WASH

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MEMORANDUM

C-211

TO: J. Haratani

FROM: R. B. Isely

DATE: July 13, 1982

RE: C-211 Attendance at a seminar: "Opportunities for the Control of Dracunculosis", June 16-19, 1982

In this memo I will attempt to share with you a synoptic view of the proceedings. Both as a passive receiver of information and as an active participant in a working group I had an opportunity to obtain a sense of the meeting and its import for the WASH Project.

Purpose of the seminar

The seminar, the first on the subject, was planned to bring together scientists involved in research on the parasite the vector and their control and public health personnel active in control efforts in the field, in order to identify both places and means for effecting control of the disease (see Appendix A, List of Participants).

Programme commentary

The programme (see Appendix B) was arranged so that participants would first have an opportunity to review the latest developments in the biological, clinical, and socio-economic dimensions of the disease. Drs. Muller, Gilles, and Ward presented papers that provided an excellent framework for answering difficult questions about the efficacy of control measures during the working groups. For example Dr. Muller presented new information on the expulsion rate of larvae from the mature worm, demonstrating that there is a decided deceleration in the rate of expulsion and probably not more than three expulsions over a two week period. Dr. Ward proposed a fascinating framework for thinking about the economic effects of the disease. These papers and others are in Appendix C.

In a second phase of the program control strategies featuring field data in many instances were presented. Of particular interest to WASH were Joshua Adeniyi's presentation on health education and that of Doug Hudgins on protection of water supplies (see Appendix D). Adeniyi made a particular point of delineating the rightful role of health education from that of technology applications. If a protected well is dug on the edge of a village where only a small fraction of the population uses it, the role of health education is to organize the community to press for additional water sources and to care for and make proper use of them, while the role of technology application is clearly to respond more appropriately to community water supply needs in placing wells. This line of thinking was carried over into the health education working group in which I took part.

At the close of the session on strategies I made a brief summary of the state-of-the-art as perceived in the session.

In the third phase of the seminar epidemiologic data on incidence and prevalence of dracunculosis were presented for India, Nigeria, francophone West Africa, and the Africa Region of W.H.O. (see Appendix E). Only that from India and Nigeria was in any sense denominator based data; that for the other regions was strictly numerator data. The report from India demonstrates that since 1947 when data were first collected a reduction in both the geographic extent and the intensity of infection (prevalence), comparing prevalence with water use demonstrates a proportionately greater decline among those who use wells only or wells and tanks as opposed to those who use tanks only (Table 1).

Table 1

Prevalence of Dracunculosis by Water Use

	Prevalence of Dracunculose		
Water source/Use	1964	1978	% decline
Tank only	8.2	1.9	70.8
Tank or well	7.4	0.7	90.5
Well only	2.4	0.2	90.6

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Unfortunately data on the proportions of the population having various use patterns was not presented, but the assumption was made that there has been a marked increase in the exclusive use of wells.

The data presented by Dr. Kale (Nigeria) suggest the possibility of some factors related to the chemical quality of surface water controlling prevalence. Despite the ubiquity of Cyclops, apparently some village less than 20 km have widely different rates. In another data set the effect of piped water is seen in the explosive rebound of the prevalence of infection two years after the system broke down in the village of Idere.

Two films were shown with a view to their evaluation by participants for possible use with decision and policy makers. The first produced in France by Prof. Marc Gentilini was remarkable for its photos of the parasite and the vector. The second a Canadian film part of a Library of films from the Canadian film board on tropical diseases was best in terms of its clinical detail. Both films were weak on preventive and control strategies. In the Canadian film the use of anti-tetanus anti-serum is to be condemned.

Working groups focused on three areas: (1) problem assessment, i.e. identifying the extent and severity of dracunculosis on a country and regional basis; (2) selection and implementation of control measures; and (3) evaluation of programs. The scopes of work for each group can be found in Appendix F.

I participated in Group II and in the subsection on health education. Because of the broad gamut of control measures to consider it was thought not possible to give equal weight to each in the larger group. Thus three of us (Ademiyi, Shulman, and myself) prepared a draft health education strategy, and others prepared similar drafts for vector control, water supply, chemotherapy, and personal health promotion (i.e. filtering water, avoiding ponds when infected, etc.). These drafts will be edited and combined in the workshop proceedings to appear later. The water supply group came up with a particularly interesting approach, in which water supply systems are compared in a two dimensional matrix according to whether they are protected or unprotected (ordinate), and according to eleven other characteristiscs (abscissa). This matrix can be found in Appendix G. Its chief value lies in its ability to compare water supply systems have certain characteristics with regard to the transmission of Guinea worm, according to their cost, infrastructural needs, reliability, and other advantages and disadvantages. What is clear is that there are no clear-cut answers for all situations.

The workshop ended with the reports of the working groups and their synthesis into recommendations, the latter following rather closely those of the working groups. In general it is recommended that:

1. The workshop proceedings be published by a major tropical diseases journal.

2. A monograph as a guide to treatment and control be issued by NAS.

3. An informal newsletter be established.

4. A pamphlet for decision-makers be prepared.

The participants concluded that this had been an historic occasion with many institutions and countries represented a process of effective control of dracunculosis has begun and a stimulus to research has been established.

A note on process is in order. The time in working groups was sufficient but could have been used more effectively had the participants been given clear objectives and a clear idea of the projected audience for their product. Because this information was not provided until late in the proceedings a certain amount of frustrated effort was undertaken. These considerations aside, however, it was a worthwhile and valuable undertaking. We at WASH look forward to the proceedings and to opportunities to use the recommendations in the context of our work with missions and host country governments.

RBI:cdej

Encs.

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APPENDIX A

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WORKSHOP ON OPPORTUNITIES FOR
CONTROL OF DRACUNCULIASIS

2100 Pennsylvania Avenue
Room 356
Washington, D.C.

June 16-19, 1982

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APPENDIX B

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AGENDA

WORKSHOP ON OPPORTUNITIES FOR CONTROL OF DRACUNCULIASIS

2100 Pennsylvania Avenue
Room 356
Washington, D.C.

June 16, 1982 - Plenary Session

9:00 A.M.	I.	Welcoming Remarks	Victor Rabinowitch, Director Office of International Affairs D. A. Henderson, Chairman, BOSTID/IOM Advisory Committee on Health, Biomedical Research and Development
		Workshop objectives, organization and products	Myron Schultz, Workshop Chairman
9:30	II.	The Life Cycle of *Dracunculus medinensis*	Ralph Muller
10:00	III.	Clinico-pathology and Treatment	Herbert Gilles
10:30		Coffee Break	
10:45	IV.	Impact of Guinea Worm Disease on the Family	William Ward
11:15	V.	Movie	
11:40		Discussion	
12:00		Lunch Break - Second Floor Cafeteria	

The Office of International Affairs of the National Research Council serves the international interests of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine

VI. Control Strategies

1:15 P.M.	A. The India Program	M.I.D. Sharma
1:45	B. Vector Control	Fergus McCullough
2:10	C. Health Education	Joshua Adeniyi
2:30	D. Protected Water Supplies	Douglas Hudgins
2:50	E. Environmental aspects of Dracuncialisis Control in Togo	F. K. Kloutse
3:05	F. Environmental aspects of Dracunculiasis Control in Ghana	E. F. Quashie
3:20	Coffee Break	
3:35	G. Further comments on protected water supplies	Gerard Rohlich
4:15	H. Summary of control strategies	Raymond Iseley
4:40	Discussion	
5:00 P.M.	Wine and cheese reception - Second Floor Patio or Third Floor Conference Lobby	

June 17

VI. Epidemiologic Information

9:00 A.M.	A. India	C. K. Rao
9:25	B. Nigeria	O. O. Kale
9:45	Movie	
10:45	Coffee Break	
10:30	C. Francophone West Africa	J. Prod'hon
11:10	E. WHO/AFRO Concerns	A. Abdou
11:30	F. Summary/Response	Brian O. L. Duke
12:00	Lunch	

June 17 and 18 - Working Groups

Group I Problem Assessment — Room 352

Chair: Donald Belcher

Rapporteur: Alfred A. Buck

Group II Selection and Implementation of Control Measures — Room 354

Chair: Herbert Gilles

Rapporteur: Fredrick Golladay

Group III Evaluation of Program — Room 355

Chair: Donald Hopkins

Rapporteur: William Ward

June 19 - Plenary Session — Room 356

A.M. Presentation of Working Group I

Discussion

Presentation of Working Group II

Discussion

Presentation of Working Group III

Discussion

Conclusions and Reccommendations

THE LIFE CYCLE OF DRACUNCULUS MEDINENSIS

Ralph Muller
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The seemingly rather bizarre life cycle of the guinea worm, *Dracunculus medinensis*, is actually very well adapted for transmission of a parasite which utilizes an aquatic intermediate host and which occurs principally in desert or semi-desert environments.

The mature female worm measures about 70 cm long by 0.2 cm wide and lives in the subcutaneous connective tissues of man. When ready to emerge it provokes the formation of a painful burning blister in the skin over the anterior end. The blister bursts, usually after immersion of the affected portion of the body in water, and the head end of the worm emerges. Numerous first-stage larvae are forcibly expelled into the water following rupture of the anterior end of the worm by the contraction of the muscles of the worm and of the host. Estimates of the number of larvae contained in the uterus of a single worm range from 1.4 to 3 million. Not all the larvae are released at once but the anterior portion of the worm becomes flaccid and dries up after removal from the water. When the host enters water again more larvae can be released through the broken end of the worm. This process can be repeated a number of times.

There appear to have been few studies to ascertain how many times larvae can be released or over what period. However, in five patients in Nigeria I found that an average of 0.5 million larvae were released on first immersion in water and that no larvae were expelled for more than a two-week period. In an experimental infection in a rhesus monkey about 104 000 larvae were released on first emergence, 26 000 three days later, 10 000 the next day and only 1000 a week later.

The period of release of larvae could be of importance in the transmission of the disease. For instance, various benzimidazole drugs have been reported to reduce inflammation and lessen the time for complete emergence of worms from an average of 4-6 weeks to 2-3 weeks although they do not appear to affect the viability of the contained larvae (Muller, 1976).

The first stage larvae measure about 640 µm long by 13.4 µm wide and have a long pointed tail; they remain active in pond water for up to a week. However, in numerous experiments I have found that they are not capable of infecting cyclops for longer than five days. The larvae thrash actively in the water similarly to free-living aquatic nematodes and are ingested by carnivorous species of Cyclops. Many Cyclops species are cosmopolitan in distribution and, while six species have been found naturally infected in various parts of the world (Muller, 1971), C. leuckarti and C. hyalinus are important host species in all endemic areas. Their importance has recently been emphasized for many habitats in India (Sharma and Wattal, 1981a).

Once inside a cyclops the larvae penetrate head first through the gut wall to the hemocoel in 1-6 hours, depending principally on the temperature. The larvae moult twice inside the cyclops and can reach the infective third stage in 14 days above 21°C. Below 19°C they do not appear to be capable of reaching the infective stage at all (Figure 1).

Cyclops will often ingest many larvae but this causes high mortality when the larvae moult and the great majority of naturally infected cyclops contain only one third-stage infective larva (Onabamiro in 1951 found that 12% contained two larvae). The third-stage larvae measure about 450 µm long by 14 µm wide and have a short bifid tail. All stages of cyclops can be infected but they are likely to have become adult by the time they contain infective larvae.

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Figure 1.

TIME TAKEN FOR *D. medinensis* LARVAE TO DEVELOP IN CYCLOPS

AUTHORITY	SPECIES OF CYCLOPS	TEMP. (^{o}C)	1st MOULT	2nd MOULT	INFECTIVE STAGE (presumed)
Fairley & Liston (1924)	*C. leuckarti*	>24	?	?	12-15
Moorthy (1938)	"	>32	5-7	8-12	14-20
Onabamiro (1954)	*C. nigerianus*	25-27	5	9	12
Muller (1971)	*C. leuckarti*	< 19	-	-	-
		21-24	8	12	14
		> 25	6-8	8-10	14*

* Demonstrated by experimental infections : animals could not be infected at 9 or 12 days.

In the laboratory uninfected female C. leuckarti were found by Sharma and Wattal (1981b) to live for a maximum of 158 days while Muller (1972) found that infected cyclops lived for less than 50 days.

Cyclops which contain third-stage larvae become sluggish and sink nearly to the bottom of a pond or step well (Onamabiro, 1954). This has been given as a partial explanation for the increased transmission in the dry season when water levels are low in endemic areas which have a high annual rainfall.

There have been no studies on the level of infection in cyclops necessary to maintain transmission but Moorthy and Sweet (1936) found 5% infection in C. leuckarti during the height of the transmission season in a step well in Karnataka state, India, and Onabamiro (1951) a similar figure for C. nigerianus in a pond in southwest Nigeria. Onabamiro estimated that a local inhabitant might ingest 200 larvae over a season. However, because of the sporadic nature of larval input into the water and the high mortality of recently infected cyclops, to be meaningful such studies really need to differentiate infective larvae in cyclops and to be carried out over a period of time.

When cyclops containing infective larvae are ingested in drinking water they are killed in the stomach but the contained larvae are activated and, in experimentally infected cats, freed larvae can be found in the lumen of the duodenum four hours after infection. However, larvae are killed in 18 hours by 0.05% HCl (maximum stomach acidity about 0.22% HCl). This is in contrast to Trichinella, a nematode in which larvae are ingested in meat, which can withstand 0.2% acid pepsin for 24 hours. This might mean that Dracunculus larvae must pass through the stomach quickly and certainly I could not infect dogs when infected cyclops were given with food. The presence of a high gastric acidity has also been given as a possible explanation for the apparent resistance often found in a proportion of the people using a contaminated water source, although this has not been borne out by clinical investigations (e.g. Gilles and Ball, 1964; Sita Devi et al., 1969).

In experimental animals larvae penetrate into the duodenal wall by 13 hours after infection, are found migrating along the abdominal mesenteries up to 12 days and are present in the abdominal and thoracic muscle planes at about 15 days. The larvae do not grow during this period (Muller, 1968) but there is probably a moult between 15 and 21 days. The developing worms migrate to the connective tissues of the axillary and inguinal regions and mating occurs between 80-100 days after infection (Moorthy and Sweet, 1938; Onabamiro, 1956; Muller, unpublished). The makes then usually move deeper between the muscle fasciae, die after about 6 months or become encysted and sometimes eventually calcify. The females move down to the extremities, usually to the lower legs, between 8 and 10 months after infection. The uterus is filled with developing eggs by 8 months and with first-stage larvae by 10 months. The gut becomes flattened and non-functional and the whole worm becomes filled by the uterus containing larvae.

The female worms become patent between 10-14 months after infection (Muller in 1971 reported a mean of 340 days in 9 experimentally infected rhesus monkeys), although occasionally patent worms have been reported from young babies.

A proportion of female worms never reach the surface, becoming encysted, and eventually calcify or are absorbed. All such worms that I have examined from monkeys have been unfertilized. Sita Devi et al. (1969) found that 29% of supposedly uninfected villagers from an endemic area showed the presence of worms on roentgenogram.

