbers in densely populated areas but are more prominent in isolated, small sparsely populated areas along streams. They abound all year in wooded and humid zones near rivers. During the dry season they are usually limited to the level of small wooded islets and forest galleries. The elimination of onchocerciasis has permitted migration back into areas in which trypanosomiasis vectors abound. Conservation of forest is opposed to tsetse elimination.

Mays (1975): G. tachinoides tolerates dry season better than the other species. Men, wild antelopes and domestic animals such as dogs, pigs and goats, serve as reservoirs for trypanosomiasis.

APHA (1977): Tsetse favors vegetation on banks and flood plains of rivers and streams. These authors believe there is little basis to fear the immediate spread of trypanosomiasis because moist areas in

irrigated lands will not be shaded by trees or bushes.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specific data found.

4.7 Vector or Intermediate Host Control

4.7.1 Eradication by Mechanical Means

No country-specific data found.

4.7.2 Eradication by Chemical Means

No country-specific data found.

4.7.3 Eradication by Biological Methods

No country-specific data found.

4.7.4 Other Control Measures

Watson (1970): Agricultural development tends to decrease the population of tsetse larve.

4.7.5 Problems Encountered

No country-specific data found.

4.8 Disease Impact

4.8.1 Impact on Population Distribution

Watson (1970): Animal trypanosomiasis effects human nutrition.

4.8.2 Impact on Economy

Trypanosomiasis impedes economic development by limiting agricultural and social development.

4.8.3 Ameliorative Programs

Mays (1975): This author recommends that any ameliorative program designed to affect the trypanosomiasis situation in Senegal recognize the irreversible nature of the problem and be prepared to operate on a long-term basis.

4.8.4 Problems Encountered

Mays (1975): A high prevalence of animal trypanosomiasis presents a constant threat to the human population of Senegal.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): All species of domestic stock in Senegal are affected by *Trypanosoma brucei* as well as other zoophilic *Trypanosomae*.

Watson (1970): *T. gambiense* was reported as the only species responsible for human infection in the Senegal valley.

Mays (1975): The primary agent of trypanosomiasis in Senegal is *T. gambiense*.

4.10 Clinical Studies and Observations

No country-specific data found.

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SN 1.0 FILARIASIS IN SENEGAL

1.2 Epidemiology

1.2.1 Geographical Distribution

Sasa (1976): Both W. bancrofti and D. perstans are endemic in certain areas of the country.

1.2.2 Prevalence

Sasa (1976): "A high incidence of W. bancrofti infection in Casamance was reported by McFadzean (1954). ...A high incidence of W. bancrofti infection (47.0%, 135 positives out of 287 soldiers examined) was reported by THIROUX (1912)... Dejou et al. (1950) made blood examinations (both at noon and midnight) of 152 male patients admitted to the Central African Hospital in Dakar. In all cases, 10 ml of blood were taken and hemolysed in 200 ml of water, or 1 ml of blood was added to 10 ml of 2% formalin solution, and the centrifuged sediment was examined for microfilariae. As a result, 14 cases (9%) were positive for microfilariae of W. bancrofti, and 22 (14%) were positive for those of D. perstans; 4 cases had mixed infection. These authors made a detailed study on the genital affections due to filariasis."

Hawking (1974): Thiroux (1912), examining soldiers, found that W. bancrofti was rare in most parts of Senegal but that at Tatick and Kaolack (161 km south-east of Dakar) the microfilaria

rates were 62% and 65% respectively. In the Sandiara area, situated a little under 100 km to the south-east of Dakar, night-blood surveys of 1841 persons in nine villages showed an overall infection rate of 23.6% with extremes of 10.9% at Sandiara and 33.7% at Sessene (Juminer et al., 1971): ...Among inpatients at Dakar, the microfilaria rate was 9.3% (Dejou et al., 1950) and various filarial lesions of the genitals have been described. Pfister (1954) examined 49 adults but did not find microfilariae. In three villages of east Senegal day films showed that 6-9% of the adults were infected (Hocquet et al., 1964).

1.2.3 Intensity

Sasa (1976): It was observed by Pelletier (1912) that elephantiasis of the scrotum was a relatively common affection in Senegal. He reported on cases of enormous swelling of the scrotum, in one case weighing 100 kg, other cases weighing 33 kg. 11 kg, 10 kg (two cases), and 7 kg.

1.2.4 Incidence

No country-specific information found.

1.2.5. Population Most Affected

No country-specific information found.

1.3. Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Sasa (1976): An. gambiae, An. funestus, C. fatigans are vectors of W. bancrofti (Kartman, 1946)

1.3.2 Vector Distribution

Sasa (1976): Kartman (1946) made an observation of the natural vectors of W. bancrofti in Dakar, Senegal. In a routine check of native villages during a malaria survey, it was found that An.gambiae and An.funestus were predominant throughout the year, outnumbering all other mosquitoes, including C. fatigans. In the examinations conducted during 1944, 137 (36.6%) of 374 An. gambiae and 117 (15.6%) of 746 An.funestus were found to harbor filaria larvae.

1.3.3 Environmental Factors Influencing Distribution

No country-specific information found

1.4 Diagnostic Procedures or Techniques

No country-specific information found.

1.5. Therapeutic Trials

No country-specific information found

1.6. Control Measures Against Human Infection

No country-specific information found

1.7 Vector or Intermediate Host Control

No country-specific information found.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

No country-specific information found.

1.10 Clinical Studies and Observations

No country-specific information found.

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Part B
National and Regional Disease Profiles
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SZ 1.0 SCHISTOSOMIASIS IN SWAZILAND

1.2. Epidemiology

1.2.1 Geographical Distribution

Jobin and Jones (1976): S. haematobium transmission occurs in the Middleveld and Lowveld, near irrigation schemes and conservation dams. S. mansoni is found in scattered foci in the Lowveld. Little transmission of schistosomiasis takes place in the Highveld. Bruce et al. (1977): Significant numbers of people are affected by schistosomiasis in the Highveld.

1.2.2 Prevalence

Jobin and Jones (1976) estimated that 106,000 individuals in the country are infected with S. haematobium and that an additional 56,850 people are infected with S. mansoni. The team concluded that if the double infection rate is assumed to be 15%, then approximately 140,000 individuals in Swaziland can be considered infected. According to the National Development plan, 1973-1974, up to 90% of the population in the Low-and Middlevelds are affected by either urinary or intestinal schistosomiasis. Additionally, an increase (15-73% over 3-4 years) in the prevalence of S. mansoni infections was noted recently in newly irrigated Lowveld areas. No new endemic areas were associated with this

increase. The rise was probably due to the unusually close association of living quarters with water sources in the irrigation schemes.

Bruce et al. (1977) estimated that 60-90% of the populations of the Middleveld and Lowveld are affected by Schistosomiasis. He reported the following rates for S. haematobium:

$\frac{46}{198}$ = 23.2% detected in military personnel in the Central Public Health Laboratory (March-May, 1977)

$\frac{83}{685}$ = 12% detected in pregnant females at the Central Laboratory (Jan-May, 1977).

1.2.3 Intensity

No country-specific information found.

1.2.4 Incidence

No country-specific information found.

1.2.5 Population Most Affected

Jobin and Jones (1976): The joint AID-WHO estimates (1976) of schistosomiasis prevalence in Swaziland included the following age-specific information:

			S. haematobium		S. mansoni	
Age group	% of total pop	no. at risk	Assumed prevalence	Estimated no. of individls infected	Assumed prevalence	Estimat no. of individl infected
5 or under	19%	95,000	5%	4,750	3%	2,850
5-14	27%	135,000	35%	47,250	20%	27,000
14 or over	54%	270,000	20%	54,000	10%	27,000
All age groups	100%	500,000	-	106,000	-	56,850

1.3. Vector or Intermediate Host

1.3.1 Species Transmitting the Disease

Jobin and Jones (1976): The intermediate host for S. haematobium in Swaziland is Bulinus (Physopsis) globosus. S. mansoni is transmitted by Biomphalaria pfeifferi.

1.3.2 Vector Distribution

Ansari (1973): As might be expected, Bulinus (Physopsis) spp. occurs throughout the Middleveld and Lowveld, the areas where S. haematobium prevalence is highest.

Jobin and Jones (1976): No information was found on B. preifferi besides local reports of the species' presence in specific dams (e.g. at Ngeina).

1.3.3. Environmental Factors Influencing Distribution

No country-specific information found.

1.4 Diagnostic Procedures or Techniques

No country-specific information found.

1.5 Therapeutic Trials

No country-specific information found.

1.6 Control Measures Against Human Infection.

1.6.1. Chemoprophylactic Measures

No country-specific information found.

1.6.2 Other Protective Measures

Jobin and Jones (1976): The provision of adequate safe water to houses has been shown to

be an effective means of reducing schistosomiasis transmission.

Responsibility in Swaziland for the provision of safe domestic water supplies is distributed as follows:

Water and Sewerage Board - Urban supplies
Ministry of Agriculture - Rural Development area
Ministry of Health - Rural spring protection
Irrigation farms, etc. - to employees..

The present level of services (as of February, 1976) and the future plans of each group are shown below:

	Now	Planned
Water and Sewerage Board	14 township	100 rural areas in 40 years, 25,000 people.
Ministry of Health	Protect 45 existing springs	will be continued for 10 years to protect 22,000 people.
Ministry of Agriculture	Uncertain - 4 Rural Development areas (RDA) exist; 24,000 people would be covered if all were to be supplied	2 extra RDA's are now being built; plans to cover 90,000 people

The plans, if complete, would protect 126,000 people in 10 years, about 1/3 of the rural population. The projected cost is $11.50 to $23.00 per capita for initial construction and $2.30 per capita per year maintenance.

1.6.3. Problems Encountered

No country-specific information found.

1.7 Vector or Intermediate Host Control

1.7.1 Eradication by Mechanical Means

Jobin and Jones (1976) discussed the fluctuation of water levels in dams: If the water level is allowed to drop 0.5 meters in one day during the rainy season (when snails lay eggs) then allowed to return slowly over one week to the original level, almost all eggs will die from desiccation. The cycle must be repeated throughout the snail breeding season, which fortunately coincides in Swaziland with the rainy season when dams are full and excess water is pouring over the spillways. Jobin and Jones concluded that this method would be more effective and less costly than chemicals. The technique only requires the construction of a siphon spillway, costing about $230.

1.7.2 Eradication by Chemical Means

Jobin and Jones (1976): Following is a description of present or recent vector control methods using chemical means:

1970 - At the Manzini irrigation scheme, focal snail control was attempted along water courses where the absence of stepping stones obliged

people to wade through the water. Chemicals were also applied in stream areas used for washing. An appreciable reduction in snail numbers was recorded. (Also hycanthone was given to nearby infected children).

1971 - Lomahasha area - In the irrigation systems of Ngonini and Big Bend, constant head application using drip feeds was combined in certain areas with focal control.