The role of reservoir hosts in the transmission of D. medinensis has not been clearly established. Infection has been reported from a wide range of mammals from many parts of the world (reviewed by Muller, 1971) but it is not always clear whether they belong to the same species, or whether they are just accidental infections from a human source.

While there is no evidence that dracunculiasis is a zoonotic infection or has ever been transmitted from an animal to man (apart from the occasional human cases reported from the United States), the possibility that infection could be reintroduced into an area in which it has been eradicated provides additional support to the need for the provision of safe water supplies as the primary method of control or eradication.

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DRACUNCULIASIS

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DRACUNCULIASIS

Pathology

The incubation period is symptomless. Occasionally just prior to the blistering and extrusion of embryos generalised symptoms of an allergic nature may be complained of - or these may also occur during surgical removal of the worm.

The mature female is usually present in the connective tissues of the limbs and trunk. It most commonly presents on the surface of the body in the feet, ankles, and lower limbs, but may present on the trunk (especially the back in water carriers), arms, and rarely the head and neck. The female secretes a toxic substance which causes a local inflammatory lesion infiltrated with eosinophils, monocytes and polymorphonuclear leucocytes. A vesicle develops in the epidermis which ruptures on contact with water, and allows the embryos to escape. Secondary infection of this lesion with ulceration is common and a spreading cellulitis may occur involving subcutaneous and deeper tissues with consequent fibrosis and deformities.

The mature female, however, may never reach the surface of the body and may be absorbed without a marked reaction on the part of the host or calcification of the worm may occur and be detected on radiological examination (Reddy et al. 1968). Secondary infection once again, however, may occur and we have seen severe infections in joints especially the knee joint and a toxin liberated from the worm may be the cause in some instances. The aspirated fluid is usually brownish in colour and contains pus cells and fragments of the worm, and in the wall of the cavity a foreign-body giant cell reaction is usual. In some cases the aspirated fluid is sterile and at arthrotomy the entire adult worm is seen in the joint (Reddy and Sivaramappa, 1968). A coiled-up worm has also been seen in an abscess cavity in the pericardium, causing constrictive pericarditis (Kinare et al. 1962). An eosinophilia may occur in the early stages of infection prior to the liberation of the embryos or with damage to the parasite. Paraplegia as well as quadriplegia due to an extradural Guinea-worm abscess have been described (Reddy and Valli, 1967; Donaldson and Angelo, 1961; Mitra and Haddock, 1970), as well as scrotal, vesical, and renal lesions.

Clinical Picture

Dracontiasis is rare before the age of 4. After this the incidence steadily increases, to become highest in the young adult.

The incidence is seasonal in many areas especially in India. Infection with a single worm is usual, but multiple infection is not uncommon. There is no racial or other immunity and reinfection is frequent, even in the already infected subjects.

The worm gives rise to no clinical signs until near the point of discharge of larvae. The active stage of the infection is accompanied by both general and local signs and symptoms.

A few hours before the appearance of the worm at the surface of the skin there may develop some local erythema and tenderness over the area in which the pointing is to take place. In some cases there may be general effects sometimes of a severe nature, but in the majority the local lesion tends to develop without any general reaction.

In severe cases there may be generalised pruritus sometimes accompanied by scattered urticaria. There may be nausea, vomiting and watery diarrhoea. In some cases dyspnoea may appear and lead to attacks resembling asthma. These general reactions vary greatly in intensity and incidence from patient to patient and locality to locality. They subside as a rule by the time the local lesion has ruptured and the ejection of larvae has commenced.

The gravid female presents somewhere in the legs or feet in over 90 per cent of all cases. It may appear elsewhere, especially in the back, the arms, and scrotum. It has been reported in the orbit. It may often be visible or palpable for its whole length in the subcutaneous tissues.

The patient complains of deep-seated stinging pain in the site in which the worm is reaching the surface. A papule or group of papules (which later coalesce) forms rapidly and enlarges over the course of 1 or 2 days becoming slowly more indurated. The central region becomes raised and eventually forms a vesicle which soon ruptures, leaving a superficial ulcer large enough to admit a probe. The head of the worm is often visible within this ulcer.

If the ulcerated lesion is douched with water a drop of milky fluid wells up in a few seconds. After an interval of about an hour further douching will have the same effect. This fluid contains myriads of active larvae ejected from the uterus in response to the stimulus of water.

Discharge of larvae will continue intermittently whenever the affected part is exposed to water until the worm has discharged its full load of larvae, which may take anything up to 3 weeks. The tissues about the presenting head of the worm become indurated, oedematous, reddened, and very tender. These reactions, which may involve wide areas around the worm, are probably allergic. Even in the absence of secondary infection walking may be very difficult and the patient is compelled to give up his work.

In the case not complicated by secondary infection the local lesion will heal completely about 4 to 6 weeks after its appearance.

Secondary infection is, however, the rule and may lead to serious and unpleasant complications.

Occasionally worms never fully mature or may die before they reach the surface. Under these circumstances they are absorbed completely or partly calcified, sometimes leaving a cord-like mass palpable beneath the skin; they may also become secondarily infected and lead to abscess formation so that the first indication of the infestation may be the discovery of fragments of the worm in the abscess contents.

Gravid females which have not yet presented at the surface are occasionally ruptured accidentally and give rise to aseptic abscesses which are frequently severe and sometimes accompanied by general symptoms.

Abscesses in relation to the worms are nearly always the result of secondary infection. Such infections may involve deep structures including tendons, the periosteum, and bones, and may be accompanied by severe or even fatal septicaemia.

In some areas a large proportion of patients (in some parts of India, over 20 per cent) suffer from joint lesions, varying from painful reddened swellings to advanced pyogenic infections with later fixation and deformity. The majority of such lesions occur in the ankles and knees. Changes in joints are believed to occur occasionally without secondary infection.

The peripheral blood usually shows an increase in eosinophils which may constitute up to 10 per cent of the total leucocytes.

Treatment

The patient should be rested if possible with the affected part elevated. The local lesion should be kept as clean as possible and secondary infection dealt with by conventional methods. A tetanus toxoid injection should be given when indicated.

Niridazole 25 mg/kg/daily for 10 days was found effective in a Nigerian study (Oduntan et al.1967). Both Kulkarni and Nagalotimath (1975) in 160 randomly selected patients in India, and Belcher et al. (1975) failed to show any beneficial effect using metronidazole or thiabendazole.

Gaitonde et al.(1979) assessed the comparative efficacy of levamisole, bitoscanate and mebendazole. None of the drugs seemed to have any effect on developing worms while only mebendazole at a dose of 100 mg.b.d. for 7 days resulted in significant symptomatic improvement.

The possible mode of action of drugs on guinea worm disease has been reviewed by Muller (1971).

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The Impact of Dracunculiasis On the Household: The Challenge of Measurement

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I. Introduction

The annual incidence of guinea worm cases is a matter of widely varying speculation. Estimates range from 10 to 48 million cases.[*6,38] However, one scholar has indicated that nearly 20 years have elapsed since these estimates were made and the doubling of the world's population without a reduction in mitigating factors has probably resulted in an increase over these figures.[13] Guinea worm is the only extant communicable disease which is caused solely by the drinking of contaminated water.[11,30] Therefore, it is presently the only disease for which there is a potential for complete eradication. This fact and its extremely debilitating nature should make it a candidate for high priority funding.[30] In fact, an international program to eradicate the disease would involve employing interventions encompassing five of the eight primary health care areas of concern defined at the Alma Ata Conference:

> education concerning prevailing health problems and the methods of preventing and controlling them
>
> an adequate supply of safe water and basic sanitation
>
> prevention and control of local endemic diseases
>
> appropriate control of common disease and injuries
>
> provision of essential drugs (19)

II. Factors in Transmission

Factors in the transmission of guinea worm work at one and the same time to limit contagion to specific and identifiable times of the year[23,31] (usually the driest season) and to increase the probability of transmission at a time when water use needs are greatest due to higher temperatures [15] and heavy labor is required for preparing the fields for planting or harvesting.[3]

*refer to reference list at end of article

The agent, the adult dracunculus medenensis, a nematode, whose life cycle has been described previously by Ralph Muller, has an incredible sense of timing.(30) The larva reaches the water source at the time of year when ponds have begun to dry up. In this way, the intermediate host, the cyclops, is in greatest concentration, and most likely to ingest the larva. Further, the probability of humans completing the infection cycle is, similarly, greatest.(31)

Differential infection rates among neighborhoods may occur in the case of those communities where the village relies on a variety of water sources. Similarly the extent to which there is selective access to a water site can influence infection and contamination. Migration of individuals to endemic areas and their periodic return can lead to recurring contamination of a local water source after a period of abatement.(42)

One author, in a detailed analysis of water use patterns, was able to demonstrate that most water sources are used for a wide variety of purposes - the most prominent, in addition to water fetching, being swimming, bathing and drinking.(15) These latter actions increase the potential for direct transmission of infection. Although efforts to provide barriers to direct access to the water site, most notably for step wells, have led to rapid reductions in guinea worm infection, many sites do not lend themselves to such barriers and even if feasible, the use of pumps or pullies generally require greater energy expenditure and may reduce the social aspects of drawing water.

A comprehensive effort to establish a nationwide surveillance system has begun in India (9) with its goal the eradication of guinea worm by December 1985. High risk villages are easy to identify because of the nature of their water supplies. The concern in establishing such a system has to be with identifying all communities with standing water drinking sources. Further, migration patterns from and to such communities should be noted as well.

III. Quality of Available Epidemiologic Information

It is a challenge to attempt to answer a question which has previously had little attention. A review of the literature on guinea worm disease provides only limited information regarding estimates of numbers of households or percentage of productive members (defined here as age 15-44) represented among the affected. A considerable number of the studies fail to provide simple community demographic information organized according to the same age and sex breakdowns they use in counting cases. Others apparently provide experience with clinical cases only.[8,44,45] For other disease entities, however, the pattern of reporting may include:

1) actual community maps showing geographic incidence and prevalence by household (18,47)
2) information on the percentage of a given age group afflicted (3,4,23,47)
3) household attack rates (20)

Therefore, in the epidemiologic literature on guinea worm, the incomplete presentation of important data severely hampers estimation of the extent of the problem.[7] In addition to a need for understanding of the variability in attack rates by household, there is a need for a unified scaling system to estimate individual case severity. This might be a complex scale which takes into consideration 1) level of pain, 2) extent of disability, and 3) duration of infection or it may be better to present each of these factors independently and to then develop a composite index which provides an overall estimate of impact. There is need, in addition, for a consensus on which of a myriad of existing systems is adopted for estimating the physical, economic, and social impact of the disease. Until that consensus is reached, however, it is necessary to examine what is currently provided about variations in levels of infection, the extent of disability possible, and the range of possible duration of such disability: Dean et al[12] have proposed the following formula for calculating morbidity impact:

$$\frac{\text{duration of illness x degree of disability}}{\text{population in 100,000's}}$$

This will provide a measure of disability per 100,000 people per year. To estimate lost working potential, it is necessary to have an idea of the average lifespan of the worker in each geographic area under investigation.

Existing studies provide a wide range of qualitative and quantitative measures of degree and duration of disability.[23,24,30,38] Based on available degree and duration disability distributions, rough attempts will made to estimate annual days of work lost.

IV. Impact of Guinea Worm on the Community and the Household

Considerations in an attack on guinea worm disease include:

1) environmental factors in transmission
2) aspects of the intensity of disease impact
3) high risk factors which lead to variation in susceptibility
4) social and health implications

Guinea worm disease is not a major killer. Thus, outside of the physical pain and anguish, its major impact is socioeconomic. This fact and the immediate problem of severe morbidity suggest that programs must emphasize not only prevention but should have an aggressive primary care component. This suggestion is a result of the growing evidence in the literature that the period of disability can be reduced considerably through timely medical intervention.[22,24] Further, emergency programs must be developed to assist those communities where attack rates deplete the ability of households to come to each other's aid at the time of planting and harvest activities. There must be an agreed upon definition of need so that this action can be swift and appropriate. The discussion which follows attempts to identify some of the parameters underlying socioeconomic impact.

Table 1 is a summary of the relationship between the agricultural season in a given area and the season of highest impact. Although these data provide only a rough sketch, it is apparent that there is a considerable overlap between major agricultural activity and time of high incidence and prevalence of disease onset. This would suggest that the potential impact of guinea worm on the economy is greater than for disease which lack such a high seasonally defined relationship to peak productivity periods.

While the environmental factors involved in the transmission of guinea worm will be exhaustively dealt with by others during this conference, it should be noted that the previously mentioned effort by India (10) to develop a continual surveillance system provides a major step forward in the eventual elimination of this dread disease. Identifying those villages without existing cases but with the necessary environmental characteristics must be a part of this effort.

The two factors which appear to be most highly related to the impact of the worm on the individual and, as a result, on his/her productivity are 1) the duration of the disability and 2) its severity. Table 2 provides an array of different categorizations used to estimate severity. The definitions of severity of impact focus on the extent to which the individual is unable to farm or participate in other economic and important household

Table 1

Summary of Studies Documenting
The Relationship Between Peak Transmission
Periods of Guinea Worm and
the Rainy Season

		Relation of Peak Transmission Period to the Rainy Seasons			
Author	Studies	During Rains	Beginning of Rains	1-3 Months Before	4 or More Months Before
Muller(30)*	16	3	2	9	2
Saxena(43)	Mayhya Pradesh			1	
Sahba et al(42)	South Iran				1
Belcher et al(3)	South Ghana			1	
Kale(23)	West Nigeria			1	
Johri, Saxena(21)	Madhya Pradesh			1	
Edungbola(15)	Kwara State, Nigeria			1	
Carme(8)	Mali	1			

*table in appendix, page

Table 2

Categorizations of Severity

I. Kothari et al (24)

(i) severe: acute oedema, erythema, ulcer and swelling accompanied by severe pain and marked disability

(ii) moderate: local swelling and ulcer with some pain and disability

(iii) mild: local swelling ulcer or both but no disability

II. Pardanani et al (38)

Grade I: visible and palpable subcutaneous worm but no acute inflammation, pre-emergent stage

Grade II: Ulceration with or without a protruding worm; inflammation but not so severe as to cause disability

Grade III: abscess, ulcer, oedema and cellulitis, with or without malaise; secondary bacterial infection resulting in disability

Grade IV: more severe manifestations with acute deformities and marked disability

III. Kale(23)

Grade I (mild): with minimal or not discomfort

Grade II (moderate): with severe discomfort but mobile - usually with a limp (31%)

Grade III (severe): with severe discomfort and immobile

IV. Packer (37)

1 - minor disability
2 - restricted activity
3 - limited activity
4 - limited mobility
5 - confined
6 - death

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activities. Although only limited evidence exists, according to the definition above, it would appear that the MMWR estimate of approximately 40%[9] of those inflicted being completely disabled is reasonable. Data from 11 communities or clusters of communities (Table 3) provide an average range of 19 to 100 days of disability. The simple mean of these 11 figures is 43.4 days (with a relatively small standard deviation of ±4.74).

Although there is obviously no correlation between village attack rate and average individual duration of disability, there is high correlation between 1) degree and disability and location of the worm in the foot and 2) length of disability and greater number of worms.