1974 - Chemical control efforts were expanded and applied to several rural areas throughout the Middleveld and in the Lowveld near Nsoko.

Present Control Efforts - Present efforts fall into two categories, according to the type of water source involved:

1) Snail control in natural streams, water conservation resources (known locally as "small dams") - spraying is carried out by a 6-man crew with one vehicle. The chemical Bayluscide (niclosamide) is applied 5 times during the October-to-March transmission season, at 7 week intervals. At the dams, the chemical is sprayed in a 3-meter band along snail infested areas of shoreline. The back-pack sprayer used contains 30 liters of water and 100-200 grams of Bayluscide. Each tankful is emptied along about 100 meters of

the shoreline; the resultant concentration at shore is approximately 1 mg. per 1 meter immediately after spraying. This same technique is used for small streams. At the streams, an effort is made to concentrate the chemicals near points of frequent human contact.

The results of this program for small dams and streams have been mixed. The data shows that the streams have been cleared or almost cleared of snails in 2-3 years, but that little decrease has been registered in the small dams.

2) Snail control in existing irrigation schemes Snail control efforts near Big Bend and Ngonini began in 1970, using Frescon (N-trityl-morpholine). System-wide transmission control was attempted; all snail habitats were treated every seven weeks during the transmission season.

Present snail control efforts in Swaziland are summarized in the following two charts. The projects mentioned are mainly joint efforts of the irrigation estates and the Ministry of Health. However, some of the projects (S.I.S. Tshaneni, Mhlume, Vuvulane, and Tambankulu) are completely under irrigation group control.

The following irrigation systems have had snail control programs appearing since 1970:

Irrigation system	Crops	Area in Hectore	Population at risk 1976
Ngonini	Citrus	600	1,000
Tambuti	Citrus	Information not available	
Ubambo 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

AREA
AREAS WHERE SNAIL CONTROL IS EXPECTED TO START IN 1976

Irrigation System	Crops	Area in Hectore	Population at risk 1976
S.I.S. Tshaneni	Sugar & rice	7,650	3,300
Mhlume	Sugar	12,000	6,200
Vuvulane	Sugar, cotton maize, veg.	4,950	3,000
Tambankulu	Sugar, citrus	1,600	4,800
Mame		800	750
River Bank Sugar Estate	Sugar	600	400
Marshall Campbell	Sugar	500	400
Matlock Estate	Sugar	200	200

From "Report of a Joint Consultation in Bilharzia Control in Swaziland;" AID, WHO, 1976.

1.7.3 Eradication by Biological Means

No country-specific information found.

1.7.4 Other Control Measures

No country-specific information found.

1.7.5 Problems Encountered

Jobin and Jones (1976) concluded that high cost and ineffectiveness were the major problems facing the "small dam" snail control program discussed in section 1.7.2.

The annual cost of 5 treatment to a dam with 1000 M^3 of snail habitat was about $127. This was equivalent to $0.63 per year per person protected, a fairly high cost for a program of only limited effectiveness. In comparison, snail control in the small streams was only half as expensive, requiring smaller amounts of chemicals and fewer continuing expenses.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

No country-specific information found

1.10 Clinical Studies and Observations

No country-specific information found.

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SW 3.0 MALARIA IN SWAZILAND

3.2 Epidemiology

3.2.1 Geographical Distribution

WHO (1975): In Swaziland, 52.7% of the population lives in malarious areas while 63.1% of that population lives in malarious areas in which no anti-malarial efforts are operant. More specific data about geographical distribution was not given.

3.2.2 Prevalence

HEW, Syncrisis: Malaria was endemic until 1945, when an eradication program began. Known cases diminished from 6,850 in 1946 to 73 indigenous cases in 1971. These cases were discovered by testing one-fourth of the population; therefore some 300 total cases were suspected at the time.

WHO (1975): The parasite rate was 0-2% in 1974 in Swaziland.

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

No country-specific data found.

3.2.5 Population Most Affected

No country-specific data found.

3.3 Vector Bionomics

No country-specific data found.

3.4 Diagnostic Procedures or Techniques

No country-specific data found.

3.5 Therapeutic Trials

No country-specific data found.

3.6 Control Measures Against Human Infection

No country-specific data found.

3.7 Vector or Intermediate Host Control

No country-specific data found.

3.8 Disease Impact

No country-specific data found.

3.9 Laboratory Studies

2.9.1 Laboratory Studies on the Vector

No country-specific data found.

2.9.2 Laboratory Studies on the Parasite

WHO (1975): The relative prevalence of *P. falciparum* was 99% in 1974.

3.10 Clinical Studies and Observations

No country-specific data found.

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SZ 4.0 TRYPANOSOMIASIS IN SWAZILAND

4.2 Epidemiology

4.2.1 Geographical Distribution

No country-specific data found.

4.2.2 Prevalence

WHO (1969): Swaziland has been free of trypanosomiasis since 1947.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

No country-specific data found.

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

No country-specific data found.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specific data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

No country-specific data found.

4.10 Clinical Studies and Observations

No country-specific data found.

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UV 1.0 SCHISTOSOMIASIS IN UPPER VOLTA

1.2. Epidemiology

1.2.1 Geographical Distribution

Ansari (1973): Urinary schistosomiasis is widespread throughout Upper Volta. The eastern part of the country appears to be less affected by S. haematobium infection than elsewhere in Upper Volta, but this impression may just be the result of insufficient surveying of the eastern area.

Little information is available concerning the distribution or extent of S. mansoni infection. Stool examinations have not been commonly made. Scattered transmission sites may occur throughout the Black Volta and Comoe watersheds, in the southwest. Additional foci may exist in the lower reaches of the White Volta.

1.2.2 Prevalence

Ansari (1973): Gaud (1955) reported a wide range of prevalence values, from 6% at Bobo-Dioulasso (Koumi) to 88% at Ouagadougou. Alause (1969) surveyed four villages and indicated the following prevalence figures:

Village	Area	No. exams	% infected with S. haematobium
Karankasso	Bobo-Dioulasso Cercle	672	41%
Silaleba	Kongoussi Area	277	18%
Kourpele	Kongoussi Area	295	40%
Bam	Kongoussi Area	470	37%

Marill (1957): Out of 1308 individuals examined in 19 communities in the vicinity of Hounde, Marill found 409 (31.2%) infected with S. haematobium.

Martin-Samos (1976) estimated that 30% of Upper Volta's population have the disease in an active form; 20% more were estimated to have suffered the disease in the past, with resultant residual organ or tissue damage.

Deschiens (1952) estimated that 8% of the population of Upper Volta was infected.

1.2.3. Intensity

No country-specific information found.

1.2.4 Incidence

Martin-Samos (1976): For both S. haematobium and S. mansoni, country-wide incidence rates are poorly known at best. The current information approaching incidence data comes from the annual "cases declared" register. Obviously, this register, based on hospital and dispensary records, greatly underestimates the occurence of schistosomiasis. As Martin-Samos noted, hematuria is so common in Upper Volta that this alone will often not suffice to motivate a person to be examined. Gross under-reporting must be assumed. It is also not clear from the register how many of

the cases declared represent new infections. With these cautions, the following data are presented:

Cases Declared by Year

Year	Total Cases	Vescal Schistosomiasis	Intestinal Schistosomiasis
1970	8,341	-	-
1971	2,767	-	-
1972	19,247	-	-
1973	18,444	17,984	460
1974	20,105	19,635	470
1975	25,167	16,297	2,870

1.2.5. Population Most Affected

Martin-Samos (1976): Age and sex-specific information concerning *S. haematobium* infection was included in a 1952-1954 survey covering 34 villages. These rates were found:

Group	No. exams	No. positive cases	%
Children	1900	833	44
Men	925	213	23
Women	925	241	26
Total	3750	1,287	34

Ansari (1973): McMullen and Francotte (1962), in their summary of prevalence studies, recorded the following composite figures: Of the 18,918 children

examined, 5,500 (29.1%) were infected. The comparable rate for adults was 6,100/21,635 (28.1%). Adult men and women were equally affected. More boys (57%) than girls (27%) were found to be infected.

1.3. Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Martin-Samos (1976): Bulinus (Physopis) spp. is widely distributed in Upper Volta and is the chief snail host of S. haematobium. B. (B.) forskalii has also been recorded, but it is not clear whether this species serves as a vector in Upper Volta. Biomphalaria spp. is the host for S. mansoni.

1.3.2 Vector Distribution

Martin-Samos (1976): S. haematobium host snails are widely distributed throughout Upper Volta, with fewer foci in the north. Biomphalaria spp., the vector for S. mansoni, is less widely distributed, occurring mainly in the southern part of the country.

1.3.3. Environmental Factors Influencing Distribution

Martin-Samos (1976) reported that no Bulinid snails are generally found in Upper Volta before August. Transmission is thought to occur between August and November. However, as an exception,

Bulinus adults were found in several habitats and in great numbers year-round at the Po dam.

S. mansoni host snails are probably less abundant between the end of the dry season and the beginning of the rainy season.

1.4. Diagnostic Procedures

1.4.1 General Diagnostic Methods

No country-specific information found.

1.4.2 New Diagnostic Techniques

Le Viguelloux (1971) showed, using the immunofluorescent test for vesical schistosomiasis, showed that egg elimination in the urine does not correlate with antibody titers. This result suggests that an elevated antibody titer cannot be used clinically to determine the extent of schistosomiasis infection.

Marill (1960) tested 463 subjects, comparing the antigen skin reaction and urine tests. He observed that 45% of the sick gave false negatives or uncertain results. Of the well, 29.3% gave false positives.

1.5 Therapeutic Trials

No country-specific information found.

1.6 Control Measures Against Human Infection

No country-specific information found.

1.7 Vector or Intermediate Host Control

No country-specific information found.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

No country-specific information found.

1.10 Clinical Studies and Observations

No country-specific information found.

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UV 2.0 ONCHOCERCIASIS IN UPPER VOLTA

2.2 Epidemiology

2.2.1 Geographical Distribution

The major onchocerciasis zones identified in Upper Volta are the valleys of the White and REd Volta rivers south and east of Ouagadougou and the Bougouriba valley in the Diebougou area. Hyperendemic areas are also found in Lawra, Manga, Zabre, Po, Ticbece-Korabie, Navrongo and Tumu areas (WHO: OCP/73.1 Annex IV-3). The Black Volta, the Boromo, the Sissili, the Pama and the Comoe-leraba are areas included in the WHO onchocerciasis Control Program. (WHO:OCP/73.1).