When one attempts to assess impact of disease on economic livelihood, studies of an Asian influenza epidemic among farm workers and malaria attacks in Thailand and on mine workers in Srilanka have shown that a mere week of worker disability, on the average, can have a major effect on productivity.[17,25,26] Assuming that 40% of those afflicted have an average of 43.4 days of complete disability, examination of village attack rates, primarily those of men and women in the highest productive periods of their lives (ages 15-44), can give us a rough estimate of days of productivity lost annually by the village.[37,41]

total days lost = % 15-44 affected* x 40% complete disability annually x 43.4 days average infliction

Thus, for every 6% of the 15-44 year old population affected, we may assume an approximate one day lost annually to productivity per worker. An attack rate of around 35% would represent a week's work lost for each member of the productive population. Among the studies reviewed this attack rate was not uncommon. In general there appears to be high correlation between village

*the most highly productive segment of the village

COMMUNITY STUDY	AUTHOR	YEAR	VILLAGE ATTACK RATE	HOUSEHOLD ATTACK RATE	% MEN 15-44 AFFECTED	% WOMEN 15-44 AFFECTED	DISABILITY SEVERITY	DURATION OF DISABILITY
Wawa, Nigeria	Abolarin*	1981	5.8%		6.4%	11.6%		
Danfa, Ghana	Belcher et al	1975	28.0%		58%	40%		37.1 days
Paris, France	Carme et al	1981					Hospital	40 days**
Nipahia, India	Johri, Saxena	1974	40.27%					
W. Rajasthan, India	Johnson, Joshi	1982	6.4%	22.4%	9.9%	4.5%		
Ibadan (Rural), Nigeria	Kale	1977	13.5%		12.6%	15.7%	I(.57), II (.31), III (.12)	100 days
Kolaba, India	Kothari et al	1969						33 days*
Ibadan (Rural), Nigeria	Lucas, Oluntan							30+ days**
Ibadan (Rural), Nigeria	Muller	re Wennen	53%		50%	50%		70+ days
Amnhaydhani, India	Ojha, Johri	1980	40%	100%	48.49%	33.3%		
Kolaba, India	Pardanani et al	1977					I(4.4), II(54.6) III(37.6), IV(3.5)	
Kurnool, India (1)	Reddy et al	1969	2.39%	36.7%				37.52
(2)	Reddy et al	1969	9.86%	60.6%				38.07
(3)	Reddy et al	1969	22.71%	70.3%				41.12
(4)	Reddy et al	1969	44.48%	87.5%				31.68
Udaipur, India	Sharma et al	1979						19.18**
Southern Iran	Sahba et al	1973	2.9%		5.0%	11.1%		
Dabri, India	Saxena	1971	17.5%					
World	MMWR	1981					40% III-IV	1-3 mos.

*consult list of references

and household attack rates. Although there was less information on the attack rates by household, where information did exist, the household attack rate averaged 5.4 times higher than that of the village. In cases where the household attack rate was lower than 5.4 times that of the village, the assumption could be made that a number of households in the village were sharing unequally in the burden of affliction.* However, a more reliable figure is needed than that presented here which was obtained from data on only 6 villages or village clusters (the standard deviation was ±2.25). In summary, those factors which seem to identify villages at highest risk of serious economic loss through lost productivity are:

1) those in which seasonality of attack occurs during peak agricultural effort
2) those with a high attack rate occuring in the 15-44 year old age group
3) those with a high worm per individual average
4) those with a long average period of disability

Similarly, it is possible to identify those households at highest risk within communities by determining those with

1) percentage of productive adults inflicted
2) a high dependency ratio (to be defined)
3) a high income needed to income available ratio
4) low socioeconomic status
5) lack of understanding of disease factors

The household dependency ratio is an heuristic statistic which attempts to estimate the extent to which household consumption demand is balanced with productivity.[14,27] Most household productivity results from the efforts of members aged 15 to 44. Since this age group also consumes a

*this is a direct function of community average household size higher level of household productivity than do those who are younger, the value in having a high percentage of productive workers in the household is marginal rather than absolute.[32] Other factors such as availability of land and the potential for obtaining high cash wages are important considerations.[35] What is significant in estimating status is the specific mix of cash and farming income. To increase yields, a household may need to purchase advanced technology (machinery, pesticides, etc.)[40] Pelto[46] has found that families which have both adequate material resources and local wage labor are the most successful. At the same time, outside work, in a cash cropping economy unless only seasonal, reduces the pool of farm workers and can accelerate village and household member out-migration.[14,29] There is growing evidence that increasing demographic pressure on the household is important since the result is the "financing" of increased total food through reduced savings and nonfood consumption.[5] The additional demand for productivity also reduces leisure time and the expenditures of resources on equally critical activities such as child care.[27] The hypothesis that there is considerable labor flexibility in rural areas as a result of constantly available underemployment has not been well demonstrated.[39] Further, during times of peak activity such as planting or harvesting, any flexibility that might have existed disappears as the marginal farm workers are conscripted to help.[29,32] The formula on page 12 provides a relative means of estimating pressure on a household, community, or region. Actual quantification of the variables would be difficult. The major point to be made by the formula is: demographic pressure is much more a function of social units to cope with the surrounding environment than a measure of people per square mile.(27) Demographic pressure is defined in the formula as all household members divided by those who are productive. Thus, the loss of a single productive member in this formula can seriously increase demographic pressure on a household:

$$\text{demographic pressure} = \frac{\text{productive adults} + \text{nonproductive adults} + \text{seniors} + \text{children}}{\text{productive adults (cash + farming income)}}$$

The stages of the lifecycle through which a household passes may also determine its ability to cope with disability. Additional children have an initial impact on household socioeconomic status because of child care demands but only modest demands on consumption.[35] As they grow, so does consumption demand until an age when they may become productive.[32]

Socioeconomic status can be represented in several ways. Household income[2] has been found to be significantly related to "a child surviving to age 5". Other socioeconomic factors which have been found related to "child mortality" are: 1) the mother's educational attainment, 2) her health, 3) household use of toilet facilities, and 4) type and availability of medical facilities.[2] In addition, an obvious and a recurring theme in the literature is the relationship between health and the extent of disease prevalence in the area.[2] Thus, the extent to which a household has a high dependency ratio, little opportunity for alternate cash income, greater consumption demands than potential for productivity, and multiple members inflicted would identify those households at high risk for further eroding of the socioeconomic and health base. One author has written that the traditional economic system may have been a better buffer against disability than is the modern.[40] The household with a high dependency ratio and a high need vs. available income ratio is forced to purchase goods on the market at the time of the year (just prior to the next harvest) when prices for these goods are the highest, further compounding economic difficulties.[34] In short, as with economic crises in general, guinea worm suggests a possible vicious cycle of problems with a potential for actual economic destruction. (figure 1, page14) Fortunately, this sequence is a worst case scenario which will occur among only a portion of the households in a given community even where the community attack rate is high. While this scenario is drawn from studies of the impact of other disease on rural productivity as well as the general literature of rural development, the important point is that the existing literature on the impact of guinea worm disease provides us with a very limited basis for estimating disease impact. Development of studies to assess this impact should be a high priority but should not divert resources away from efforts to eliminate guinea worm as a health threat. Rather, those studies which should be assigned highest priority are those which provide field workers with clear guidelines in deciding where to focus scarce resources. What are needed are:

1) refined comprehensive surveillance schemes

2) systems for identification of communities and households at high risk of serious socioeconomic and health repercussions of infection

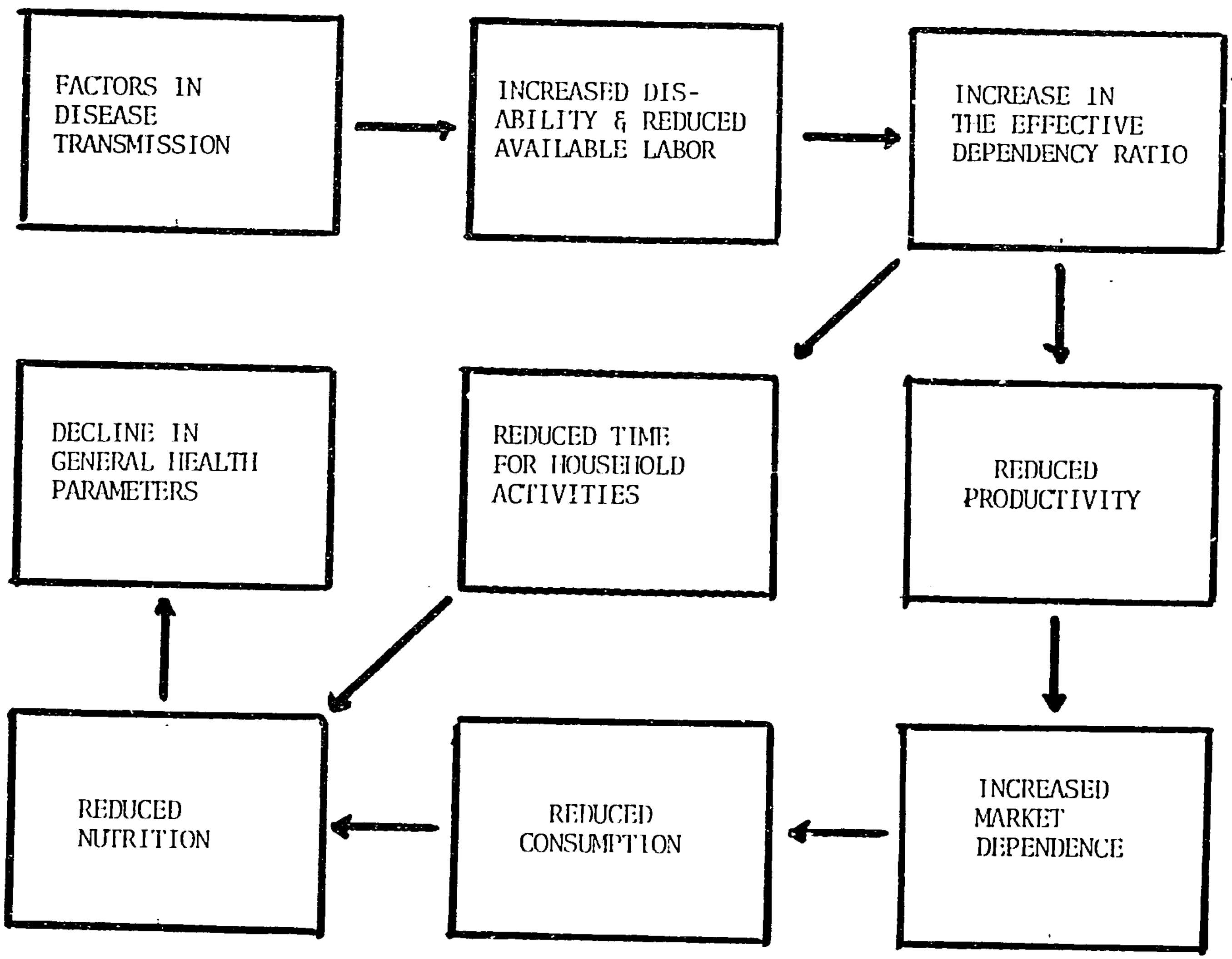
3) careful estimates of variables influencing loss of productivity as the result of disease

4) studies which provide criteria for determination of allocating limited resources in a balanced fashion to preventing primary disease care, and social welfare efforts for those affected most

To conservatively estimate the annual impact of guinea worm on productivity world wide and to justify financing development of a coordinated effort of eradication, let us assume that the estimated range of 10 to 48 million cases of guinea worm annually is correct, that the 15-44 year old

Figur

ESTIMATING THE EFFECT OF GUINEA WORM ON
HOUSEHOLD SOCIOECONOMICS AND HEALTH



population makes up about 1/3 of the total, that 40% of those afflicted by guinea worm are significantly disabled and that the figure of 43.4 days complete disability for severe cases is accurate. Then if, we value the daily wage at a conservative one dollar (US) per day, the total annual lost wages would range from 56 to 277 million dollars. It is felt that these estimates are extremely conservative.

	Estimate A	Estimate B
	10 million cases	48 million cases
population aged 15-44 (33%)	3.3 million	16 million
workers completely disabled (40%)	1.3 million	6.4 million
cost per disabled worker (US $1/day)	$43.40	
Total lost annual productivity (US $1/day)	$56,419,875	$277,760,000

This, of course, does not take into consideration agricultural profit lost nor government and private resources diverted from other development efforts. Thus, any program which expends less than the lost productivity cost in guinea worm or in reducing its equivalent annual impact could be argued to be cost effective.

Summary

Guinea worm is one of the few parasitic diseases which could be completely eradicated through the avoidance of drinking contaminated water. The worm has a major impact on household productivity because of its frequent occurence with peak farming activities. Its ability to severely disable those afflicted is the major reason for attempting its eradication. Attempts in this paper to estimate its impact are based on sketchy information. At the same time, the existing literature permits an assessment of its impact which may justify the establishment of a comprehensive surveillance system and a balanced approach which includes preventive and curative services. There is a need for establishing more complete data bases, comparing those attached with the remainder of the village population in order to identify high risk communities and households.

There is need to determine the extent to which guinea worm is responsible for the following sequence of events in order to build a case for a comprehensive intervention program:

1) increased disability
2) reduced manpower
3) an increase in the effective dependency ratio (due to disabled adults)
4) reduced leisure time
5) reduced productivity
6) increased market dependency
7) reduced savings
8) reduced consumption
9) reduced nutrition
10) decline in general health parameters

Programs to deal with guinea worm should not, however, wait until this information is available. Its impact has already been demonstrated in numerous studies worldwide.

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The Relationship Between Peak Transmission
Periods of Guinea Worm Disease and Rainy
Seasons: A Summary of Studies

Region	Transmission season	Peak transmission	Rainy season	Authority	Date
India					
Rahasthan	May-October	July	June-September	Lindberg	1946b
Bombay	February-May	March	June-October	Pradhan	1930
Mysore	February-July	March-May	July-September	Singh and Raghavan	1957
Madras	March-June	May	July-September	Fairley and Liston	1924b
	February-June	May	July-September	Patnaik and Kapoor	1967
Andhra	February-May		July-September	Reddy et al.	1969a
Pradesh	April-June	May	——	Rao and Reddy	1965
(Hyderabad)	October-July	March	July-September	Rao	1942
	January-May	March-May	July-September	Lindberg	1935
Gujarat	May-July	June	June-September	Patnaik and Kapoor	1967
Madhya Pradesh	——	March	June-September	Bildhaiya et al.	1969
Pakistan					
Tharparkar	June-October	September	June-September	Ansari and Nasir	1963
Iran					
Larestan	March-August	June	November-February	Lindberg	1936
		May-July		Sabokbar	1968
Dahomey		December-February	May-August	Roubard	1913
Nigeria					
W. State	January-June	April	June-September	Onabamiro	1952
N. States	May-October	——	May-September	Ramsay	1935
Ghana	——				
Gambaga		June	May-August	Graham	1905
N.W. Ashanti	Mainly November-June	April	May-August	Scott	1960
Algeria					
Adrar	May-September	September	September-November	Rousset	1952

From: Muller, Ralph "Dracunculus and Dracunculiasis" Advances in Parasitology, vol. 19, 1971, pp. 73-151, table VI.

APPENDIX D

DRACUNCULIASIS ERADICATION IN INDIA - plan of operations, progress, problem and prospects

M.I.D. Sharma*

Abstract

It is well known that the intensified campaign against smallpox launched in India in July 1973 resulted in making the country free from the disease in less than two years. The operations against it mainly consisted of search for cases and execution of containment measures to liquidate the foci so found. Considering that a similar approach could be made use of in eradicating the exclusively water-borne disease, dracunculiasis (guinea-worm), operations against it have been started. The disease is endemic in seven states. A total of 10582 villages in 80 districts with a population of 12.2 million are affected with the disease. Emphasis is on search for cases, to identify disease endemic places and infective water sources. Importance is being given for the provision of safe water supply in such places and chemical treatment of infective water collections with temephos. The participation of the community is being ensured through vigorous health education activities. Hope has been expressed that the disease would be eradicated within a period of five years. The main points have been highlighted and other details have been given in this paper.

Introduction

Eradication of smallpox from all the countries, declaration about which was made by the World Health Organisation in December, 1979, has undoubtedly been an unprecedented achievement.

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The achievement of smallpox-free status in India in the brief period of about two years beginning in July, 1973 clearly demonstrated the sound basis of the strategy of the intensified campaign against the disease. Besides invaluable benefits to the humanity at large in several respects this miraculous achievement has been responsible in generating confidence in the leadership of the country, technical and non-technical administrators, health organisations, community and its leaders and health workers that such successes against other diseases are possible and well within their reach with all the consequential benefits.

It is well known that operations against smallpox mainly consisted of "search for cases and execution of containment measures to liquidate the foci so found." It was thought that for a country like India such an approach can be successfully made use of for eradicating the disease due to the infection of Dracunculus medinensis (guinea-worm). Experienced epidemiologists elsewhere have also been thinking on the same lines and are confident that with the implementation of a well thought-out, fool-proof strategy, with keeping eradication of the disease as the firm ultimate objective success against it can also be achieved, within a few years.[1,2,3,4,5] By way of recapitulation it may be stated that guinea-worm disease spreads from water sources like step-wells, ponds and tanks which can be identified and dealt with. It is an exclusively water-borne disease. It is an infection of the subcutaneous and deeper tissues with about a metre long female worm, Dracunculus medinensis which takes about one year to mature. In 85 per cent of cases a blister appears on a lower extremity, specially the foot and when this part is immersed in water the larvae are discharged which are swallowed by cyclops species (class crustacea). After a fortnight the disease can be transmitted to a new host who drinks this infective water.[6] The larvae liberated in the stomach or duodenum migrate through the viscera, become adults and reach the subcutaneous tissues. The disease has an incubation period of about 12 months and again the female reaches the skin to discharge the larvae and thus the cycle is repeated.

Dracunculiasis is one of the oldest tropical diseases and has been known to exist in India from very early times.[7] It was estimated in 1947 that out of 48 million persons residing in areas endemic for the disease in the whole world 25 million were in India.[8] It is a disease of remote rural areas where there is water scarcity. The disease usually disappears from places where protected water supply is made available. The latest information has been obtained through visits to all villages in the known affected/suspected districts by paramedical personnel who enquired about the occurrence of cases from the year 1977 onwards. It was found that seven states viz. Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu are having areas endemic for the disease. A total of 10582 villages, in 80 districts with a population of 12.2 million are affected with the disease.[9, 10]

Dracunculiasis as a health problem

The programme to eliminate dracunculiasis would not only reduce the suffering from the disease, but might also have demonstrable secondary effects on agricultural output (in some areas, up to 30 per cent of the workforce is incapacitated during the period of maximum agricultural activities) and also very likely tertiary effects on nutrition of young children in affected villages. Though infection by itself does not cause mortality but it does result in prolonged suffering and disability of its sufferers up to about three months. A number of the patients also suffer from several complications as a consequence to the disease. At least 0.5 per cent of them may be permanently disabled.[3,5] The preventable economic loss therefore is enormous.[11,12]

It is some-times argued that the population under risk is so small that the disease as such is not a major health problem. It is a fallacious consideration from the point of view of the affected community because health planners always advocate that plans should cater to the felt needs of the people.

Moreover the venture is more than justified on economic considerations alone. When a disease is eradicated from a country or all countries of the world the gains in terms of money are infinite.

The epidemiological features of the disease are such that it cannot spread to other non-endemic areas. The spread of the infection is only from specific water sources to specific receptive water collections. In fact there is little possibility of other than known water sources to get infected. It is also a disease of remote and under developed areas where the movement of persons remains extremely limited. These indeed are the reasons which make the disease easily eradicable in practice.

Plan of operation for disease eradication

The Government of India based on the recommendations of the task force on "Eradication of guinea-worm disease in India" agreed to undertake eradication of this totally eradicable disease. The National

Institute of Communicable Diseases has been made the focal point to plan, guide and monitor the operational activities and their impact on disease incidence in the endemic states. In this connection an "Operational Manual on Guinea-Worm Eradication" has been prepared. In it the details of the strategy, calendar of activities, job description of staff and methods of assessment of activities and the results there of have been given.

The main components of the disease eradication programme are briefly stated below:

Identification of disease endemic areas and infective water sources:

The first essential step in the disease eradication programme is the identification of villages with dracunculiasis cases having occurred from the year 1977 onwards through case search operations carried out by para-medical personnel. In endemic areas the disease is very well recognised and the past or present cases are well known to the local inhabitants. Therefore the information can easily be elicited from a few prominent persons of the place. Similarly the infective water sources are identified with the help of the cases and community leaders. Three case search operations have already been carried out and it is planned that such operations would be undertaken twice during the coming years. In places where no cases are detected during two consecutive years, would be declared as having eradicated the disease.[13] The lists of endemic villages have been given to the concerned Public Health Environmental Engineering Organisations so that they arrange to supply safe water in these places on priority basis. The current International Drinking Water Supply and Sanitation Decade has provided additional stimulus and impetus to such an activity.[14] The infective water sources are to be closed where alternative safe water supply is available. In places where this is not possible these can be made safe as far as the transmission of dracunculiasis is concerned, by minor engineering measures like converting them in to draw wells.

Use of Temephos as a cyclopscidal agent:

It is well recognised that provision of safe water supply in all the disease endemic places would take time, the water supply may be intermittent, there is possibility of its break down at times and due to various reasons the people may continue using water from infective sources. It is therefore necessary that these water sources are periodically treated with a cyclopscidal agent. Temephos is considered most suitable because of its effectiveness and very low mammalian toxicity.[4,15] Sand granules containing two per cent of temephos have been found to be a suitable formulation. This is applied at the rate of one gram per 20 litres of water (i.e. 50 gms. per cubic metre). This gives a dosage of one part of temephos per million parts of water. Premeasured quantity of granules in a sprinkler for a particular water collection, is to be applied uniformly. The first application is to be made immediately before the transmission season. The effectiveness of temephos for different types of water collections may vary. Usually its application is repeated every six weeks or so as indicated by the density of cyclops, during the transmission season in a particular place.

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The method of finding densities of cyclops by using the recently designed device named funnel net may be adopted.[15]

<u>Personal prophylaxis</u>: For individual protection the simple measure of sieving water through a double-folded muslin cloth is advocated. This will filter out the cyclops and thus make the water safe.[7] Boiling of such water though effective is neither practical nor economical.

<u>Treatment of cases</u>: Treatment of cases is undertaken as a medical relief measure and to encourage the patient to visit the nearest primary health centre or dispensary where he is to be imparted the necessary health education. The age old treatment of laboriously rolling out each emerging worm a few centemetres each day is no longer necessary. Any of the drugs like niridazole, thiabendazole and metronidazole can be given to the patient for quick expulsion of the worm. Other measures are also taken for the prevention or treatment of complications.[2, 17]

<u>Health education</u>: Health education is an important and very vital component of the disease eradication programme. All the staff and all the available media are to be used for this purpose. They are to be informed about the mode of transmission of the disease, methods of personal prophylaxis and the details of activities being undertaken for the eradication of the disease. The affected communities and particularly the active cases with blisters are instructed about the imperative necessity of their not entering into drinking water sources.

Evaluation of the programme: Officers responsible for the implementation of the programme at the central, state and peripheral levels are to undertake concurrent evaluation. The evaluation would be achievements related to the main operational activities, for example quality and thoroughness of case search operations, progress in the provision of safe water supply. In the disease affected places and chemical treatment of infective water sources. The evaluation exercise is also to include the impact of the operational activities. This is measured in term of the reduction in the number of affected places and incidence of cases till no affected village or new case is recorded in any of the endemic states for two consecutive years.

If a place with fresh case(s) is found during any of the case search operations, proper epidemiological investigations are to be carried out as to how and from where the person(s) acquired the infection and necessary remedial action is instituted accordingly.

In conclusion it may be stated that dracunculiasis except in the endemic areas has not got the image of a frightening disease as far as the administrators are concerned. Therefore for maintaining their continuous interest in and support to the programme regular feed-back on the program and also the problems hindering the activities is essential. Careful watch has also to be kept on logistics with regard to the timely and adequate supply of equipment and material. Similarly the interest of the staff in the programme activities is maintained by highlighting the achievements and providing supportive supervision by pointing out to them remedial actions for the removal of shortcomings noticed. It is hoped that the disease would be eradicated from the country within the next five years.

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CYCLOPOID COPEPODS: THEIR ROLE IN THE TRANSMISSION AND CONTROL OF DRACUNCULIASIS

by

Fergus S. McCullough*

Introduction

Leiper stated, as long ago as 1906, that the "practical study of dracontiasis, one of the oldest known and, in some regions, the most prevalent of tropical diseases, has been singularly neglected". Until very recently Leiper's opinion has remained largely unchallenged in spite of the major socio-economic advancements and outstanding technological achievements of the last 50 years.

"Why have practical studies, with a few notable exceptions, aimed at the prevention and control of dracunculiasis, been so rarely and spasmodically undertaken during the present century?" This question is perspicacious, as *Dracunculus medinensis* may be considered one of the few human parasites with so few evolutionary options, *ipso facto*, as to put it on the endangered species' list, especially if, added to its own limitations, mankind's concerted efforts to bring about its demise could be enlisted.

The main reasons for the long neglect of these studies are as follows:

- globally, the distribution and public health importance of the disease does not compare with such other parasitic infections as malaria, schistosomiasis, soil transmitted helminths, etc: at global level, therefore, its priority is relatively low;
- nationally, the disease is seasonally restricted to small, often isolated communities located in impoverished areas without, to say the least, political influence, and with little chance of benefit from concerted public health activities;
- neither effective drugs nor a vaccine to treat or prevent the disease exist. Infected villagers have, therefore, little incentive to seek treatment at dispensaries/hospitals and tend to rely much more on traditional methods: consequently the true

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gravity of the malady is often hidden. The villager accepts the infection fatalistically and mostly without complaint; the overworked clinician realises that there is little he can effectively do to prevent/cure the patent parasite; and public health workers are mostly over-burdened with other more urgent health priorities;

- while the methods of preventing dracunculiasis are simple, their organisation and effective implementation in remote, rural areas are surprisingly complex and, not infrequently, daunting. However, recent advances in primary health care concepts give rise to more promising control prospects;
- prevention and control of dracunculiasis demands a multi-disciplinary approach;
- biologists have, for obvious reasons, concentrated in the main on medical entomology, occasionally on malacology and hardly ever on the Subclass Copepoda, probably because so few important human parasites are transmitted by the latter group.

In the present paper an attempt will be made to summarize the role of cyclopoid copepods in the transmission and control of dracunculiasis.

Attention will be drawn to some unresolved problems, with special regard to the intermediate hosts and their preferred habitats, particularly those deserving to be more fully studied with the aim of developing more cost-effective, integrated control strategies.

Freshwater cyclopoid copepods

These minute, pin-head sized crustaceans are biologically very successful, comprising many genera with diverse feeding habits, found almost exclusively in standing or slow-flowing waterbodies and with a world-wide distribution in marine, brackish and freshwater habitats. For example, the pelagic, marine forms occur in enormous quantities and play a crucial role in the food chain of many fishes and whales. In addition, parasitic copepods are a favourite subject of study in many Biology Departments, as the parasitic

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way of life has been exploited by numerous members of many different copepod families, and every stage of parasitism, between ordinary free-living forms and the most complex or degenerate parasites, is exhibited.

The free-li ‹g, freshwater cyclopoid copepods (kn›wn also, for brevity, as cyclops), are pear-shaped organisms, comprising a cephalothorax, an abdomen and a telson with a tail of two caudal rami. The sexes are separate and the egg hatches into a typical nauplius larva, which is then succeeded by several metanauplius stages before moulting into the first of five successive copepodid stages. Almost nothing is known of the susceptibility of the different instars to the infective larvae of Dracunculus. Moreover, few publications specify confirmation of the taxonomic status or the exact age or size class of infected cyclopoids.

Taxonomy and biology of cyclops acting as intermediate hosts

Dr Ralph Muller (1971) in his review entitled, "Dracunculus and dracunculiasis" has listed 17 species of cyclops which can potentially act as intermediate hosts in different endemic areas; in addition, Cyclops vernalis americanus has proved an excellent experimental host (Mueller, 1959 and Muller 1968), although it has not been recorded in dracunculiasis endemic regions. More recently, Steib (1982), working in Upper Volta, has added two more species (Thermocyclops incisus and Metacyclops exsulis) to the list of potential intermediate hosts. Further species will no doubt be incriminated as more research in natural transmission sites is undertaken in the future.

Concerning the taxonomy and biology of cyclops, the following aspects are salient, but few have been exhaustively studied:

- only large, predatory species can readily ingest D. medinensis larvae and can thus act as potential intermediate hosts: of these carnivorous species the older and larger copepodid stages are more predatory than the younger and smaller ones (Steib, loc. cit.). The smaller herbivorous species are excluded as natural intermediate hosts;

- in each endemic zone usually one only of the local predatory species is the dominant intermediate host by virtue of its preferred habitat and/or its seasonal population dynamics;

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- even among carnivorous species some are more compatible to D. medinensis infection than others. While intermediate host specificity does not strictly occur, there exist some species of predatory cyclops which are more resistant to infection than others;
- the reproductive biology, bionomics and behaviour of the dominant intermediate host species in natural transmission sites (seasonal ponds, step-wells etc.) in most endemic zones, in relation to biotic and abiotic parameters and according to cyclops/D. medinensis infection patterns, has scarcely been studied even though valid techniques to do so are now available (see Anon, 1982). Obviously, data from such studies, together with information on human/water contact patterns, could help to identify and predict, with reasonable certainty, according to geographical area, the most important site or sites of transmission;
- some species of carnivorous cyclops are more difficult, for unknown reasons, to maintain in the laboratory than others, but good experimental hosts (eg. C. vernalis americanus) do exist;
- Muller (1971) has already pointed out that nothing "is known of the number or density of infected cyclops necessary for continued transmission in a particular habitat". Sound data on this subject are a prerequisite for a rational evaluation of control measures directed against the copepod hosts.