2.2.2 Prevalence

A survey conducted by WHO (WHO:OCP/73.1) in 932 communities showed that onchocerciasis is prevalent in Ouagadougou, Sapone, Kombissin, Zorgho, Ziniare, Bousse, Fada N'Gourma, Bogande, Diapaga, Koupela, Tenkodogo, Gaoua, Die'bouogou, Oahigouya, Sequenega, Djibo, Koudougou, Tenhado, Reo, Leo Fara, Boromo, Dedougou, Nouna, Tougan & Toma; Bobo-Dioulasso, Orodara, Hounde, Banfora, Kaya & Barsalogho; Boulsa, Kongoussi, Pissila, Yako, Gourey, Zabre, Manga, Po, Tiebele, Tiankouro, Gueguere and Zambo "Cercles". (WHO: OCP/73.1, Annex IV-3). The highest prevalent rates were found in Banfora, Kaya, Zabre, Manga, Tiebele and Poko. (WHO:OCP/73.1, Annex IV-2). The estimated population in the units surveyed was 4,450,380. The total number of persons examined was 2,336,606 (52.5%). The es-

timated number of persons with onchocerciasis was 587,450 (13.2%). (WHO: OCP/73.1).

Blindness was found to be high in Banfora, Kaya, Zabre, Manga, Tiebele, Po, Tiankoura, Zambo and Gueguere. (See WHO:OCP/73.1, Annex IV-2 p.p. 31-48). Prevalence of blindness and impaired vision and percent with microfilariae in skin snips, by age and sex, in the village of Loumana were 16.8 and 12.5 in males, and 11.4 and 8.2% in females, respectively. (These were age-adjusted totals). The age ranged from 0 to 50+ years. (WHO: OCP/73.1, Table 4). Prevalence rates by age for the"First" and "Secondline" communities were 7% in the 0-4 year olds, 33% in the 5-9, 88 in the 10-14, 91% in the 15-29 and 92% in the 30+ age groups. In the "Secondline" the percentages were 1.5% 18%, 32%, 85% & 87% in the 0-4, 5-9, 10-14, 15-29 and 30+ age groups. (WHO: OCP/73.1, Annex IV-1; Table IV-1.5).

The estimated relative risk of having blindness and impaired vision if onchocerciasis is present in the same village (Loumana) was 10.56 (WHO: OCP/73.1 Annex IV- 1 table IV-1.6). The severity of ocular lesions in patients with onchocerciasis (in the three severity classes) for the "First", "Second" and Thirdline villages was shown to be highest in the "Firstline", 54% in the "Second" and 40% in the Thirdline villages). (WHO: OCP/73.1, Annex IV-1 Table IV-1.8).

A study conducted in the village of Saint Pierre by Rolland (1972) showed that the prevalence rate was 90% and was virtually the same in all age groups from 5 years upward.

Ocular complications were extremely high, 29% of subjects had microfilarial in the anterior chamber of the eye and 38% had punctate keratitis. The findings were the same as those found in Niarba and Tigre villages. In another study in the Bisa area, Rolland (WHO/ONCHO/74.112) found that the 113 subjects followed for six years (1968-1974) developed severe eye lesions in the posterior chamber due to heavy infection with O. volvulus microfilariae.

Prevalence studies conducted during the month of April (WHO: OCP/PR/75.2) showed high rates at Mouvielo, Sinkiero and Kimpeo in Diebougou District. (Prevalence rates were 85.2%, 78.5% adn 69.2% respectively). During the month of May, the Prevalence rates were 70.7% at Tenasso (Orodara District), 67.7% at Pindie, Bobo-Dioulasso District, 63% at Nabissirabogo, 57.0% at Pissongue, 52.8% at Kourioguin, 45.9% at Zamse & 33.4% at Tanziega, all in Fada N'Gourma District. Tenasso peul had a prevalence rate of 13%. The figures for June were highest at Poya (71.4%), Dan (68.2%), and Diosso (60.8%) in Bobo-Dioulasso. Gandemtenga, Tampanga, and Youkin (all in Fada N'Gourma District) had prevalence rates of 21.3%, 19.1% and 10.3% respectively. Blindness was highest in Diebougou, Fada N'Gourma and Bobo-Dioulasso Districts, the village of Mouvielo being the most affected with 14.3% blindness. (See WHO: OCP/PR/75.2, Progress Report, April - June 1975, table 2).

2.2.3 Intensity

The microfilariae density per skin snip was highest in Diebougou District where the villages of Mouvielo, Sinkiero and Kimpeo had a density of 48.8, 32.9 and 16.6 in that order. High intensities were also found in Fada N'Gourma, Bobo-Dioulasso and Orodara Districts. (WHO: OCP/PR/75.2, Table 2).

2.2.4 Incidence

Lamontellerie (1972) found high incidence rates in the cantons of Louman, Sindou, Beregadougou, Banfora, Nafona, Tingrela, Sienana, Soubakanie-dougou, Diefoula, Karaborola & Bas-Komono. Variations in incidence rates were also observed.

2.2.4 Population Most Affected

The adult male population is the most affected population group. In heavily infected areas and where the women are frequently exposed to the biting of S. damnosum the differences are small. (WHO: OCP/73.1). Lamontellerie (1972) found that onchocerciasis was prevalent among children in hyperendemic villages. Sex specific studies in the same villages showed high prevalences among the adult male group.

2.3 Vector or Intermediate Host Bionomics.

2.3.1 Species Transmitting Onchocerciasis

Onchocerciasis is transmitted by species of S. damnosum

complex (WHO: OCP/73.1). Eight species have been identified (Vajime, WHO: OCP/SAP/76.1):

S. squamosum ("Bille" form)

S. yahense ("Yah" form)

S. soubrense ("Soubre" form)

S. damnosum ("Nile" form)

S. sanctipauli ("Bandama" form)

S. sirbanum ("Sirba" form)

S. sudanense ("Sirba" form)

S. dieguenense ("Dieguera" form)

Dunbar & Vajime (WHO: OCP/71.87; WHO/VBC/71.320) suggested that 17 cytotaxonomical categories may be recognized. S. squamosum, S. sirbanum and S. damnosum are strongly believed to be very good vectors of onchocerciasis. (WHO/SAP/76.1). Two general types are recognized, namely the forest type and the savannah type. (WHO/SAP/76.1; WHO/VBC/71320.)

2.3.2 Vector Distribution

Species of Simulium damnosum complex, the vector for onchocerciasis, are found both in the savanna and forest zones. (WHO: OCP/SAP/76.1). The vector is found in the water courses of the Black Volta, Red Volta, White Volta, Oti-Pendjari, Comoe-Leraba and their tributaries and tributaries of the Niger in Upper Volta. (WHO: OCP/73.1 Annex IV-3). The "Nile" form has been found in the Volta River, Samandeni and Transilla-Nouna and the Sirba form in De'dougou

Nouna and Bobo-Dioulasso areas. (Dunbar & Vajime, WHO; 171).

2.3.3 Environmental Factors Influencing Distribution

The distribution of S. damnosum complex species is influenced by such factors as vegetation, hydrology, climate, rainfall, relief and physico-chemical properties of the water courses where breeding takes place. (WHO: OCP/73.1). Biting activity is slowed down or stopped at temperatures below 17°C and above 30°C. (WHO: OCP.73.1).

Synchronic, inverse and bimodal variations have been observed in the Volta River Basin of which Upper Volta is a part. The three variations observed represent distinct characteristic breeding places for the S. damnosum species, e.g. the forest and savanna zones. The population of S. damnosum fluctuates in the synchronic variation according to the water levels. Breeding takes place in large rivers. (WHO: OCP/73.1, Annex III-1).

In the savanna zone, inverse variation is observed. S. damnosum in this zone breeds only at low water levels. (WHO:OCP/73.1, Annex III-1). The pre-imaginal breeding place inthe bimodal variation exist during the dry seasons at low water on rocky shelves of low water channels and high water levels on submerged vegetation of mean level bed. (WHO: OCP/76.1, Annex III-1).

2.4 Diagnostic Procedure or Techniques

2.4.1 General Diagnostic Methods

Two main diagnostic criteria are used in the recognition of onchocerciasis in mass examinations:

(1) detection of typical onchocercal modules by inspection and palpation and,

(2) demonstration of microfilariae of O. volvulus in routinely taken skin snips. (WHO: OCP/73.1).

Other methods are used in clinical diagnosis of onchocerciasis: quantitative and qualitative analysis of microfilariae in skin snips, (WHO: Onchocerciasis, symptomatology, pathology, diagnosis, 1974)., differential diagnosis for differentiating O. volvulus from other microfilariae e.g. W. banerofti; the Mazzotti test (WHO: OCP/73.1); examination of microfilariae of O. volvulus in the urine, (WHO: OCP/73.1) and demonstration of O. volvulus microfilariae in the eye. (WHO: OCP/73.1).

2.4.2 New Diagnostic Techniques

New diagnostic techniques include:

(1) The complement fixation test (Lautigue, WHO/ONCHO/66.50) used when a decision has to be made concerning the suitability of a given type of treatment.

(2) Intradermal tests used by Fulsang and Anderson (Fulsang & Anderson, WHO/ONCHO/77.132) as a possible diagnostic technique. This test is valuable for diagnosing onchocerciasis in patients in whom microfilarial densities are low but its practical value needs further study.

(3) The enzyme linked Immunoabsorbant Assay (ELISA) being studied at the Minerva Institute of Medical Research, Helsinki (OCP/STAC/76.2).

(4) The membrane filtration technique developed for the quantification of W. bancrofti has been adapted for use in the diagnosis of onchocerciasis. (WHO: ONCHO/76.119).

2.5. Therapeutic Trials

2.5.1 Studies on New Drugs

Arsenical, antimonial and other compounds have been tried. (SASA, 1976). Metrofonate has been found to have a partial microfilaricidal action but no effect on the adult worm. (WHO/ONCHO/72.91 Rev. I). Limited initial studies have been conducted on: Niridazole, Levamisole and Dihydroemetine. (WHO: ONCHO/72.91 Rev I Annex II-1). Nividazole was found to be infective by some and of undesirable toxicity by others. Levamisole showed no action against O. volvulus at doses used in the treatment of ascariasis. Extended doses were suggested. Dihydroemetine had no action on O. volvulus.

Potential macro- and microfilaricides include metrifonate, levamisole and Nitrofuranatoin while suramin, tetracycline and levamisole are being studied for use in chemoprophylaxis. (WHO/ONCHO/72.91. Rev. 1, Annex II-1). Mel W has also shown to have some action against O. volvulus.

2.5.2 Mass Treatment

Mass treatment campaigns with the two established drugs suranin & DEC, have been discouraged due to the uncertainty and undesirable toxicity of these drugs. Equally important is the severe side effects caused by these drugs. (WHO: OCP/73.1; WHO/ONCHO/72.91, Rev. 1, Annex II-1).

2.5.3 Problems Encountered

The development of new drugs or new combination of the known ones has been limited by the lack of suitable laboratory animal models, lack of trained and qualified medical technicians, pharmacologists and clinicians in the country, lack of facilities for pharmacological studies and the incomplete knowledge on the parasite-host relationship. (WHO: OCP/73.1).