Preferred habitats of the cyclopoid hosts and season of transmission

Transmission of D. medinensis is normally not associated with flowing water courses, with draw wells or with impoundments, such as lakes and dams, which retain large volumes of water even at the climax of the dry season.

Running water, in general, is incompatible with the maintenance of carnivorous copepod populations. They may occur in draw wells, but exposure to infection is mechanically minimal in such habitats. While some species of potential intermediate hosts may occur in large impoundments, their populat[illegible] density in them is relatively low and this is probably the main reason for the low transmission potential of such waterbodies.

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Both seasonally dense populations of cyclopoid hosts and high transmission potential are associated with two main types of waterbody, viz:

(i) step-wells in the Indian sub-continent and cisterns ("birkehs") in Iran;

(ii) small, usually impermanent, man-made ponds, constructed to provide seasonal, domestic water-supply, and therefore much used during a particular part of the year.

With regard to the main seasons of transmission the present consensus seems to be:

- in none of the endemic areas is transmission associated with the peak of the rainy season;
- in the Sahel and dry savannah areas of West Africa maximum transmission may take place at the onset of the rainy season, coinciding with the main planting period;
- in the wetter savannah zone, nearer to the West African coast, and probably to the South of Sudan, peak transmission usually coincides with the advance of the dry season prior to the drying up of village ponds;
- in Iran, Pakistan and India transmission is generally confined to areas of low rainfall and is maximal during the summer months;
- in all endemic areas peak densities of intermediate hosts and transmission of *D. medinensis* is confined to less than three months per year;
- the incidence/prevalence rates of dracunculiasis is intimately related to local rainfall/evaporation patterns. Prediction of "good or poor dracunculiasis years", by analysis of local meteorological data, has not yet been studied in depth.

evelopment of *D. medinensis* in the cyclopoid host

The Russian biologist Fedtchenko was the first to describe this phenomenon ust over a 100 years ago. Muller (1971) has noted the historical significance or tropical medicine of this discovery.

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During the last 50 years the salient features in the development of D. medinensis larvae in the cyclopoid host have been adequately described, though some minor and quantitative aspects remain to be elucidated.

Both epidemiologically and from the viewpoint of intervention, Muller's (1971) observation that, although the larvae may remain active in pond water for a week, the "percentage infection rate in cyclops fell sharply after three days of storage in pond water and was nil after six days" is pertinent. Although data on temperature were not given, it can be predicted that the sensitivity of the first stage larvae to temperature, like that of later stages, within the cyclops host, is more pronounced than that of the cyclopoid copepods themselves to this parameter.

The first stage larvae are ingested by the intermediate host and actively break through the gut wall to reach the haemocoel where, at temperatures above 25°C, they moult twice to reach the infective third stage in about two weeks. Thereafter they may continue to develop for a further few (1 to 3) weeks.

There is little information in the literature on the average life-span of infected and uninfected cyclops in relation to the range of abiotic factors normally recorded in natural transmission sites.

In nature a single larva only is found in the copepod host and multiple infection tends to be lethal. However, Muller (1971) mentions that "experimentally infected adult cyclops [C. vernalis americanus] may have up to five larvae". Steib (loc. cit.) has drawn attention to observations that infection not only retards development of the cyclops host, but also that infected immature cyclopoids do not become mature. He also draws attention to the problem that little is known of the precise status of different cyclopoid species and their developmental stages in the transmission of dracunculiasis. Moreover, Steib notes that the "importance of the different instars of each cyclopoid species in acting as intermediate host of Dracunculus depends on the following condition

(a) the feeding habits of the cyclopoids: whether or not the different instars of each cyclopoid species ingest Dracunculus larvae;

(b) the potential for enduring infection with Guineaworm larvae and the species-specific resistance of cyclopoids: whether or not the Dracunculus larvae may conclude their development in the different cyclopoid instars without being killed by the host or without lethally damaging the host.

(c) the survival time of infected cyclopoids after the Dracunculus larvae have reached their infective stages".

With regard to the behaviour of infected cyclops, Onabamiro (1954) noted that specimens harbouring third stage infective larvae tend to remain at the bottom of the pond, in contrast to uninfected specimens (C. nigerianus, Kiefer) which exhibit marked vertical diurnal migration. The role of the behaviour of infected cyclops to transmission potential remains conjectural.

Cyclops control

Should global eradication of any pathogenic human entaparasite be anticipated, D. medinensis is probably, for many reasons, the prime candidate despite the fact that control relies, for the time being, on preventive, rather than curative, measures.

Prevention at community level can best be achieved by a combination of (i) sustained health education aimed at ensuring maximum awareness of the problem and commitment to overcome it by self-reliant means;

(ii) provision, if possible by appropriate technology, of safe and enduring domestic water supply and, if necessary,

(iii) control of infected cyclops by chemical/biological methods or by, for example, simply ensuring that drinking water from potential transmission sites is sieved during the short period when Dracunculus is patent. A research study on the latter topic, based on appropriate technology and community participation concepts, is presently being carried out by Dr K. Steib in Upper Volta, supported by the Director's Initiative Fund of the UNDP/ World Bank/WHO Special Programme for Research and Training in Tropical Diseases.

Inevitably, dracunculiasis prevention must be multi-disciplinary and good coordination of the different elements involved is mandatory. Control of Dracunculus at village level lends itself to primary health care principles; at national level, marked reduction, if not elimination, of the infection is attainable, where enthusiasm and support by all concerned are assured.

The possible need to control cyclops should not be omitted from this triumvirate of preventive measures. Rural people, in general, are conservative and prefer traditional water sources, or they may be forced to resort to them if the improved water supply fails to function adequately. In the Upper Region of Ghana, for example, more than 50% of over two thousand pumps had ceased to function within two years of installation.

Chemical control of cyclops

Compounds used for control of cyclops should be: highly toxic to all developmental stages of cyclops; of low cost; of insignificant toxicity to mammals and fish; tasteless at effective concentrations; readily available; easily applied; effective residually for at least four, preferably around twelve, weeks; stable in storage.

Many chemicals have been tested (Muller, 1970), though few under field conditions, and the organophosphorous temephos (Abate®, primarily used as an insecticide, see WHO, 1975), in sand granule formulation, is presently considered to be the compound of choice. This formulation is commercially available (1% active ingredient), and at the recommended dose of 1.0 mg/litre cyclops should be eliminated from the waterbody for between 5 and 7 weeks. Muller (1979) observed that the sand granule formulation of temephos "provides a very convenient method of adding the compound to ponds as it has limited solubility and the quantities do not have to be dispensed with any great accuracy". Since issuing the WHO/FAO Data Sheets on temephos in 1975, two year feeding studies in rats have been completed and no significant difference between the incidence of tumors in exposed rats (10 mg/kg, 100 mg/kg and 300 mg/kg of temephos in the diet) and control animals was found. Moreover, during large-scale field trials and operational use in Thailand and Indonesia of temephos in the drinking water at a target concentration of 1 mg/l, no complaints have been reported.

The timing and frequency of applications will vary according to the local epidemiological conditions. The timing of the first application will depend on local rainfall/evaporation patterns. It should also coincide as closely as possible with first evidence of patent infection in the community, bearing in mind that larvae in the intermediate host require about two weeks to develop to the infective third stage. Therea applications may be repeated at monthly intervals until the end of the transmission season. Rarely more than four applications during the transmission period in any endemic area are likely to be necessary.

The recently published operational manual (Anon, 1982) entitled "Guineaworm Eradication Programme in India" gives very clear, practical details for the use, properties, formulation, dosage and frequency of application of temephos. This document should provide an excellent model for the preparation of other national manuals on dracunculiasis control.

The need for both small and large-scale field testing of the efficacy of temephos for D. medinensis control in different endemic areas representative of the range of epidemiological conditions cannot be too strongly stressed. After the methodology of applying temephos has been clearly defined, the feasibility of its use under the supervision of community leaders deserves to be encouraged. Similarly, studies to identify improved residual formulations, permitting reduction in the frequency of application, are desirable.

Biological control of cyclops

Two field investigations on the biological control of cyclops have been recorded some 40 years ago in India (Moorthy and Sweet, 1936; Gidgeon, 1942); in recent years no biocontrol studies have apparently been carried out. Certain species of fish predators have been advocated on the basis that, apart from efficacy, they may be cheaper and more permanent than repeated chemical control. In permanent step-wells, Gideon recommended the use of Rasbora doniconius, while Moorthy and Sweet reported encouraging results following the introduction of Gambusia and Barbus spp. The latter authors describe routine methods for the use of fish as biocontrol agents of cyclops in 35 endemic villages. Transmission of dracunculiasis was eliminated in six villages and significantly reduced in four others. The maintenance of fish in the transmission sites posed certain problems, but these were not insurmountable; the first measure in routine control of D. medinensis transmission by small predatory fish should be the establishment of hatcheries for regular supply purposes. They pointed out that a successfully controlled step-well could, of course, function as a hatchery. Moreover, in India the custom of keeping fish in the drinking water supply is widespread.

In spite of these encouraging results, it is noted that the new manual on dracunculiasis eradication in India (Anon, 1982) makes no mention of biological control. In Africa, where many transmission sites dry up each year, the only fish which may be considered for biocontrol are those belonging to the so-called annual species. The efficacy of certain invertebrate competitors/predators of cyclops should also be explored.

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HEALTH EDUCATION STRATEGIES FOR THE CONTROL OF DRACUNCULUASIS

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HEALTH EDUCATION STRATEGIES FOR THE CONTROL OF DRACUNCULUASIS

Behavioral factors contributing to the transmission of Dracunculuasis have been sufficiently and clearly documented[1]. There is a general agreement among behaviorists that the transmission cycle involves two clear distinguishable and preventable behaviors of man[2] viz:

(i) An infected person harbouring an adult worm gets in touch with water containing cyclops (the intermediate host);

(ii) A susceptible person fetches and drinks the contaminated water containing the infected cyclops.

But although the associated behaviors may appear obvious and simple, it is paradoxical in that we have a situation whereby man pollutes his own source of drinking water and then consumes the water without taking any measures to protect himself from the possible effects of his action. The second paradox is that preventive measures are much cheaper, effective and adaptable whereas curative measures are very costly, inconveniant and unperfected; yet affected populations have not always taken sufficient advantage of preventive measures. The third paradox is that compared with many other vector-borne infections the control of dracunculuasis is more responsive to educational intervention yet educational efforts have not been relatively rewarded.

Health Education activities for the control of dracunculuasis have focused on three broad areas:

(i) Community awareness and perception of the disease especially with respect to the notion of causation and remedy;

(ii) Availability and acceptability of disease control measures by targeted populations;

(iii) Community participation and acquisition of skills needed for the surveillance of introduced control measures.

With respect to the first area, research evidence continues to show a marked shift from the traditional, regionalised and unscientific notions of causation and prevention to the more proven, scientific and cosmopolitan ones. For example, studies carried out in some rural populations in Nigeria where dracunculuasis is endemic show that more and more people over time are associating the cause of the disease with polluted water[3]. But then, when disease assumes epidemic proportions people begin to doubt the validity of their notion of causation and begin to find other causes which are less scientific to explain the situation. This means that infection is considered normal and acceptable provided it does not go out of proportions. This type of coping behavior is not peculiar to one culture. There is that usual expectation of a new explanation to any abnormal situation in any culture and people are always satisfied with the invention or suggestion of a new reason[4] Here, it is being hypothesized that for any endemic disease which is linked with people's lifestyle (as dictated by their natural environment) and to which no effective remedy has been found, there will always be a tendency on the affected population to demonstrate a minimum level of tolerance for the disease. The danger of this attitude from an intervention point of view is that remedies sought for the disease may not go beyond coping measures. This has a strategic implication for timing of intervention to coincide with abnormal situations when people will be receptive to new information and will be willing to accept new measures hitherto extra-orainary.

The second unique peculiarity in the control of dracunculuasis is the "application gap" in the acceptance of available control measures. As already noted, technology for the prevention of dracunculuasis has been more perfected for preventive than for curative measures. Improved water supply in form of provision of protected wells and springs or pipe-borne water which break the contact between the infected person and the vector has been responsible for dramatic reduction in prevalence rates in many areas of the world. Though there have been instances of rejection of water improved measures these have been sporadic and largely attributable to lack of community participation and involvement in the planning and execution of such projects[5]. But with respect to curative measures for the disease, the available technology is far from being perfected. For example, the criteria for early diagnosis are not yet well defined and removal of the adult worm has not been as dramatic as the infected person would want it or at best curative medicine has succeeded only in the prevention of complications such as tetanus and treatment of ulcers. The educational implication is that the replacement of traditional approaches which are considered to be ineffective with modern ones which are considered to be more effective is bound to face major problems of acceptance unless efficacy of modern technology is well proven to be far superior to traditional ones.

The third aspect of control measure is in relation to the importance of community participation and involvement with the ultimate goal of self-reliance in the surveillance of control measures once developed. In the control of dracunculuasis, the mark of success of most intervention programmes has always been a marked short term reduction in the prevalence and incidence of the disease whereas the most important evaluation criteria for successful intervention should be the extent to which the affected population has accepted responsibility to carry out the established control measures on a permanent basis. This is because there has not been a major break-through in chemotherapy and even when this is achieved, the usefulness is limited because re-infection is so easily possible.

Health Education activities have focused largely on human behaviors or actions and inactions which pre-dispose to the spread of the disease. There is no specific protection like immunization for dracunculuasis and the intervention at early stages of the on-set of the disease is made difficult by the long period of incubation. The morbidity rates are only dramatic when its endemicity assumes epidemic proportions. Also the benefits of preventive actions cannot be easily demonstrated as it takes about 2 years to see significant reduction in incidence rates. These factors combine to make dracunculuasis a disease of under-perceived seriousness.

Educational intervention must therefore include short range control measures for purifying water to make it potable as well as long range measures for improvement of sources of water supply by structural protection and vector control. For lasting results or eradication, educational efforts must emphasise training and acquisition of skills by the affected population for eventual maintenance and management of improved water sources. Therefore, the resources for control of dracunculuasis must preferably be found primarily in the affected community itself and the real over-driving force should exist as a component of the local health delivery system. It is also important when innovative control measures are being introduced that the rate should be within reasonable limit and the magnitude within the economic resources of the population but the size sufficient to make an impact.

For analytical purposes, four behavioral change models could be used in designing health education strategies for the control of dracunculuasis. These models are:

(i) The Behavioral Control Intervention Matrix Model;

(ii) The Replacement Model;

(iii) The Application Gap Model; and

(iv) The Primary Health Care Model.

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It must be noted that these models, though distinctive, are inter-related and there may be an over-lapping application of two or more of them at the same time.

I The Behavioral Control Intervention Matrix Model:

Developed by Mr. William Brieger[6] in the course of his field work on dracunculuasis control in Ibarapa District of Oyo State, Nigeria where the disease is endemic, the model emphasises that a clearer understanding of human behaviors contributing to the disease involves the following three steps:

(i) Identification of behavioral control action levels for the disease based on epidemiological information. Action levels identified for dracunculuasis from an epidemiological point of view are health promotion, specific protection, early detection, limitation of disability and rehabilitation.

(ii) Identification of behavioral factors which operate at each behavioral control action level. For example, regular boiling or filteration of water from doubtful sources belongs to the action level of health promotion, the action levels of specific protection and early detection are not very applicable for the control of dracunculuasis as there is no immunization or prophylactic measures against the disease and the incubation period before symtoms appear is very long. The action level of limitation of disability is limited more or less to the treatment of ulcers resulting from the worm as well as the prevention of tetanus infection which could incapacitate or cause the death of the infected person. The rehabilitation action level is usually social and economic in the form of adjustment due to deformities as well as loss of income from lost working days and temporary unemployment.

(iii) Tailoring of behavioral interventions to the characteristics of each action level. For example, health promotion action level will require health information and community development strategies whereas the action level of limitation of disability will revolve around strategies aimed at utilisation of modern health services for the removal of worms, treatment of ulcers and anti-tetanus immunization. Strategies applicable to the action level of rehabilitation might include health insurance, unemployment benefits and social welfare services.

other words, a level of behavioral control action level may be defined as any distinctive point or stage in the transmission of a disease at which an individual or community could engage in behaviours or actions capable of preventing the disease, reducing its severity and associated disabilities and disallowing its transmission to healthy individuals.

II <u>The Replacement Model</u>:

The theoretical basis of this model developed by Adeniyi[7] for the control of dracunculuasis is that the choice of health service and the subsequent prescription of remedy for a disease are to a large extent pre-determined by the existing under-lying notion of the cause of the disease as perceived by the individual and illustrated in the chart below:-

The Replacement Model Applied to Dracunculuasis

	Old Traditional Approach*	Modern (Western) Approach
(i) Notion of Causation	SUPERSTITION An enemy has used super-natural means to effect the sufferer by charming the worm to appear on his leg.	GERM THEORY A person is infected by drinking water containing infected cyclops.
(ii) Diagnosis	DIVINATION Use of oracles by traditional diviners to know the enemy in order to appease him	PHYSICAL EXAMINATION Physical examination, trace source of water supply for examination for cyclops.
(iii) Remedy or treatment	TRADITIONAL MEDICINE Folk medicine (herbs) sacrifice to the god, charms and amulets.	DRUGS Drugs (ambilhar) for worm removal. Anti-biotics in form of tablets and injections for accompanying ulcer, anti-tetanus immunization.
(iv) Prevention	Charms and amulets, medicinal scarifications and taboos.	Alternative source of water supply (protected wells), purification of water, Health education.

* Based on the Yoruba Belief System in Nigeria.

This model shows a marked but consistent and logical difference between the old traditional approach and the modern approach to the control of dracunculuasis and that when a change from traditional to modern is contemplated, it is helpful to have adequate information of the notion of causation, diagnostic criteria, type of remedy and type of prevention practised in both approaches. In order to ensure compliance with modern treatment regimens for the control of dracunculuasis, health education must take the following factors into consideration:

(i) The existing level of social, economic and cultural development in the community concerned as well as the degree of compatibility of traditional and modern approaches to the disease; the more compatible both are the greater the chance of success of change efforts;

(ii) The relative strengths of the traditional over the modern methods being contemplated should be identified to show whether there are any good things in the old which can be integrated into the modern that can make modern methods gain acceptance in the affected population.

III <u>The Application Gap Model</u>:

Also developed by Adeniyi[8] the application gap model assumes that -

(a) The technologies available for the various types of health problems are at different stages of development or levels of sophistication ;

and (b) There is a wide variation in the level of acceptance of these technologies in different communities.

Indices for measuring level of sophistication of a health technology with respect to a given disease include potency of drugs, cost effectiveness of treatment or preventive measures, ease of administration of drugs, duration of treatment, presence or absence of side-effects, and the extent to which the technology is "designed to fit" man and not man to "fit into" the technology. In other words, the design of any technology should take into consideration the whole range of the characteristics of the consumers. For example, a drug for children may be preferred when in liquid form instead of tablets in a culture where traditional drugs for children are usually in liquid forms. Though a high level of technological sophistication should logically bring about a high level of acceptance, this is not always the case. There are diseases like tuberculosis, tetanus and yaws in which technology has been perfected but acceptance is low probably because morbidity and mortality indices for these diseases are less severe and less dramatic.

Using this analogy, control efforts for dracunculuasis are already severely limited in that technologies in use are not yet perfected. The usefulness of the "Application Gap Model" is that it makes the health educator to be aware of the limitations of the technology he has in hand in his attempt to gain acceptance for it. The less perfected and the less accepted a technology is, the greater the task of health education. Using the application gap model, it is possible to determine the relative progress which has been made in the control of many tropical disease as shown in the following chart: Health education intervention might face an uphill task in the control of dracunculuasis because the available modern technology is yet to be perfected and its acceptance is low. For health education to lead to acceptance, there must first be a demonstrable perfection of technology.

The Application Gap Model Applied to Selected Tropical Diseases

	Level of Technological Sophistication	
Level of Acceptance	Perfected	Not perfected
High Acceptance	Smallpox	Cancer, Diabetes
Low Acceptance	Yaws Tetanus Tuberculosis	Malaria Schistosomiasis Onchocerciasis DRACUNCULUASIS

IV **The Primary Health Care Model:**

According to a 1977 report of a UNICEF-WHO Joint Committee on Health Policy,[9] the characteristics of a primary health care input to a health programme may be summarized as follows:

(a) a government policy to encourage community participation and the inclusion of primary health care at all levels of regional and decentralised planning points;

(b) tapping of external resources to supplement limited local resources;

(c) establishment of association or ties with other rural and urban development programmes

(d) mobilisation of local resources - human, financial and material, as well as training, supervision and use of primary level workers selected by the community and whose orientation is not necessarily restricted to health;

(e) use of existing traditional systems such as local government cooperatives, ceremonial events and cultural practices and beliefs as basis for expanding community participation efforts;

(f) determination and use of community felt needs, degree of readiness for change and capacity to undertake projects based on estimates of available infrastructure for the purpose of setting priorities and strategies for intervention;

(g) use of other programmes in non-health sectors and programmes in which children are beneficiaries as entry points;

(h) use of non-governmental organisations as channels for community participation;

(i) engaging in activities which are acceptable and adaptable to local situations.

These characteristics of the primary health care model provide sufficient framework for integrated team efforts for dracunculuasis control with sectors which are not medically oriented. The primary health care resources are to be found primarily in the community itself. This will allow participation and involvement of target population in the planning and implementation of educational intervention strategies as dictated by the situational realities of their environment. Also, self-reliance, which is fundamental to long-term control measures will be promoted by the application of the primary health care model. Primary health care has already been introduced in Idere, in the Ibarapa District of Oyo State, Nigeria by Akpovi[10] to bring health services within the reach of the people for the control of dracunculuasis.

The overall conceptualization of the ac tivities of Akpovi's research and its culmination at the intervention phase shows that the focus of change efforts was on a triad of factors which may be summarized as:

(1) The existing behaviors which are associated with the diseases;

(2) The situational realities under which these behaviours occur especially the barriers to desired behaviors needed for the control of these diseases, most importantly economic and geographical factors;

(3) The organised systems and institutions to which people belong such as social, cultural, religious, technological, political, etc., which impose rules and codes of conduct sometimes at variance and conflicting with desired actions and behaviours required for the control of dracunculuasis.

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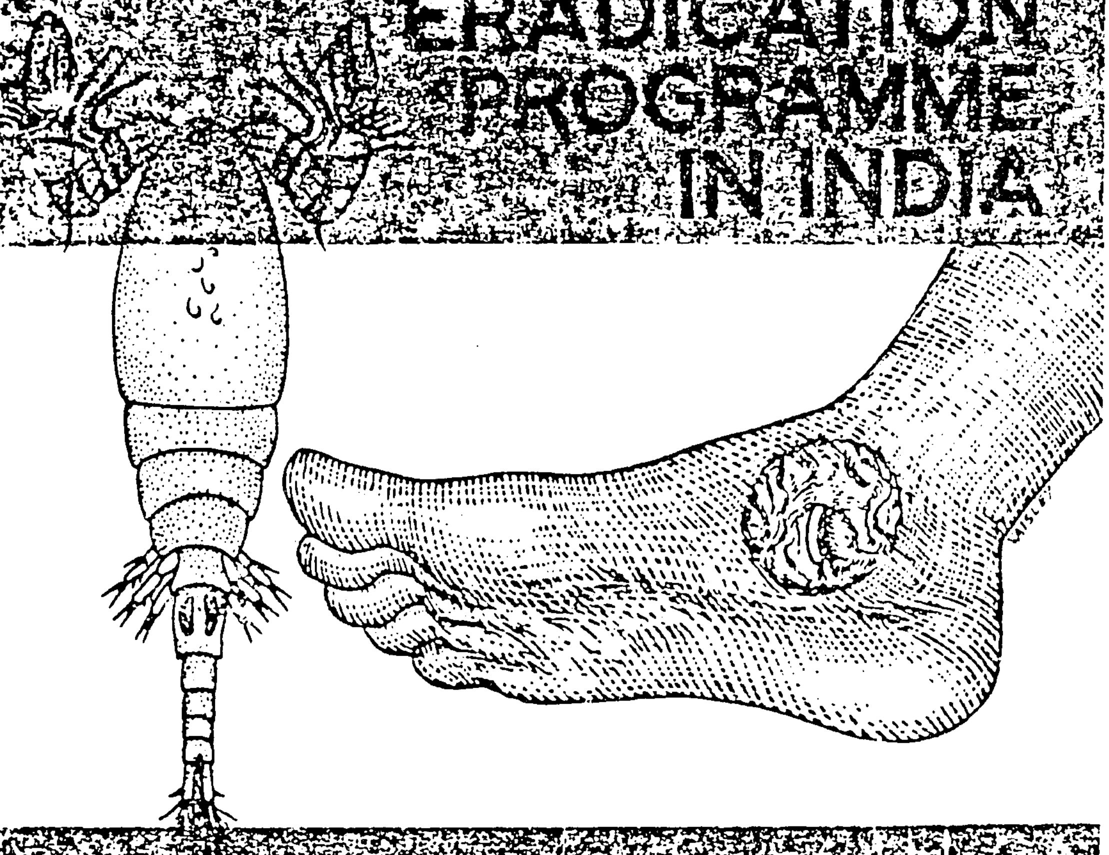
A Research on Social and Behavioural Aspects for the control of four tropical diseases - malaria, schistosomiasis, onchocerciasis and dracunculuasis in the context of primary health care is in progress at the African Regional Health Education Centre, University of Ibadan, Nigeria. An interdisciplinary research team of 21 from 10 specialities are collaborating in the research which is supported by grants from the Social and Economic Research Scientific Working Group of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases Project 800432. The development of this paper is largely based on personal experiences as the Principal Investigator in this Research Project.

OPERATIONAL MANUAL

GUINEAWORM ERADICATION PROGRAMME IN INDIA



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DIRECTORATE GENERAL OF HEALTH SERVICES
NIRMAN BHAVAN
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Dr. I. D. Bajaj
DIRECTOR GENERAL

FOREWORD

After the achievement of smallpox free status in India, Government of India have now taken up the task of eradicating another dreadful disease "Guineaworm" (Dracunculiasis) from the country. Though the disease is prevalent in many other countries of Asia, Africa and South America, India is the first country in the world to undertake the programme. It will be a proud day for India when the guineaworm disease is eradicated.

The disease manifested by a blister usually in the lower extremity causes considerable human sufferings to the poor community, mostly agriculturists, in rural areas, thus causing a considerable economic loss. In India 12.2 million people living in over 10,000 villages in 80 districts of seven states are affected.

A Task Force constituted by the Government of India formulated the strategy for the eradication of this disease. The National Institute of Communicable Diseases is entrusted with the responsibility of planning, guiding, monitoring and evaluating the programme.

Considering that this is the decade of drinking water supply and sanitation, provision of safe water for domestic use would greatly help in achieving the goal of eradication of this disease.

With the introduction of the lucid and comprehensive operational manual on guineaworm eradication programme, persons working in the field would find it useful to carry out their day to day work and would serve as an instant guide and do it yourself kit.

I hope this comprehensive manual will be very useful for those connected with this important programme.

Sd

INTRODUCTION

Dracunculiasis or Dracontiasis popularly known as guineaworm disease has been known since antiquity. It is caused by a nematode *Dracunculus medinensis*. Fedtschenko (1871)* was the first to demonstrate the developing stages of its larvae in cyclops; it was later confirmed by Manson (1892)**. In 1936, Moorthy and Sweet*** fed dogs with cyclops infected with *D. medinensis* from a human source and described the different stages of developmental forms of the larvae.

2. Geographical Distribution

Outside India the disease has been known to exist in Africa (East, West and Central), Sudan, Egypt, Afganisthan, Pakistan, Burma, Arabia, Iraq, Iran, some regions of USSR (Turkestan), West Indies and South America. According to an estimate made in 1947 about 48 million people were living in different endemic countries of which India alone accounted for 25 million. Estimates made in 1963 have shown that five million persons were exposed to the risk of this infection. A recent survey made by the National Institute of Communicable Diseases, Delhi has shown that Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu are endemic for the disease. The disease is confined to villages where tanks, ponds or step wells are the main sources of drinking water.

3. Life Cycle of the Parasite

Cyclops is the intermediate host for transmitting guineaworm infection to man. Cyclops of both sexes as well as all ages can transmit the infection.

The adult female guineaworm measuring 60 cm to 100 cm in length and 1.5 mm to 1.7 mm in diameter, is milky white in colour and looks like a thick twine of thread. The female worm after migrating to the subcutaneous tissue secretes a toxin before parturition which gives rise to a blister on the part of the body from where the worm emerges in the host. It soon

*Fedtschenko, B. A. (1871) : Inviest. Imp. Obs. Liub. Estest Vozrao, Antrop, Moskova 8 : 71. Quoted by Moorthy 1938, *Amer. J. Hyg.* 27, 457.

**Manson, P. (1893) : Quoted by Moorthy 1938, from Davidson's . and Diseases of Warm climates P. 941

bursts forming an ulcer. When the infected person with the ulcer enters into water, anterior end of the worm is ruptured. The contact with water bursts a loop of the uterus liberating thousands of larvae. Each contact with water liberates successive floods of larvae until the whole supply is exhausted. On an average one female worm parturates about three million embryos in its life span. The embryos which lie coiled up after discharge from the worm, soon stretch out in water and begin to swim vigorously with a tadpole like motion. Unless the embryos are ingested by cyclops, they perish in water after sometime. Usually the larvae can live for about six days in clean water but in muddy water or moist soil they may survive up to three weeks.