Mass treatment with drugs known to have macro- and microfilaricidal actions against O. volvulus parasites, has not been feasible because of the undesirable toxic levels and severe side effects of these on onchocerciasis patients. (WHO: OCP/73.1 Annex II-1). The use of melarsonyl potassium has been discontinue due to a high risk of death from arsenical encephalopathy. (WHO: ONCHO/72.91 Rev. 1; Annexes I & II). The re-infectionn after treatment and the long life span of the adult O. volvulus parasite (15 to 20 years) are serious problems. (WHO: OCP/73.1)

However, the development of new drugs for tropical diseases in recent years has become difficult due to:

(a) the distance between the pharmaceutical laboratories and the areas where the drugs are used. This factor makes it difficult to organize preparatory clinical research on the safety and efficiency of the drugs and their final evaluation in established medical institutions and in the field. (WHO: OCP/73.1 Annex V-5).

(b) the scarcity of suitable facilities for clinical evaluation of the newly developed drugs and for training local physicians in that field. (WHO: OCP/73.1 Annex V-5).

(c) the general dearth of experienced pharmacologists, and clinicians capable of carrying out evaluations according to modern standards. (WHO: OCP/73.1 Annex V-5).

2.6 Control Measures Against Human Infection

2.6.1 Chemoprophylactic Measures

Use of drugs such as melarsonyl, DEC, etc. for chemoprophylactic purposes has been discouraged due to the adverse reactions associated with these drugs. (WHO/ONCHO/73.1 Annex II-1). Insect repellents have been used as alternatives.

2.6.2 Other Protective Measures

Wearing protective clothes such as long trousers, etc., avoiding or minimizing contact with the vector so as to reduce the number of bites and the delibrate migration from onchocerciasis areas to non-onchocerciasis regions are among the other means used to protect the population at risk against onchocerciasis. (WHO: OCP/73.1)

Such measures, however, have not proven to be effective because of the constant population movement from one endemic area to another and because of the nature of activities in which the target population is involved, particularly, the adult male group.

2.6.3 Problems Encountered

The main problems encountered in protecting the population in endemic areas from getting the disease are: the complex parasite-host relationship, e.g. the nature of

of activities in which the population is involved makes it impossible to avoid contact with infected female S. damnosum, the lack of an effective drug for chemoprophylaxis, the inadequate knowledge about the effective transmission of O. volvulus larvae, and the constant migration of both the population at risk and the vector. (WHO: OCP/73.1; OCP/73.1, Annex VI-2.A).

2.7 Vector or Intermediate Host Control

2.7.1 Eradication by Mechanical Means

The eradication of S. damnosum in their identified breeding places has been carried out by destroying such known breeding sites, by modifying the ecological area so as to discourage the vector from breeding or decolonizing the area, by modifying the watercourses where breeding takes place, e.g. building upstream dams in order to slow the water current and by trapping the S. damnosum flies. (WHO: DCP/73.1; WHO:OCP/73.1, Annex III-3).

2.7.2 Eradication by Chemical Means

Insecticides and larvicides are being used in the eradication of S. damnosum. Different formulations of DDT are being used. (WHO: OCP/73.1 Annex III-3) Larvicides such as OMS-466 (methoxychlor), OMS-786 (Abate), OMS-1155 (methyl-Dursban= methylchloropyrifos), OMS-1170 (phoxim) and OMS-1197 (chlorphoxim) have been tried. (WHO: OCP/73.1, Annex III-3). Spraying by the use of helicopters and other aircrafts is also being carried out.

(WHO: OCP/PR/75.1).

2.7.3 Eradication by Biological Methods

The biological control of the vector, using known predators, parasites and pathogens of S. damnosum is being studied. It is not yet of any practical significance as a control measure. (WHO: OCP/73.1).

2.7.4 Other Control Measures

Fly catches (trapping) has been suggested and even used as another means of reducing the population size of the field in area. (WHO: OCP/PR/75.1; OCP/PR/75.2).

2.7.5 Problems Encountered

Eradication of the vector by mechanical means, e.g. ecological transformation of the known habitats of the fly, destruction of breeding sites, etc. has been hampered by the lack of personnel to carry out the program and financial constraints. The seasonal variations, the long flight range of the vector and the incomplete knowledge about the resting and migratory characteristics further complicate the problem. (WHO: OCP/73.1 Annex III-3) (WHO: OCP/73.1). Constructing dams upstream in order to slow the river flow has proved to be an ineffective method because of dam spillways which provide new ideal breeding sites for S. damnosum (WHO: OCP/73.1; OCP/73.1 Annex III-3).

The use of insecticides such as DDT, and larvicides, e.g. Abate, methoxychlor etc. has been minimized because of

the cumulative and toxic effects of these compounds on the non-target fauna.(WHO: OCP/73.1; OCP/73.1 Annex III-3).

Water regulation projects, e.g. at Loumana have resulted in the creation of breeding places. (WHO: OCP/73.1 Annex 2.8 V-5).

2.8 Disease Impact

2.8.1 Impact on Population

Areas heavily infected with S. damnosum have been deserted, especially "Firstline" and "Secondline" villages where transmission and infection rates are high, e.g. an estimated area of 27,000 sq. km. has been abandoned. (WHO: OCP.73.1, Annex VI-5). The young population in the productive age has moved from endemic villages to towns or to areas free of onchocerciasis. This continued migration has led to over population in onchocerciasis free areas and depopulation in the endemic areas.(WHO: OCP/73.1; OCP/73.1, Annex VI-5). The banks of the Black Volta once densely populated are now among the abandoned areas as a result of heavy onchocerciasis transmission. (WHO: OCP/73.1, Annex VI-2.A). The unequal population distribution has led to high population densities in such cantons as Dissin and Dano in the North-eastern sector where density averages 41.8 persons per sq. km. reaching 93.4 per sq. km. in Dissin area. There is increased immigration of the Mossis from the densely populated Yatenga Plateau in the northern part of the country. Emigration to Ghana and Ivory Coast is also on the

increase. (WHO: OCP/73.1, Annex VI-2.A).

2.8.2 Impact on Economy

An economic analysis conducted by WHO (WHO: OCP.73.1, Annex VI-5) showed that onchocerciasis decreases the working capacity of these affected, burdens the community with the care of large numbers of blind people, leads to the desertion of good agricultural land and requires expensive public health action. (See OCP/73.1 Annex VI-5, table VI-5.7).

Decrease in productive capacity has been observed in onchocerciasis areas, as the disease attacks the population in the productive age, e.g. more than 95% of the blind are over 15 years of age and men are affected more than women. In Bisa area the ratio is 63 men and 37 women in every 100 blind persons. (WHO: OCP/73.1 Annex VI-5). The total cost for maintaining the 40,000 blind persons in the country is about U.S $640,000 per year. (the average annual income per head in the hyperendemic zone is U.S. $16). The total number of farms in the regional Development Office (RDO) of Ouagadougou is 104,000 which represents 468,000 active persons. The total area farmed is 75,000 hectares less than average and the average value of production per hectare is U.S.$15.8, making an annual loss because of under-employment of U.S $1,188,000. (WHO: OCP/73.1 Annex VI-5). In the Koudougou RDO, the loss due to underemployment is about U.S. $900,000 per year. (WHO: OCP/73.1 Annex VI-5).

Studies and reports concerning the Mossi plateau indicate a decline in yields. (WHO: OCP/73.1 Annex VI-5).

According to an estimate by the Ministry of Agriculture, the financial loss due to fall in yield is equivalent to U.S. $800,000 yearly in the Koudougou and Ouagadougou ORDs. This economic decline is caused by over population which has led to over exploitation of the available arable land. (WHO: OCP/73.1 Annex VI-5).

The cost of onchocerciasis in the national budget is another significant factor, e.g. expenditure on drugs and minor equipment for onchocerciasis treatment was about U.S. $12,000 in 1971. This kind of expenditure represents 20% of the total health bill and on this basis, the total expenditure on onchocerciasis treatment in 1971 would be US $60,000. The cost of onchocerciasis control represents about 0.02% of the national revenue. The total cost including that provided by the European Development Fund (FED) of the European Economic Community, and by OCCGE is much higher than the estimations given above. (WHO: OCP/73.1, Annex VI-5).

2.8.3 Ameliorative Programs

WHO, the European Development Fund (FED), the OCCGE and the National government have launched an extensive onchocerciasis control program whose aim is re-claim the fertile valleys that have been deserted due to heavy onchocerciasis infection. (WHO: OCP/73.1 Annexes VI-2.A and VI-5).

The eradication of S. damnosum will make agriculture and farming programs possible and this in turn will increase economic production. Under employment will also be in-

creased because of the creation of new jobs in developmental projects. (WHO: OCP/73.1 Annex VI-5). The eradication of the vector will mean a disappearance of blindness caused by O. volvulus and therefore an increase in the working group and a reduction of the national expenditure on the treatment and maintenance of onchocerciasis patients and blind individuals. (WHO: OCP/73.1, Annexes VI-5, and VI-2.A).

The agricultural development program includes:

(a) Enlargement and intensification of the existing extension services, to be handled in conjunction with UNDP/FAO project UPV-7 at the Centre Agricole Polyvalent and Matourkou to the west of the project zone. (WHO: OCP/73.1, Annex VI-2.A).

(b) Farm development which is to include the integration of animal husbandry with crop production through the development of animal traction with special attention to selection and training of draught animals, and meat production. (WHO: OCP/73.1 Annex VI-2.A).

(c) Improvement in land tenure system, e.g. encouraging development of more stable land tenure systems and introduction of the statutory rights concept to those who till the land. (WHO: OCP/73.1 Annex VI-2.A).

(d) A creation of an elementary agricultural infrastructure, especially water resources, e.g. construction of water wells for drinking and for small scale irrigation projects. (WHO: OCP/73.1 Annex VI-2.A).

(e) Development of other infrastructure facilities such as storage facilities (silo for grain and other produce), distribution centers for farm inputs, repair shops for farm implements, animal traction equipment, etc.; and multi-functional meeting rooms for extension work training courses. (WHO: OCP/73.1 Annex VI-2.A).

(f) Provision of adequate health services with mobile teams for disease control and treatment of onchocerciasis patients. (WHO: OCP/73.1 Annex VI-2.A).

(g) Provision of rural education facilities (schools), with adequate programs to keep the younger people in farming and to prepare capable participants in the economic development of the local areas; creation of training facilities for the local women, for example, courses in home economics, hygiene, child care, nutrition, handcraft, etc. (WHO: OCP/73.1 Annex VI-2.A).

2.8.4 Problems Encountered

The general problems encountered in the development and implementation of the meliorative programs include lack of trained manpower, e.g. only about 10% of the population attend school; there is one physician per 7,900 people in urban areas but only 1 per 188,000 in the rural areas, (WHO: OCP/73.1 Annex VI-5); poor road network, e.g. only 30% of the routes are passable in the rainy season, and lack of commercial infrastructure. (WHOP OCP/73.1 Annexes VI-4 and VI-5). The financial resources are the major constraint as a whole.