The larva measures 500–7 μ in length and 15–25 μ at its greatest breadth. Hyperinfection of cyclops results in retarding the growth of the larvae as well as killing of the host. The larva on reaching the midintestine of cyclops, breaks through the soft wall and comes to lie in the coelomic cavity within 1–6 hours after ingestion. It feeds on the gonads (ovaries and testes) of cyclops and undergoes two moults, the first moult between the first and the second stages and the second moult between the second and the third stages of larval development. It takes about two to three weeks for the complete development of the larva, depending upon the temperature of the breeding water. The third stage development of larvae takes place in the vertebrate host.

When a person drinks water containing infective cyclops, the gastric juice of man kills the cyclops and activates the third stage larvae which escape from the dead cyclops. They then penetrate the gut wall and migrate, usually to the retroperitoneal connective tissue, where they mature into male and female adult worms in about six months after entering into man.

The male worm measures about 12 to 30 mm in length and 0.4 mm in diameter. It dies immediately after copulation and gets absorbed in the body. The fertilised female migrates to subcutaneous tissue of the body and is generally found in those parts of human body which are likely to come in contact with water. It takes about one year for the complete development of female worm (i.e. from the entry of third stage larva into man till the adult female worm parturates larvae). The double uterus packed with millions of larvae almost occupies the whole of the female worm. After forming a blister and ulcer, the female parturates thousands of larvae into water which are ingested by cyclops. Thus the life cycle continues.

One to five adult worms are generally encountered in an infected person in one season. A person may become reinfected year after year.

The cyclops are minute crustaceans of the size of a pin head (0.5–3.0 mm in length) varying from creamy white to light brown colour. The cyclops breed in wells and in temporary water collections like ponds, tanks, lakes, drains, rice fields, irrigation channels and slow moving streams. However, their breeding is more prolific in shallow bodies of stagnant waters having luxuriant surface growth and marginal vegetation.

Morphology : The cyclops have an elongated body. It is more or less cylindrical in shape and is divisible into three main regions viz. the head, the thorax and the abdomen. The tail end branches into two fork-like caudal rami. The head and the thorax are firmly fused to form cephalothorax. The cephalothorax is followed by four sharply differentiated thoracic segments. The last thoracic segment (5th) in the female fuses with the first abdominal segment to form the genital segment and consequently the abdomen is four segmented in the female, while in the male there is no such fusion and the abdomen consists of five segments. The male and the female cyclops can further be distinguished on the basis of the larger body size of females and strongly built geniculate first antenna in males.

Feeding habits : The vector cyclops species are predominantly carnivorous feeding mainly on small microscopic organisms. However, in the absence of their preferred food material, cyclops may also feed on dead aquatic animals, algal filaments and other aquatic vegetations.

Life history : Copulation takes place between the mature male and female individuals nearly 2–3 days after the emergence from the last developmental stage (copepodid). After successful mating the male transfers sperms packed in two kidney shaped spermatophores to the site of opening of seminal receptacle of the female cyclops.

Fertilization and oviposition : The ova are fertilized as they traverse through the female reproductive tract consequent to the separation of mating pairs. The oviposition commences after 3–4 days of mating; the fertilized eggs are deposited externally on either side of the female genital segment and form two sac-like structures (ovisacs). Each ovisac contains varying number of eggs ranging from 10–60.

Hatching : Eggs usually take 24–48 hours to incubate and at the end of the incubation period each egg hatches independently leaving behind the egg membrane still intact in the ovisac. Towards the completion of hatching, the female drops off the empty ovisacs from the body. Subsequent ovisacs are produced at an interval of 24–48 hours. A female mesocyclops in its life may lay eggs 32–36 times with a total population of 1120 to 2760.

Larva : The freshly hatched larva is about 80 μ in size and pear-shaped in appearance. The larva undergoes a series of six successive moults before reaching the next developmental stage i.e. copepodid. Under favourable conditions the larval development is complete within 5–7 days.

Copepodid stage : The copepodid stage takes 8–10 days for development. The copepodids resemble adult cyclops except that they are smaller in size, have lesser number of antennal segments and the size of last urosomal segment is usually twice as long as the preceding segment.

About 18 species of cyclops have been reported from various parts of India. Among these *Mesocyclops leuckarti* Claus and *M. hyalinus* (Rehberg) are the known vectors of the guineaworm disease. One of the recent studies undertaken by the National Institute of Communicable Diseases (NICD) on the prevalence, distribution and ecology of cyclops species in various parts of the country revealed that *M. leuckarti* and *M. hyalinus* are not only widely prevalent but also dominant species throughout the country. The other species of cyclops found in India are *Cyclops varicans rubellus*, *Tropocyclops prasinus* and *Eucyclops agilis*.

Seasonal variation : Cyclops population has a direct correlation with water temperature. In Northern India cyclops density starts building up with the rise in water temperature in February and reaches its maximum during the summer months, i.e. April, May and June. Thereafter, a temporary decline takes place in cyclops density during the monsoon season viz. July, August and September due to the dilution of breeding waters and dispersion of cyclopoid population. Winter months are detrimental for cyclops as the low temperature leads to high cyclops mortality and reduced reproductive activity.

Method of Sampling Cyclops Population

Many conventional methods like, plankton net, sweep net, well net, etc. have been in use to measure the density of cyclops. Some workers use the technique of sieving measured quantity of breeding waters. Recently a new device has been designed at the NICD which can be conveniently employed in all types of breeding places. This is called the funnel-net.

The device is in the shape of a funnel, the sloping walls of the cone being made of stainless steel wire-mesh (Figure—1). The bottom of the funnel is fitted with a cylindrical pipe (nipple) which can be unscrewed. A circular stainless steel wire-mesh (of the type used in the main body of the funnel) is soldered to the inner circular wall of the nipple, about three mm below the top of its margin as shown in the inset of Figure—1. Thus the nipple forms a three mm deep circular rim above the wire-mesh on which

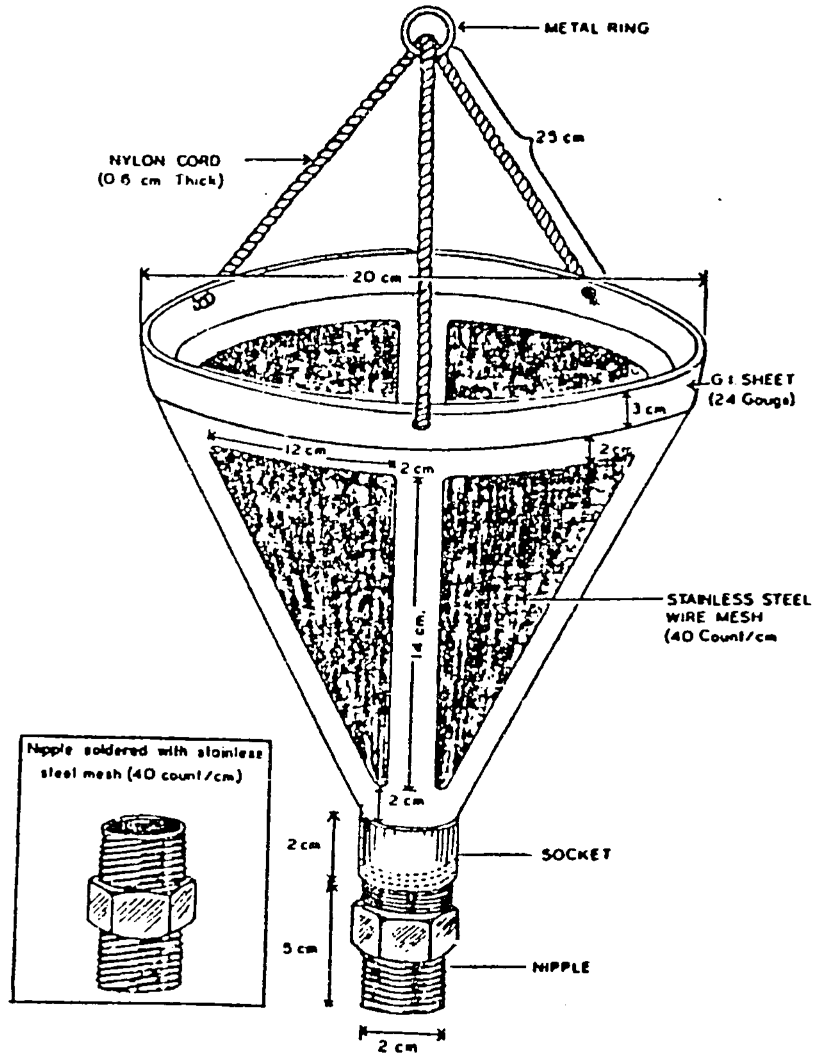


Fig. 1. Funnel net

the cyclops are collected. The device is tied to a nylon rope similar to what is used in well-net.

Operation of the Device

The funnel-net can be operated like a well-net in deep waters or like a sweep-net in shallow waters. In deep waters like draw wells, step wells, deep tanks, etc. it is gently lowered into the water till it touches the (bottom) ground. After the water waves have settled down (in about two minutes), it is slowly pulled-up. The flow of water through the wire-mesh is so free that the funnel net is pulled out with practically no water inside it. The cyclops are arrested on the circular wire-mesh at the top end of the nipple. Usually three dips are taken for each breeding place.

The number of dips or sweeps can be discreetly increased in low density areas or in very big water collections but a constant number should be maintained for comparison of data at different points of time.

Transfer of Cyclops to Wide-mouthed-Bottles

After each dip or sweep the cyclops collected on the circular wire mesh of nipple shall be immediately recovered lest the cyclops get dried up and stuck to the wire-mesh. So when the funnel is pulled up from the breeding waters, the nipple is unscrewed immediately and its top end (mesh side) is inverted into a beaker (100 ml capacity), half filled with water. The nipple (with the mesh completely immersed in water) is thoroughly stirred so that the cyclops on the wire-mesh are transferred to the beaker which in turn are transferred to the wide-mouthed-bottle. The cyclops recovered from three dips or sweeps are pooled into the same wide-mouthed-bottle. The bottle is covered with crape silk cloth and fastened tightly with double rubber bands, it is labelled, giving the particulars of the breeding place and the date of collection.

The funnel should be thoroughly washed with water to free it from any cyclops before using it for the next breeding place. Clean water should be used for cleaning the device.

Counting of Cyclops

The crape silk cloth covering the bottle should be dipped in water in such a way that any cyclops sticking at the bottom of the cloth during transit are recovered. Any one of the following methods can be used for counting the cyclops.

Small quantities of water from the wide-mouthed-bottles are pipetted into a watch-glass or a petri dish. A trained eye can easily distinguish cyclops from other copepods and count them with the help of a hand lens. [illegible] difficult to count actively motile cyclops if their densities are high. In such [illegible]es, it is better to kill the cyclops in the cavity glass with a drop of forma[illegible] and make the count.

Another convenient method to count cyclops is to strain the contents of the wide-mouthed-bottle through a fine sieve (three cm diameter net with a small handle) and transferring cyclops to a watch glass half filled with water. If their number is high, the cyclops can be killed with a drop of formalin before counting.

Care should be taken that all the cyclops are recovered from the wide-mouthed-bottle as well as the small sieve. It is always better to have a second or even a third washing of the bottle if debris has collected at the bottom of the bottle.

Frequency of Collecting Cyclops

In normal routine surveys, the densities of cyclops can be determined every season.

When anti-cyclops control measures (chemical) are undertaken, the pre-treatment densities should be measured just before applying the cyclopsicide. During post-treatment period weekly densities may be obtained for four to eight weeks (or more) depending upon the residual effect of the chemical.

Recording

The data should be maintained in a permanent register giving particulars, such as the location and type of breeding place, the volume of water, the number of dips or sweeps for each breeding place, the date and time of collection of cyclops, the quantity of cyclopsicide used, the number of cyclops collected each time, etc. If more than three dips or sweeps are made in any breeding place it should be specifically mentioned.

5. Signs and Symptoms of Guineaworm Disease

The habitat of the female guineaworm is the connective tissue of the limbs and trunk. In 90 per cent of cases it emerges from some part of the lower extremities. Rarely it may come out from other parts of the body. Sometimes the worm may die before maturity and may be absorbed or calcified.

The infection does not cause death but it is associated with considerable morbidity due to disabilities which confine the individual to his home from several weeks to as long as six months.

In some cases the appearance of the worm at the surface of the body is preceded by slight fever and urticaria. A blister is caused by the irritating toxic secretion of the worm resulting in burning sensation which may induce the patient to immerse the affected part in water. The resulting ulcer from the rupture of the blister may heal spontaneously after the worm comes out. The first symptoms appear usually simultaneously with the appearance of the blister and may consist of urticaria, nausea, vomiting, diarrhoea, asthma, giddiness and fainting. They are believed to be due to an anaphylactic reaction. Later symptoms may result from sepsis. Should the worm be injured or broken while lying in the subcutaneous tissues, the affected part may become painful, inflammed and oedematous and cellulitis may ensue. In some cases arthritis, synovitis, contractures of tendons and ankylosis of joints may be observed. There may be assotiated eosinophilia.

Patients with multiple blisters/ulcers are not uncommon. A patient may show two or more worms concurrently or consecutively.

6. **Diagnosis**

The clinical diagnosis in endemic areas is sufficiently obvious and presents no difficulty. In cryptic infections there is generally eosinophilia. The worm cannot be seen but may be felt underneath the skin. Calcified worms can be demonstrated by X-ray. Intradermal test has been found positive in some endemic foci but it is not useful in detecting cryptic infections.

7. **Epidemiological Features**

The disease is entirely rural in its distribution. Areas with very low water table where ponds, tanks or step wells form the main drinking water sources are favourable for transmission of this disease. Factors governing the spread of guineaworm include :

— contact of infected person with drinking water;
— presence of vector species of cyclops in the drinking water; and
— absence of measures to remove or kill cyclops from the drinking water.

Salient epidemiological features of guineaworm disease are summarized below :—

1. It affects the poor rural communities.
2. It is found in dry areas with low water table.
3. The males are affected more frequently than females due to greater rate of exposure.
4. The disease is met with in all the age groups except infants.
5. The incubation period is about 10–14 months.
6. Multiple cases in a family may occur.
7. Summer months show highest incidence.
8. Some persons in a family may suffer year after year while others always escape.
9. Worms are expelled without treatment usually in three to four weeks. In a few instances it may take as long as six months or ore.

10. Man is the main reservoir. Dogs, cats and other domestic animals are also affected but these reservoirs do not play a role in human spread of the disease.

Factors Favouring Endemicity

Prevalence of guineaworm in a locality depends upon the presence of the vector and the contamination of water supply. When an infected person with ulcer gets into a step well or a tank or a pond, large number of embryos are liberated from the worm inside the wound. These embryos are swallowed by cyclops. Consumption of water containing infected cyclops by the inhabitants causes the infection. Thus the infection is perpetuated when persons with blisters have a free access to the drinking water supply and the inhabitants consume unfiltered/unboiled water containing the cyclops. The social customs of the inhabitants and insanitary conditions of the area determine the extent of disease transmission. The cyclops live on organic matter and are found generally in shallow waters. Heavy rainfall and flooding wash away the cyclops, thus resulting in low level of transmission. The disease is confined generally to areas with low rainfall.

Economic loss

The programme to eradicate guineaworm disease would not only just eliminate human suffering caused by this infection but it will also have demonstrable benefit on agricultural output. In some areas, up to 30 per cent of work force is incapacitated during the periods of maximum agricultural activities. Thus the preventable economic loss is enormous.