2.9 Laboratory Studies

2.9.1 Laboratory Studies on the Vector

Thompson et. al. (WHO/ONCHO/72.98) observed positive phototaxis in newly emerged flies of both sexes. Dunbar and Vajime (WHO:ONCHO/71.87; WHO/VBC/71.320) recognized 17 cytologic categories in two subgroups and believed that most of them, if not all, represent distinct species.

According to Vajime, eight species are now known.

(WHO:SAP/76.1). Female S. damnosum bite mostly in the early morning and before dusk, but in dull weather, feeding continues throughout the day. (Blacklock 1926a, 1927; Van den Berghe 1941; cited by Fallus, 1964) noted that the flies bit man more in the open than in the woods and dense vegetation seemed to restrict the movement of the vector.

Resistance and tolerance of S. damnosum to insecticides, e.g. DDT has been reported. (WHO: OCP/73.1 Annexes III-2 & III-4).

Biting activity is slowed down or stopped at temperatures below 18°C and above 30°C. (WHO: OCP/73.1). Larvae of S. damnosum can develop only in fastflowing rivers. (The current speed is 50 to 200 cm/sec.). Female S. damnosum lay their eggs in batches of about 250 at water levels or up to 50 mm below the surface on partially submerged supports and the eggs hatch in 36-48 hours. (WHO: OCP/73.1). Males feed exclusively on plant juices and play no role in the transmission of onchocerciasis. Females mate once in their life and new-born females also feed on plant juices before taking the blood meal. (WHO: OCP/73.1). No self-perpetuating laboratory colonies have been established so far. (WHO: OCP/STAC/75.2). Mating has not been observed in laboratory conditions. (Waddy, 1969).

2.9.2 Laboratory Studies on the Parasite

Onchocerca volvulus is not a uniform species. Two strains, the forest and the savanna, are believed to exist. (WHO: OCP/73.1). At least seven species of

onchocerca have been reported from animals in Africa and morphological criteria are to be developed in order to distinguish O. volvulus from other filarial genera. (WHO: OCP/STAC/75.2). The savanna strain of O. volvulus can develop in the savanna type of S. damnosum species while the forest strain does well only in the forest form of S. damnosum complex. (SASA 1976, citing Duke (1966). The Sudan savanna strain causes more severe eye lesions as compared to the forest strain found in the forest and Guinea savanna zones. Blindness is more prevalent in the Sudan savanna zone than in the forest and Guinea savanna areas. (Kershaw et. al. 1954; Rodger, 1959; Budden, 1963a; Quere et al., 1963; and Monjusiau, et. al., 1965, all cited by Sasa, 1976). Histopathological studies (Omar et. al, WHO/ONCHO/76.130) on the savanna strain of O. volvulus have shown that O. volvulus is not a uniform species.

2.10 Clinical Studies and Observations

Most of the severe lesions are due to reactions to the presence of the microfilariae. (WHO: OCP/73.1).

In the early stages of onchocerciasis no detectable reactions are produced by the adult worm and no visible or palpable nodules. (WHO:OCP/73.1). Most of the nodules in onchocerciasis patients are found around the hips, on the sides of the chest wall and around the knees. Head nodules are uncommon except in children. (WHO:OCP/73.1; Sasa, 1976.)

The frequency and severity of the clinical manifestations of onchocerciasis are associated with the intensity

of the infection and the most important types of clinical manifestations are: unsightly and intensely pruritic skin rashes, atrophy and plepigmentation, hanging groins and hernia, anterior and posterior eye lesions, chronic sclerosing keratitis, inflamatory reactions of the iris, ciliary body, retina and choroid, etc. (WHO: OCP/73.1; WHO: Onchocerciasis, Symptomatology, pathogensis, diagnosis, 1974).

From a public health standpoint, ocular lesions are the most important. These occur more frequently and are more severe in the savanna area than in the forest zone. (WHO: OCP/73.1; Sasa, 1976).

Weight loss has been observed in severe onchocerciasis patients and microfilariae have been found in blood vessels and in deep organs. Invasion of the eye by microfilariae in childhood has been observed in hyperendemic areas of the savanna region. (WHO: Onchocerciasis, Symptomatology, pathogenesis, diagnosis, 1974; Sasa, 1976). Prehydermia, lymphadenopathy, and haematological conditions such as intradermal reactions, serological reactions are also observed in onchocerciasis infections. (WHO/ONCHO/66.48). Lartigue (WHO:ONCHO/66.49) observed that microfilariae of O. volvulus are subject to periodicity, e.g. various quantities were obtained at different times of the day.

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UV 3.0 MALARIA IN UPPER VOLTA

3.2 Epidemiology

3.2.1 Geographical Distribution

Jeffery and Gibson, (1966): Malaria was identified in Ouagadougou.

Coz et al., (1970): Malaria was identified in the savanna regions of southwest Upper Volta, specifically in Koumbia.

WHO, (1975): In 1974, the entire population of Upper Volta lived in malarious areas where no specific antimalarial efforts were operant. More specific data about geographical distribution of the disease were not given by this source.

3.2.2 Prevalence

Jeffery and Gibson, (1966): Of 137 children, ages 1 - 17 years, in Ouagadougou in 1966, 78 or 56.9% had positive blood films.

Coz et al., (1970): Malaria was haloendemic (spleen rate greater than 75% in children 2 - 9 years old while low in adults) in the savanna regions, specifically in Koumbia in 1970.

WHO, (1975): In areas without antimalarial efforts in 1974, the spleen rate was 65 - 75% and the parasite rate was 50 - 80%. In areas with control measures, the parasite rate was 10 - 35%. The overall malaria mortality for 1974 was 50.804 per 100,000.

3.2.3 Intensity

No country-specific data found.

3.2.4 Incidence

No country-specific data found.

3.2.5 Population Most Affected

No country-specific data found.

3.3 Vector or Intermediate Host Bionomics

No country-specific data found.

3.4 Diagnostic Procedures or Techniques

3.4.1 General Diagnostic Methods

Jeffery and Gibson, (1966): Malaria was diagnosed by examination of thick and thin blood films obtained daily by finger puncture and stained by a standard Giemsa method. The parasite count was estimated by recording the number of asexual parasites seen per 1,000 leukocytes. These values were converted to parasites per cubic millimeter of blood by a factor of 8 based upon 8,000 leukocytes per cubic millimeter as the average count of leukocytes.

3.4.2 New Diagnostic Techniques

No country-specific data found.

3.5 Therapeutic Trials

3.5.1 Studies on New Drugs

Pirame et al., (1968): The effectiveness of a combination of sulphormethoxine and pyrimethamine against *P. falciparum* in 6 children, ages 6 - 27 months. The dose for children less than a year old was 500 mgs. For those 1 - 3 years old, the dose was 1 gram. It was found that with this drug combination fever and asexual parasitemia cleared by the third day of therapy but gametocytes persisted.

3.5.2 Mass Treatment

Lasch and N'Guyen, (1965): At Ouagadougou Hospital in 1964 it was observed that in five out of six of the patients admitted for malaria, Nivaquine (chloroquine sulfate) produced a satisfactory response for a while. Relapse, the reappearance of parasites in the blood, occurred within three weeks in these five cases. This fulfills the criteria for the development of resistance of *Plasmodia* to chloroquine. This resistance was not taken to be

universal because chloroquine was effective in other cases in the same region. The above cases were finally controlled with quinine and amodiaquine.

Jeffery and Gibson, (1966): Tests were conducted in 1966 on chloroquine diphosphate and chloroquine sulfate (Nivaquine) in an effort to substantiate the report of plasmodial resistance made by Lasch and N'Guyen in 1964. This study did not substantiate this previous report. Sixty-five percent of these patients responded normally, i.e. were cleared of parasitemia by the second day after treatment with a dose of 10 mgs./kgs. of body weight. Virtually all patients were cleared of parasitemia by the third day. This is the accepted clearance rate for sensitive strains. After reviewing the report by Lasch and N'Guyen, Jeffery and Gibson concluded that the former report of non-response may have arisen for the following reasons: initial tests were conducted on clinically ill children of a non-immune age group which would have presented a greater challenge to the drug than a semi-immune ambulatory population would; the technique used by Lasch and N'Guyen may have been questionably reliable; there was an inadequacy of locally available materials for diagnosis.

Richard-Lenoble et al., (1973): A study was conducted in an effort to determine chloroquine resistance of P. falciparum. One hundred patients, ages 2 months to 35 years, were treated with a dose of 25 mg./kg. of body weight of chloroquine given over a three day period. The patients were followed for 28 days. Clinical symptoms abated in 3 - 4 days including the parasitemia but 5 cases of reinfection occurred by the 27th

day. It was concluded that there was no sign of P. falciparum resistance to chloroquine at that time.

3.5.3 Problems Encountered

No country-specific data found.

3.6 Control Measures Against Human Infection

3.6.1 Chemoprophylactic Measures

Lasch and N'Guyen, (1965): The accepted regimen for suppressive therapy with chloroquine is presented below.

Accepted Chemoprophylactic Regimen with Chloroquine

Children less than 1 yr. old	-	25 mgs. every other day
1 - 3 yrs. old	-	33 mgs. per day
4 - 6 yrs. old	-	50 mgs. per day
7 - 12 yrs. old	-	75 mgs. per day

At Ouagadougou Hospital, Lasch and N'Guyen used the following regimen for suppressive therapy with chloroquine:

Children less than 2 yrs. old	-	50 mgs. per day
2 - 5 yrs. old	-	75 mgs. per day
5 + yrs. old	-	100 mgs. per day

3.6.2 Other Protective Measures

No country-specific data found.

3.6.3 Problems Encountered

Lasch and N'Guyen, (1965): Nine hospitalized children, ages 1.5 - 12 years, were given the above regimen (see 3.6.1) of chloroquine chemoprophylaxis by Lasch and N'Guyen at Ouagadougou Hospital. The patients received medication daily for periods ranging from 15 -55 days. Breakthrough attacks of malaria occured while the patients were hospitalized and were confirmed by the presence of asexual parasites on thick blood smears. These breakthrough attacks were treated with therapeutic doses of quinine or amodiaquine with prompt abatement of clinical signs. The authors

cited several possible reasons for this non-suppression. Even though the drug was given in greater than required doses and would have suppressed a re-infection, the breakthrough attacks may have been relapses of existing infections. The lowered host resistance may have been another factor, though this is doubtful because the patients responded well to therapeutic doses of other antimalarial agents. They, therefore, concluded that the drug, chloroquine, failed as a chemoprophylactic agent to suppress malaria.

3.7 Vector or Intermediate Host Control

3.7.1 Eradication by Mechanical Means

No country-specific data found.

3.7.1 Eradication by Chemical Means

Vector resistance reported below (see 3.7.5).

3.7.3 Eradication by Biological Methods

No country-specific data found.

3.7.4 Other Control Measures

No country-specific data found.

3.7.5 Problems Encountered

Hamon et al., (1968, (3)): Resistance of *Anopheles funestus* Giles to Dieldrin was noted in Bobo-Diolasso in 1959. During Nov. - Dec. 1967, investiagation by these authors revealed the occurrence of approximately 11% Dieldrin-resistant females among the wild populations of *A. funestus* Giles. In Bobo-Diolasso, the female *A. gambiae A* were found to be sixteen times less susceptible to DDT than previously. Hamon et al. attribute the selection for resistance in the *Anopheles* species to the use of DDT and Endrin (chemically similar to Dieldrin) for the protection of cotton crops in that area.

WHO, (1975): Vector resistance to DDT and Dieldrin was reported for 1974.

3.9 Laboratory Studies

3.9.1 Laboratory Studies on the Vector

Cox et al., (1970, (2)): It was found that *A. gambiae B* is somewhat more zoophilic than *A. gambiae A*, but that the A strain appears to be a better vector for *P. falciparum* than the B strain.

Cox et al., (1970, (1)): The use of pyrimethamine in the savanna regions of Koumbia does not inhibit sporogony in *A. gambiae* when tests were conducted on children with blood gametocytes.

3.9.2 Laboratory Studies on the Parasite

Lasch and N'Guyen, (1965): According to Young and Eyles (1963), the criteria for establishing resistance of *P. falciparum* to chloroquine is persistence of fever for 72 hours after therapy has begun and the presence of parasites in the blood after six days. Reappearance of parasites in the blood within 3 weeks is also indicative of resistance.

Coz et al., (1970, (1)): Pyrimethamine prophylactic therapy produced resistance of *P. falciparum* to the drug in 1958. The use of pyrimethamine was halted but was re-instituted again in 1967 - 1969. This reactivated *P. falciparum* resistance to pyrimethamine.

WHO, (1975): The relative prevalence of *P. falciparum* in the Upper Volta in 1974 was 85%.

3.10 Clinical Studies and Observations

No country-specific data found.

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UV 4.0 TRYPANOSOMIASIS IN UPPER VOLTA

4.2 Epidemiology

4.2.1 Geographical Distribution

WHO (1969): Flare-ups of trypanosomiasis occurred in 1967 in Tagowara, Orodara, Mane-Korsimoro and Kaya.

4.2.2 Prevalence

WHO (1969): The prevalence for 1967 was 1,174 cases out of a total population of 5,054,000.

4.2.3 Intensity

No country-specific data found.

4.2.4 Incidence

WHO (1969): The incidence for 1965 was 221 new cases; for 1966, 189 new cases and for 1967, 197 new cases.

4.2.5 Population Most Affected

No country-specific data found.

4.3 Vector or Intermediate Host Bionomics

No country-specific data found.

4.4 Diagnostic Procedures or Techniques

No country-specific data found.

4.5 Therapeutic Trials

No country-specific data found.

4.6 Control Measures Against Human Infection

No country-specific data found.

4.7 Vector or Intermediate Host Control

No country-specific data found.

4.8 Disease Impact

No country-specific data found.

4.9 Laboratory Studies

4.9.1 Laboratory Studies on the Vector

No country-specific data found.

4.9.2 Laboratory Studies on the Parasite

WHO (1969): All domestic animals in Upper Volta are susceptible to infections by *T. brucei* and other zoophilic *Trypanosomae*.

4.10 Clinical Studies and Observations

No country-specific data found.

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UV 5.0 FILARIASIS IN UPPER VOLTA

5.2 Epidemiology

5.2.1 Geographical Distribution

Sasa (1976): In Upper Volta, the distributions of both W. bancrofti and D. perstans vary greatly according to latitude and rainfall. The prevalence of the two diseases is highest in the damp savannah zone of the southwest, between 10.5 and 11.5°N, where some 1200 mm of rain fall yearly. Specifically, there is a large focus of W. bancrofti infection in the area around Banfora. The prevalence rates for W. bancrofti and D. perstans decrease progressively to the north, through the dry savannah, to the edge of the saharan zones. In this northern most dry area, infection rates are low.

5.2.2 Prevalence

Sasa (1976): Pfister (1952) investigated the country-wide prevalence pattern for D. perstans in Upper Volta. He conducted daytime blood examinations in four regions situated at different latitudes and receiving different amounts of annual rainfall. W. bancrofti prevalence was also examined, although microfilarial counts for this disease are normally low during the day. Pfister found that the prevalence rates for D. perstans and W. bancrofti were highly correlated with latitude and annual rainfall:

Latitude (° N)	Rainfall (mm/yr)	D. perstans %	W. bancrofti %
10.5-11.5	1200	70	5
12-13	800-1000	28	2.5
13-14	600-800	12	2.1
14 +	$\angle$ 600	4.7	0

Four carriers of D. streptocerca were also found. It was not determined whether these cases were imported or native.

The variation of W. bancrofti with latitude and rainfall was confirmed by Brengues (1973), who reviewed the results of blood surveys conducted recently by several workers in Upper Volta. Highest prevalence rates were again observed in the rainy south. Brengues noted a microfilarial rate of 38.7% (545/1407) in Koupela and a rate of 39.9% (246/617) in Tingrela of the Banfora region. Transmission was intense but seasonal. Lamontellerie (1972), in a very complete study also situated in Banfora, investigated inter-and intra-village variations in W. bancrofti and D. perstans prevalence. W. bancrofti was found in 130 out of 147 villages, with a prevalence of 7,812/59,082 = 13.2%. The prevalence distribution was as follows:

% Prevalence W. bancrofti	0.0	0.1-0.9	1 - 4.9	5 9.9	10-19.9	20 29.9	30 +
No. villages	17	13	35	20	19	31	12

The most highly infected villages (Tiecouna, 42.6%; Tionouna, 42.1%; Kitobama, 38.7%; Sitiena, 38.2%) were found in the flood plain between the Komoe and Leraba Orientale rivers. These four villages formed a central focus of infection for the region. Infection declined gradually moving along the roads from these villages, suggesting that human carriers and not mosquitoes were

spreading the disease.

D. perstans infection was found to be more highly prevalent than infection with W. bancrofti. An overall prevalence of 33.8% (20,013/59, 082) was noted, with the following distribution:

% Prevalence D. perstans	3.3-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9	60-69.9	[illegible]
No. villages	6	17	25	32	35	23	6	3

The distribution of D. perstans infection was not related to road or river patterns, ethnic variations, or W. bancrofti distribution. In short, the disease seemed to be randomly distributed. Generally, in each village, D. perstans was more prevalent than W. bancrofti infection. Only nine villages, all in the flood zone of Lafegue and Yamnaon, exhibited the reverse situation.

For both W. bancrofti and D. perstans, occasionally substantial intra-village prevalence differences were found to exist by Lamontellerie (1972). He attributed these differences to varying human-vector relations within separate areas of the villages.

Lamontellerie also compared, in his 1972 article, the results of his study to those of previous studies in Banfora. He concluded that those differences which existed were due to variation in the populations sampled rather than systematic errors or differences in technique. Lamontellerie also cited two studies which had compared dry and rainy season filarial prevalence rates. The

studies had found rates to be higher in the rainy season. This observation led Lamontellerie to suggest that seasonal variations in prevalence, perhaps linked to seasonal transmission cycle, were partly responsible for conflicting survey results.

5.2.3 Intensity

Sasa (1976) Pfister (1952) noted, as part of his large scale survey of filariasis, that all of the 44 W. bancrofti carriers observed (out of a population of 1440) were apparently healthy and free from clinical filariasis signs, such as elephantiasis and adenitis.

Lamontellerie (1972) investigated the prevalence of elephantiasis as a function of village filarial infection rates. He found that the rate of elephantiasis clearly increased with increasing village infection rates:

Prevalence Rate of Filariasis	0.0	0.1-1 0.9	1-4.9	5-5.9	10-19.9	20-29.9	30+
Total No. of Villages	17	13	35	20	19	31	12
No. Villages w/Elephantiasis	0	0	3	5	7	22	10
Rate-Villages w/Elephantiasis	0	0	8.5	25.0	36.8	70.9	83.3

5.2.4 Incidence

No country-specific information found.

5.2.5 Population Most Affected

Sasa (1976): Pfister (1952) examined 5232 persons in 50 villages for D. perstans infection: 85% of the old people, 67% of adult males, 58% of the adult females, 25% of the

boys and 20% of the girls were found to be infected.

5.3 Vector or Intermediate Host Bionomics

Brengues et al. (1966): W. bancrofti was found to be transmitted by A. gambiae and A. funestus.

Sasa (1976): Naturally infected A. welcomei were reported (Brengues, 1968). For the two vector species - A. funestus and A. gambiae - the infection rate was found to be very low, only 0.70%.

5.3.2 Vector Distribution

Brengues et al. (1966) found A. funestus to be rare in the forest areas near Tingrela in Upper Volta. Both A. funestus and A. gambiae were observed more frequently in the savannah habitats of the area.

5.3.3 Environmental Factors Influencing Distribution

Brengues et al. (1966) studied the factors influencing W. bancrofti vector abundance and activity near Tingrela, in west Upper Volta. The methods used were day captures in dwellings and direct night captures on man. He observed that A. gambiae was most abundant at the end of the rainy season and remained high until December. Years with early, steady rain favored higher vector densities than those with late, violent rain, since the former set of conditions encouraged the establishment of stabilization of breeding places.

Brengues et al. found that transmission intensity followed seasonal cycles. Overall, transmission occurred from May to November. From May to July, transmission

was light and due solely to A. gambiae. In August and September, when both vector species were abundant, transmission was intense. During October and November, moderate transmission due to A. funestus was found.

The relative importance of the two vectors was observed to differ from year to year. Brengues et al. calculated the number of infective bites per man per year at Tingrela, and gave the following data:

	1964-1965	1965
A. gambiae	20.7	16.1
A. funestus	8.3	14.5

Brengues et al. also noted that both vector species preferred to feed inside dwellings and on man. However, outdoor and zoophilic feeding were commonly found.

Daytime activity for the vectors was negligible. A. gambiae was most active between 2 and 4 A.M. A. funestus exhibited different cycles in and out of buildings. Inside, the vector was most active at 3-4 A.M. Outside, the 3-4 A.M. activity peak was still present, but a secondary peak also occurred between 12 midnight and 1 A.M. Lamontellerie (1972) concluded, based on his studis near Banfora, that there was no relation between vector density and human W. bancrofti infection rates. A relation was found to exist, though, between the number of infected mosquitoes and the degree of transmission. Still, it appeared that increased infection in vectors did not lead to geographical spread of disease. Rather, high

vector infection assured intense transmission in the original transmission area.

5.4 Diagnostic Procedures or Techniques

No country-specific information found.

5.5 Therapeutic Trials

No country-specific information found.

5.6 Control Measures Against Human Infection

No country-specific information found.

5.7 Vector or Intermediate Host Control

No country-specific information found.

5.8 Disease Impact

5.8.1 Impact on the Population Distribution

No country-specific information found.

5.8.2 Impact on the Economy

Lamontellerie (1972) estimated the importance of W. bancrofti infection in different areas of Upper Volta near Banfora. He observed that filariasis from W. bancrofti was widespread in the northern cliffs zone, but of little importance or economic effect. In the middle flood zone, W. bancrofti infection was prominent and important. The southern drainage zone was little affected by W. bancrofti infection.

5.8.3. Ameliorative Programs

No country-specific information found.

5.8.4 Problems Encountered

No country-specific information found.

5.9 Laboratory Studies

5.9.1 Laboratory Studies on the Vector

Brengues et al. (1966) studied the longevity, parous female rate, and duration of gonadotrophic cycle of A. gambiae and A. funestus in Tingrela, Upper Volta. Eighty-two percent of examined A. gambiae female were parous, compared to 71% of A. funestus females. The high figure for A. gambiae was considered to be partially due to the seasonal time of sampling. The study was done between July and November. Hamon (1963) reported an excess of parous females occurring at this season, and quoted a lower mean annual parous female rate of 68.5%.

Brengues et al. observed a 48-hour gonadotrophic cycle in parous females. For nulliparous females, a 4-5 day cycle encompassing two blood meals was noted. The daily survival rates noted were 0.95 for A. gambiae and 0.92 for A. funestus.

In the same study, Brengues et al. attempted to explain an unusually low infectivity rate (0.70%) observed in A. gambiae and A. funestus near Tingrela. He postulated that the low rate was due to either vector-parasite incompatibility, hypoinfection, or hyperinfection (leading to high vector mortality or reduced flying ability).

5.9.2 Laboratory Studies on the Parasite

Bain and Brengues (1972) studied, by histological techniques, the passage into the vector haemocoele of W. bancrofti microfilariae. Two vectors - A. gambiae and

A. aegypti - were used in the study. The microfilariae, it was shown, migrate through the stomach wall where the digestive cells are swollen and, meeting the resistant basal membrane, they remain in the epithelial cells.

In the Anopheles studied, the number of microfilariae reaching the haemocoele increased with the number ingested. This was not the case for the Aedes. The Anopheles result was explained by the formation of excrescences of the gut epithelium due to the passage of microfilariae; these hypertrophies allowed for increased subsequent crossing.

5.10 Clinical Studies and Observations

No country-specific information found.

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Part B
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ZA 1.0 SCHISTOSOMIASIS IN ZAIRE

1.2 Epidemiology

1.2.1 Geographical Distribution

Ansari (1973):

"S. mansoni distribution is roughly accorded to four large geographical regions:

(1) northern and north-eastern region: northern Ubangi (Banzyville), Uele, Kibali-Ituri, Lake Albert;

(2) eastern region; foci on Lake Edward, Lake Kivu and Lake Tanganyika;

(3) south-eastern and southern region; Katanga and Kasai;

(4) western region; includes the small focus of Buku-Bandu near Tshela and especially that of Kimpese.

This distribution is obviously approximate because in the large foci, which are in constant growth, the infection often exceeds the geographical limits described above. Thus, the Katanga epidemic ascends the River Lualaba to Kasongo while the focus of Ituri spreads southward to Butembo, a station at an altitude of 1,800 m where infected planorbes (B. pfeifferi) have been collected.

Extensive zones are free from intestinal schistosomiasis: Kwango in the south, Congo-Ubangi in the north (with the exception of a narrow band along the Banzyville frontier) and,

in the centre, the regions of Lake Leopold II, Tshuapa, and Sanuru north of the 5th Parallel south. The valley of the Lualaba River from Kasongo to Kisangani (Stanleyville) is also due to the absence of snail hosts. The Kisangani region is uninfected, with the possible exception of the town itself where planorbes were found several years ago by LASSANCE (1958).

Briefly, in Zaire, two very important zones of intestinal schistosomiasis exist: Ituri-Uele and Kasai-Katanga, united in the east by the secondary foci of Lakes Edward, Kivu and Tanganyika. These zones are probably the two most ancient localizations of S. mansoni. In fact, from 1922 the reports of the 'Direction generale des Services medicaux' indicate that the greatest number of cases occurs in the Eastern Province and in the Province of Katanga which, under the administrative division, included Kasai and Lower Katanga. Originating from these two ancient foci, the endemicity has progressed slowly, allied to the population movements resulting from economic development, and spreading along the main paths of communication wherever there is commercial exchange...

To the west, the endemicity is stationary and mainly confined to the region of Kimpese where the infection could well have been introduced by

the foreign workers recruited for the construction of the Matadi-Leopoldville railroad.

The final observation to be made with reference to S. mansoni is that in Zaire, man is the only reservoir of the parasite. Although many species of rodent, both wild and domestic, have been infected experimentally, the natural infection which is very slight, is found only in a few foci and always in a small proportion of specimens: Albertville (1.6-4%); Irumu (one rodent). In other regions or localities, Bunia, Lake Albert, Lake Kivu, Kasongo, the rodents have been shown to be negative (SCHWETZ, 1953a, b; 1954, 1955, 1956, GILLET, 1953). Monkeys have never been found to be carriers of S. mansoni.

S. haematobium was probably imported into Zaire. The establishment of this parasite, which comes from the neighboring countries, occurred insidiously in Katanga. It was only in 1925 that the 'Direction generale des Services medicaux' first mentioned urinary schistosomiasis in Zaire and more especially in Katanga, 38 cases. From then on, the infection moved progressively toward the north following the Luapulato River to the east and the Lualaba River to the west. The extreme southeasterly point of Upper Katanga, the first region to be affected by urinary schistosomiasis, is also the major area affected.

and the urinary form clearly predominates over the intestinal form. However, moving northward, the prevalence of S. haematobium steadily declines whilst S. mansoni becomes progressively important. ...The same phenomenon is observed in following the western limit of the focus starting from Upper Katanga. At Sakania, urinary schistosomiasis is more common than the intestinal form (SCHWETZ, 1953b).

Finally, Kasongo and Kibombo being unaffected, S. haematobium is again found at Kindu which is at present the northern limit of its spread from Katanga.

A very small focus has been reported at Bosobolo, in the northern part of Equateur Province. It is probable that the infection was introduced there from the north.

The focus in Moyen Congo is situated on both sides of the Congo River downstream from Luozi but its extension is rather limited.

In Bas-Congo urinary schistosomiasis is located in two foci of little importance; the village of Buku-Dundji and the Island of Mateba. The former locality lies near the enclave of Cabinda where urinary schistosomiasis and the presence of B.(Ph.) globosus have been reported. This focus is mentioned merely for information; 46 cases occurred in 1939 but only one case in

1951 and the focus has probably disappeared by now. Another focus situated on the island of Mateba, several kilometers downstream from Boma, is also unimportant; the cattle raised since 1894 on this island harbour S. bovis. The two parasites live side by side in their respective hosts (GILLET, 1950).

S. intercalatum has been discovered in foci distributed along the River Congo, Lualaba from Yalikina (at the mouth of the Lomami) downstream, to Kongolo upstream with intermediate points at Yakusu, Kisangani (Stanleyville) and Ponthierville. The parasite provokes an intestinal schistosomiasis (usually) with associated symptoms; the urines are rare positive and the eggs eliminated have a long terminal spine. This long terminal spine combined with the lozenge-shape of the eggs, gives them a strong resemblance to those of S. mattheei. The morphology of the adult worms is also similar and experimentation shows the infectivity of the two species to be comparable. Sheep can be infected equally well by S. mattheei and S. intercalatum, yet they are resistant to S. haematobium. The resemblance between the two species is, therefore, very strong. This explains the hypothesis put forward by SCHWETZ (1951a) according to which S. intercalatum could be an adaption to man of S. mattheei. An unsuccessful

search has been made for natural infection of sheep and goats at Yakusu (FISHER, 1934) and of sheep only at Kisangani (Stanleyville)."

Warren and Hoffman (1976): (Quoted abstracts) Becquet; R. (1967) - "A detailed general review of Schistosoma intercalatum is presented. S. intercalatum occurs mainly in the Congo and Gabon The geographical distribution of S. intercalatum in other west African countries, e.g., Cameroon and Central African Republic is discussed. Clinical symptoms are of the usual schistosome pattern with abdominal pains and constipation accompanied by bloody mucus. Infected women abort in about the 3rd month of pregancy. Rectal biopsy is used in diagnosis: the eggs have a terminal spine and stain with Ziehl stain. Rectoscopic examination reveals a particularly fragile mucosa."

Deschiens, R. (1971) - "The geographical distribution of Schistosoma intercalatum in man in Africa has increased. Foci of S. intercalatum, whose molluscan hosts are Bulinus (Physopsis) africanus and B. (Pyrgophysa) forskalii, were known in Congo Kinshasa, Congo Brazzaville and Gabon and became extended between 1966 and 1968 and 1971, as a result of nomadic migration, the

disease spread to Central and North Camerooon and to South Chad. Prophylactic measures are discussed."

Davadie, J.A., A. Degremont, and M.A. Pothier (1966)-- "The incidence of schistosomiasis and other parasitic infections was investivated in 4 localities in the Niari Valley, Congo Republic. Examinations of faecal and urine samples showed that Schistosoma haematobium was present in all the localities. S. mansoni was not detected and is not considered to be endemic..."

1.2.2 Prevalence

Ansari (1973): Gillet and Wolfs (1954) gave the following data:

Hospital or dispensary	All causes		Schistosomiasis			
	cases	deaths	urinary		intestinal	
			cases	deaths	cases	deaths
Kakielo	2,999	29	331	1	28	-
Tela	870	-	23	-	11	-
Kiniama	13,426	-	143	-	131	-
Kasenga	16,136	-	52	-	24	-
Chibambo	5,439	-	398	-	51	-
Kilwa	10,452	-	87	-	17	-
Lukonzolwa	4,312	.41	5	-	878	1
Luanza	5,194	22	129	-	727	1
Pweto	6,582	23	45	-	151	2

At Lubumbashi (Elizabethville): 58.9% urinary schistosomiasis among children (DRESSE, 1951) and 15.8% intestinal schistosomiasis for the same age group (DELVILLE and DRESSE, 1951). In the Lufira lake area 12.1% of 3,019 persons were infected with S. haematobium, 6.3% with S. mansoni and 1.4% with both species (RIPERT et al., 1969). Further north, in the Lualaba valley, the proportions are reversed: at Mulongo on Lake Kabumba (to the east of Mwanza), there were four cases of urinary schistosomiaisis and 811 cases of intestinal schistosomiasis out of 10,795 cases treated; at Muyumba the figures are respectively 63 and 314 cases out of 3,657 patients treated (GILLET and WOLFES, 1954). However, in the region of Kongolo, S. haematobium again predominates due to the great abundance of B. (Ph.) globosus and the rarity of planorbes: 69.4% urinary schistosomiasis and 13.6% intestinal schistosomiasis."

Warren and Hoffman (1976): (Quoted abstracts) Ripert, C. and D.P. N'Gimbi (1970)- "In an epidemiological study of intestinal and urinary schistosomiasis in the region of the Lufira lake in Katanga, the authors have made use of the intradermal and complement-fixation reactions. The results are compared with those obtained in microscopical studies for the presence of eggs.

The WHO standard antigen for the intradermal reaction was used. It consists of an acid-soluble protein fraction of Schistosoma mansoni. The results were read 15 minutes after the injection of antigen. Sera for the complement-fixation (CF) test were lyophilized and kept in evacuated sealed ampoules till required. The antigens used in the two reactions were essentially the same. In addition, microscopic examination of faecal and urine samples from the patients were made. The results were presented in a number of tables and figures. In the series studied, 76.3% were positive for the intradermal reaction and 61.0% for the CF test, whereas only 16.9% of the patients had eggs of S. mansoni and S. haematobium in the faeces of urine. It is noteworthy that only a single examination for eggs was carried out. The highest percentage of those excreting eggs occurred between the ages of 10 and 15 years, while the intensity of positive immunological reactions was greatest between the ages of 15 and 20 years. In that age-range, the intradermal reaction was most sensitive and appeared to be more intense in males. Highest titres were obtained in the CF test in patients aged between 5 and 10 years. In those excreting eggs the intradermal and CF reactions were positive in 93% and 65% respectively, and the values for

those not excreting eggs were 73% and 52% respectively, in the same tests."

Ripert, C., P. Carteret, and M. Gayte (1969)- "Schistosomiasis was investigated in 54 villages around Lufira lake, Katanga. The presence of Schistosoma mansoni and S. haematobium and the relative numbers of intestinal and urinary forms of the disease were noted. Some facts of geographical and historic interest about the infections are recorded. Results, based on the examination of faeces for eggs, showed that in the area of the Lufira Lake nearly all the surrounding villages are affected. Those least involved are situated at some distance from the swampy plains or canals and slow-flowing tributaries before they discharge into the lake. There was a similar rate of infection in males and females, and excretion of eggs in faeces was maximal in persons aged between 10 and 15 years. Infection rate based on egg counts of both parasites was 16.9% of the population; 12.1% had eggs of S. haematobium in the urine and 6.3% had those of S. mansoni in faeces, while the eggs of both species were present in 1.4% of the patients examined. The lake itself was not the principal site for molluscan vectors, since fishermen were not infected in greater numbers than those working on the land."

Bengtsson, E. and J. Pellegrino (1966) - "Autochthonous schistosomiasis in man does not occur in Sweden, but in recent years some 70 Swedes, returned from Africa, have been found with the disease. Between 1960-1964 about 6,500 Swedish soldiers served for roughly 6 months in Katanga Province, Congo. Their work entailed much wading in rivers and streams. Ordinary medical examinations of 5,500 of these men, including examinations of urine and stools and of blood films for eosinophilia, disclosed 5 infections of schistosomiasis within 6 months of their repatriation. It was thought probable that other cases were being missed, so lyophilized sera were taken from 382 men on their return home, and from 243 men about to depart overseas; these sera were flown to the laboratory of the second author at Belo Horizonte, Brazil, for a complement-fixation test and a cercarial slide-flocculation test. The 11 men giving positive results in one or other, or both, of these tests were subjected to intradermal skin tests with a WHO reference Schistosoma mansoni antigen, the weals being recorded after 15 minutes; eggs were sought for in their stools by Ridley and Hawgood's method and by rectal snips; their eosinophil counts were determined; and a thymol test was done on each. The results are set out in a table. Of the 382 men, 10 gave positive

flocculation and 4 positive complement-fixation tests; one man giving a negative in the former, gave a positive in the latter test. Eggs were recovered in stools from none of the 382 men immediately on their return, but S. mansoni eggs were recovered from one of these men 3 months later, and he then had a marked eosinophilia; rectal snips yielded eggs (6 S. mansoni and 1 S. haematobium) from another 6 men, but not from the man with positive stools. The skin tests were not entirely significant and the degrees of eosinophilia fluctuated; in most cases the latter became significant if the counts were repeated over some months after exposure to infection.

The authors conclude that there should be systematic examinations for these infections at intervals of troops returning from areas endemic for schistosomiasis. The cercarial flocculation test is sensitive and reliable for the diagnosis of freshly acquired and inapparent infections; in later stage infections the complement-fixation test may be more reliable. A search for eosinophilia over some months is most helpful; and the danger of reliance on a single negative stool examination for the exclusion of schistosomiasis is emphasized."

1.2.3 Intensity

No country-specific information found.

1.2.4 Incidence

No country-specific information found.

1.2.5 Population Most Affected

Warren and Hoffman (1976): (Quoted abstract) Ripert, C. and C. Raccurt (1970) - "The schistosome burden of the population around lake Lufira, Katanga, has been evaluated by egg counts of *Schistosoma mansoni* and *S. haematobium* in 1100 faecal and 2345 urine samples. Previous findings of the presence of these parasites by the authors are briefly described and compared with those by other authors. The faecal samples were collected in bottles and weighed. Then these were homogenized by shaking with glass beads in a solution containing acetic acid and sodium acetate of pH 5.0, sieved, and counts of *S. mansoni* eggs were made in a volume of 0.05 ml. on a microscope slide. For enumeration of *S. haematobium* eggs volumes of urine samples were shaken and measured, then centrifuged for 10 minutes, and counts of eggs were made on the deposit. The results presented in tables and figures indicate the distribution of both species in faeces and urine, according to age and sex.

In the age-group 0-4 years, the number of eggs in 1g faeces and in 10 ml. urine was greater than in the 4-9 years group. Statistical analysis of the results obtained in these counts from samples representative of the whole population in the Lufira area allowed the evaluation of the significance of parasitism due to the two species of parasite to be made. Eggs were most numerous in the faeces of those below the age of 15 years; they decreased in number with age, followed by a subsequent increase in older women. The young people with eggs in faeces are generally more careless of hygiene and provide the main hazard for the spread of infection by water pollution."

1.3 Vector or Intermediate Host Bionomics

1.3.1 Species Transmitting the Disease

Ansari (1973): For S. mansoni - B.pfeifferi, B. smithi, B. stanleyi, B. Sudanica

For S. haematobium - B. (Ph.) globosus

For S. intercalatum - B. (Ph.) globosus

1.3.2 Vector Distribution

Ansari (1973): "B. smithi is found only in Lake Edward while B. stanleyi is known only in Lake Albert. The other two species have a broader but apparently more irregular distribution. B. pfeifferi is much more common than B. sudanica and is the most important intermediate host of S. mansoni in Zaire. These planorbes are numerous in some regions (Great Lakes, Ituri, Uele, Katanga, Kasai) but much less numerous in others (Bas-Congo) and are even absent in extensive areas. Although in the past few years B. pfeifferi has been found at Kisangani (Stanleyville) (LASSANCE, 1958), planorbes are not found in the hinterland of this locality, probably not until the Lindi River, and there are probably none in the Lualaba valley from Kisangani up-river to Kibombo-Kasongo. B.(Ph.) globosus is very abundant in eastern Zaire from north to south, but it is found more rarely in the regions of Lubilash (Kasai) and the Bas-Congo, although these areas have been throughly searched. The distribution area of B.(Ph.) globosus is far larger than the endemic zone of S. haematobium which is located principally around Katanga. The region of the great lakes (Tanganyika, Kivu, Edward, Albert) seems to be at present free from

urinary schistosomiasis. The regions of Kisangani (Stanleyville), the north-east (Uele, Ituri), Rwanda and Burundi are also unaffected.

Bulinus spp., sensu stricto, are quite common in the great lakes and in several of the small eastern lakes (Monkoto region). The role of B. (B.) coulboisi in the transmission of S. haematobium in Zaire is not yet proven. B.(B.) forskalii is widespread in Zaire, but attempts to transmit S. haematobium experimentally through it have failed (GILLET, 1949)."

Warren and Hoffman (1976): Parent, M. (1963) - The author studied for 7 years the populations of snails in lake, river and drain-pipe habitats in Jadotville, Katanga. Estimations of populations in the 3 habitats were made monthly. There was a negative correlation between rainfall and mollusc numbers in rivers but not in the other 2 habitats. Drain-pipes can apparently act as reservoirs of snails which can repopulate rivers after rains or chemical treatment. Biomphalaria alexandrina pfeifferi and Physopsis africana are the vectors of human schistosomiasis in jadotville. The habitats studied were previously described in Lietar.

1.3.3 Environmental Factors Influencing Distribution

No country-specific information found.

1.4 Diagnostic Procedures or Techniques

No country-specific information found.

1.5. Therapeutic Trials

1.5.1 Studies on New Drugs

No country-specific information found.

1.5.2 Mass Treatment

Warren and Hoffman (1976): (Quoted abstract) "Therapeutic doses of niridazole administered to patients in Congo (Kinshasa) suffering from amoebiasis or schistosomiasis failed to produce any myelotoxic effects. Certain clinical findings suggested that the compound triggered haemolysis in some of the patients whose red blood cells were deficient in glucose-6-phosphate dehydrogenase. These phenomena appeared to be benign in most instances, and did not prejudice the therapeutic activity of the drug."

1.6 Control Measures Against Human Infection

No country-specific information found.

1.7 Vector or Intermediate Host Control

No country-specific information found.

1.8 Disease Impact

No country-specific information found.

1.9 Laboratory Studies

1.9.1 Laboratory Studies On the Vector

Warren and Hoffman (1976): (Quoted abstract)

Bisseru, B. (1967) - The metacercariae of *Echinoparyphium recurvatum* and *Echinostoma revolutum*, cosmopolitan parasites of wild and domestic birds, were found encysted as natural infections in the schistosome-transmitting snails, *Bulinus africanus* and *Biomphalaria tanganikanus* from the Congo.

The metacercariae were identified by experimental infection of laboratory animals, from which adult worms were recovered. Miracidia from eggs produced by these animals were used to infect other kinds of snail hosts, in which development to the cercarial stage proceeded, viz. *E. recurvatum* in *B. truncatus* and *E. revolutum* in *B. truncatus*, *B. glabrata*, *Planorbarius dufouri* and *B. tropicus*. Cercariae emerging from these snails became encysted (in the usual echinostome fashion) in the bodies of these or other species of snails, sometimes causing their death. Metacercariae of *E. recurvatum* were encysted in *Lymnaea auricularia* var. *rufescens*, *Planorbis sp.*, *Planorbarius dufouri* and *Indoplanorbis exustus*, which are 4 new hosts for these stages; metacercariae of *E. revolutum* were encysted in *B. glabrata*, *B. truncatus* and *I. exustus* which are also new hosts.

E. recurvatum and *E. revolutum* are here recorded for the first time from the southern half of Africa In the author's opinion they may have a wide distribution in that country and may be responsible for the death of, and have possible uses in the control of, schistosome-transmitting molluscs.

1.9.2 Laboratory Studies on the Parasite

No country-specific information found.

1.10 Clinical Studies and Observations

No country-specific information found.

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