Factors Favouring Eradication

1. The transmission is limited to easily definable foci.
2. Interruption of transmission in an area for even a single season is enough to stop further transmission of infection.
3. The preventive measures are easy to apply and highly effective. Even a simple measure like sieving drinking water through a cloth will filter out cyclops.
4. Affected persons and contaminated water sources can be easily identified.
5. Rural developmental activities, particularly provision of safe water supply will contribute to the decline of the intensity and extent of endemicity.

8. **Treatment**

The age old effective treatment for dracontiasis is laboriously rolling out each emerging worm onto a small stick, a few centimetres e[illegible]day accompanied by measures to prevent secondary bacterial complications. However, in the late sixties, several compounds were tested and reported to cause quick emergence of adult female worms and healing of the ulcer. Some of these chemicals like, niridazole (dose 25 mg/kg body weight daily for 10 days), thiabendazole (dose 50 mg/kg body weight daily for three days) and metronidazole (dose 400 mg for an adult daily for 10–20 days) have been used. However, these drugs have no effect on the developing stages up to pre-emergent worms. Surgical removal of the pre-emergent worms is possible but hazardous.

9. Prevention

As the infection can occur only through drinking water containing infected cyclops, prevention of the disease can be achieved either by protecting the drinking water from physical contact with the lesion in patients, or by preventing people from drinking water containing infected cyclops, or by freeing the water from the cyclops. To avoid pollution of drinking water, individuals with guineaworm ulcer should be prevented from entering into water used for drinking and washing themselves near such places. In the absence of protected water supply it is not possible to prevent people from using the infected water for drinking purposes. In these circumstances, the water can be freed from cyclops, either by sieving out or by killing them by physical, chemical or biological agents. Raising the water temperature up to 60°C kills cyclops. Boiling or sieving of water could be practised by families who have the knowledge of disease transmission and means to do so. Chemicals such as temephos are very effective and safe as cyclopsicidal agents. Introduction of fish in water as a biological method of cyclops control has also been tried.

10. Current Status of the Problem

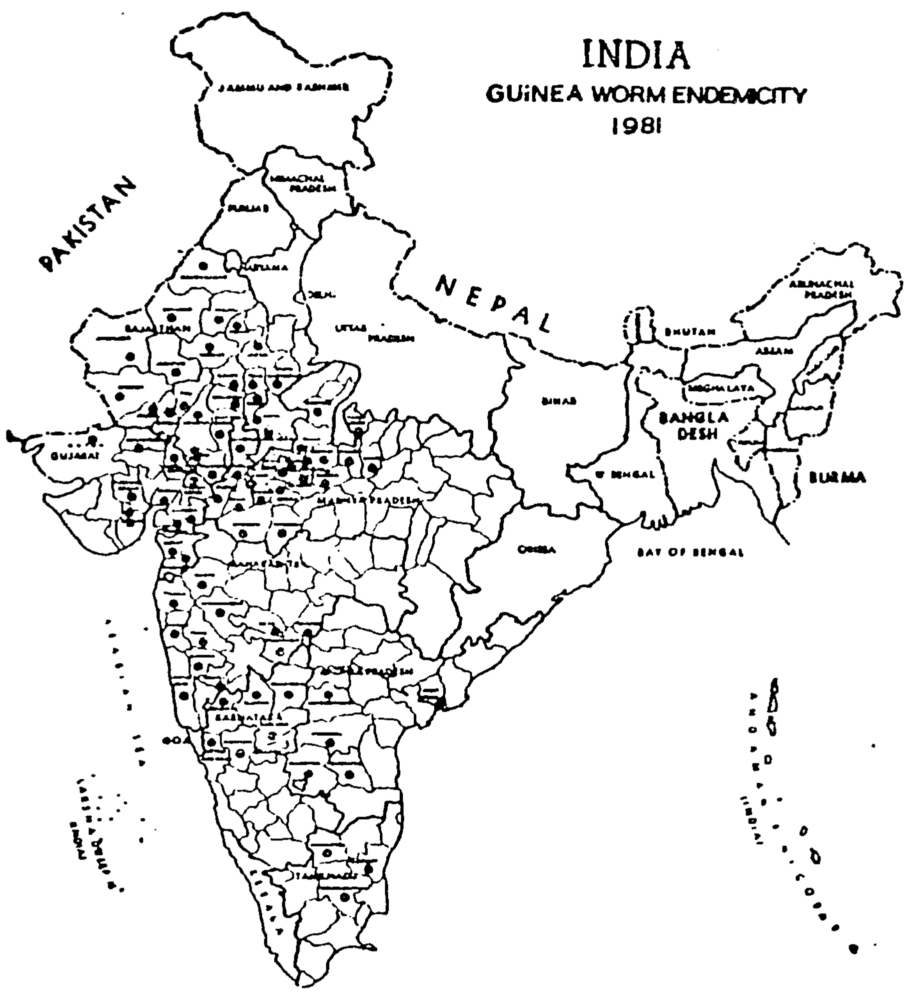
The guineaworm eradication programme was conceived of in early 1979. As a first step attempts were made to delimit the problem by asking information from the states in respect of the affected district PHCs and villages with guineaworm disease. It was found that there were seven endemic states with 47 districts, 139 blocks and 728 villages affected. Total population of the affected villages was about 1.8 million. To get the accurate baseline information in respect of the above data, active searches were planned in all the districts of seven endemic states for detection of guineaworm affected villages. Any village where an active case of guineaworm during the three years preceding the search had occurred, was considered to be a guineaworm affected village. On the basis of information collected during the searches, the latest position of guineaworm disease as on 31st December, 1981 is shown in Table—1. The states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and

Tamil Nadu are endemic. Eighty districts, 468 blocks and 10582 villages have reported cases of guineaworm disease. Map of India showing endemic

Table — 1

Guineaworm Endemic Districts by States/Union Territories

	States/Union Territories	Total No. of Districts	No. of Districts endemic for guineaworm
1.	Andhra Pradesh	23	5
2.	Andaman & Nicobar Islands	2	—
3.	Arunachal Pradesh	6	—
4.	Assam	11	—
5.	Bihar	31	—
6.	Chandigarh	1	—
7.	Dadra & Nagar Haveli	1	—
8.	Delhi	1	—
9.	Goa, Daman & Diu	2	—
10.	Gujarat	19	11
11.	Himachal Pradesh	12	—
12.	Haryana	12	—
13.	Jammu & Kashmir	10	—
14.	Karnataka	20	7
15.	Kerala	11	—
16.	Lakshadweep	1	—
17.	Madhya Pradesh	45	20
18.	Maharashtra	26	11
19.	Manipur	6	—
20.	Meghalaya	3	—
21.	Mizoram	3	—
22.	Nagaland	7	—
23.	Orissa	14	—
24.	Pondicherry	1	—
25.	Punjab	13	—
26.	Rajasthan	26	23
27.	Sikkim	4	—
28.	Tamil Nadu	15	3
29.	Tripura	3	—
30.	Uttar Pradesh	56	—
31.	West Bengal	17	—
	Total	402	80



districts is shown above The population of the affected villagesis 12.2 million. District-wise details for each state are as follows :—

ANDHRA PRADESH

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	Anantapur	5	75	159863
2.	Cuddapah	3	12	12043
3.	Kurnool	21	449	769036
4.	Mahaboobnagar	4	31	65457
5.	West Godavari	3	18	45586
	Total	36	585	1051985

GUJARAT

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	Banaskanta	6	57	81006
2.	Baroda	1	1	786
3.	Bhavnagar	2	3	49345
4.	Bharuch	1	1	466
5.	Kheda	5	8	29648
6.	Kutch-Bhuj	2	3	1268
7.	Panchmahal	6	27	44076
8.	Sabarkanta	10	141	170856
9.	Surat	2	3	7191
10.	Surendra Nagar	3	4	3419
11.	Valsad	8	67	115741
	Total	46	315	504802

KARNATAKA

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	Bellary	8	76	216333
2.	Belgaum	1	1	1768
3.	Bijapur	12	107	213755
4.	Dharwar	8	52	82244
5.	Gulberga	14	344	453724
6.	Raichur	10	126	175022
7.	Uttara Kannada	2	16	27119
	Total	55	722	1169965

MAHARASHTRA

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	Ahmednagar	3	6	5588
2.	Beed	9	36	37530
3.	Nanded	6	50	54202
4.	Nasik	6	76	70862
5.	Osmanabad	8	17	40376
6.	Pune	5	27	15810
7.	Raigad	17	278	227490
8.	Ratnagiri	10	335	55457
9.	Sangli	4	7	29944
10.	Satara	8	47	90283
11.	Thane	9	53	58586
	Total	85	932	686128

MADHYA PRADESH

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	Barwani	14	109	165277
2.	Bhopal	2	10	15675
3.	Damoh	3	5	4858
4.	Dewas	6	35	138514
5.	Dhar	13	545	291705
6.	Guna	3	162	285352
7.	Hoshangabad	4	14	18998
8.	Indore	3	25	68375
9.	Jhabua	9	325	211813
10.	Khandwa	2	13	31472
11.	Mandsaur	5	62	142418
12.	Rajgarh	6	628	313604
13.	Ratlam	6	58	148531
14.	Sagar	10	185	237705
15.	Sehore	4	110	112995
16.	Shajapur	7	394	302785
17.	Shivpuri	3	24	14527
18.	Tikamgarh	1	2	1349
19.	Ujjain	6	110	242626
20.	Vidisha	6	63	132456
	Total	113	2879	2894736

RAJASTHAN

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	Ajmer	4	15	20513
2.	Banswara	8	680	49732
3.	Barmer	8	561	634083
4.	Bhilwara	7	71	68345
5.	Bikaner	2	10	16241
6.	Bundi	4	117	91267
7.	Churu	3	9	60560
8.	Chittorgarh	10	112	102900
9.	Dungarpur	5	692	449821
10.	Ganga Nagar	2	3	2317
11.	Jaipur	1	2	4088
12.	Jaisalmer	3	56	62575
13.	Jalore	7	134	195060
14.	Jhalawar	5	588	88000
15.	Jodhpur	8	287	1343887
16.	Kota	7	167	1127773
17.	Nagaur	11	386	548846
18.	Pali	8	139	118794
19.	Sawai Madhopur	3	7	2279
20.	Sikar	4	13	52582
21.	Sirohi	3	16	32693
22.	Tonk	3	43	41886
23.	Udaipur	12	1032	743523
	Total	128	5140	5857765

TAMIL NADU

Sr. No.	Affected district	Affected block	Affected village	Population of affected village
1.	South Arcot	3	7	7072
2.	Dharampuri	1	1	279
3.	Trichirapally	1	1	2697
	Total	5	9	10048

11. Disease Eradication Programme

To formulate a plan for the eradication of guineaworm disease from the whole country it is imperative that the disease foci are identified and properly demarcated. It is essential that for each focus the infective water source is also identified so that necessary measures can be taken to make the water source safe.

There are several epidemiological features of the disease which make its eradication from the country feasible and practical. For example, it is easy to recognise guineaworm disease in the population. Likewise it will be easy to identify the infective water sources with the help of the patients as well as community heads. Infected persons (cases) living in the endemic village can be educated without much difficulty to keep away from drinking water sources so that the larvae of the worm are not discharged into the water. It is usually during the hot summer months that a potential endemic area of the disease suffers from acute scarcity of water. It is at this time that people are prone to draw water for domestic use from infective sources since safe water sources are not easily available in the areas. If this can be prevented the chain of disease transmission will be broken. The epidemiological characteristics of the disease are such that its spread remains cofined only to a very circumscribed area and newer areas are rarely affected. Therefore once the transmission is interrupted in an area for a single season, the disease will be eliminated from there for ever. From the available information it appears that domestic animals like dogs, cats, cattle and horses also get infected like man by drinking water from the same infective water sources. However, these animal reservoirs do not play an important role in the human disease transmission. Once the water source is made safe, transmission of the disease to man as well as to animals would cease.

It is apparent that for the success of the guineaworm eradication programme, the case search operations and identification of infective drinking water sources and rendering them safe are the three essential steps.

11.1 Case Search Operations

The Ministery of Health and Family Welfare, Government of India and the Director General of Health Services, have made the National Institute of Communicable Diseases (NICD) as the nodal point for coordinating, directing and assisting in the implementation of case search operations as well as in carrying out the other disease eradication activities. The Director, NICD in consultation with the State Health Authorities is to determine the periods when the case search operations and identification of infective water sources would be undertaken. Similarly, the details of the measures for rendering infective water sources safe and action for the provision of safe water supply would also be decided through such consultations.

The first case search operation was carried out in December, 1980 and the second and third case search operations were completed in May-June and September-October, 1981 respectively. It is planned that these operations will be repeated during the same months in 1982 and 1983. It is expected that due to the disease eradication activities no case is likely to be detected after two years of operations. By undertaking similar searches in two subsequent years the position will be confirmed. If no case is found then declaration about the eradication of the disease may be made. On the other hand, if some missed cases are detected, the disease eradication measures will have to be implemented with renewed vigour and zeal and to that extent the time for the declaration of the country as free from the disease will be postponed.

State Health Authorities

The Director of Health Services with the assistance of the officer earmarked to be incharge of the disease eradication programme in the endemic state would convene meetings in March and July every year till 1984 of all Chief Medical Officers/District Health Officers of the endemic districts and of districts suspected to be endemic for the disease as well as representative from State Public Health Environmental Engineering Organisation (SPHEEO). In these meetings the activities related to the case search operations, identification of infective water sources, measures

for rendering them safe and action for providing safe water supply in endemic villages/hamlets would be thoroughly discussed and the calendar of activities would be chalked out. In this meeting the use of District form-1 "Guineaworm Case Search" would be discussed and explained. The information received from the Primary Health Centres (PHCs) on PHC forms 2 and 3 (Appended), and the District form-1 would be completed in triplicate by the Chief Medical Officer/District Health Officer. The copies will be sent to the officer incharge, guineaworm disease eradication programme at the State Headquarters and one to the Director, NICD, Delhi. State Programme officer will summarise the information received from the districts on guineaworm disease on State form-1 in duplicate. One copy will be retained by him and the other will be sent to the Director, NICD, Delhi.

District Health Authorities

After the State level meeting the Chief Medical Officer/District Health Officer would convene a meeting of Medical Officers incharge PHCs which are endemic or suspected to be endemic for the disease and explain to them in detail about the methodology of conducting case search operations, identification of infective water sources, making them safe by use of chemical (temephos) and provision of safe water supply in endemic villages/hamlets as discussed above. In this meeting the use of the following forms would be explained and discussed.

PHC form-1. Worker's/Supervisor's Case Search Schedule.
PHC form-2. Worker's Case Search Report.
PHC form-3. PHC/Block Case Search Summary Report.

The PHC form-1 would be so prepared that one copy is supplied to each worker and supervisor and another copy is retained by the Medical Officer incharge PHC for the purpose of supervision and check.

Each supervisor with the help of the concerned worker would complete in duplicate PHC form 2. One copy would be retained by him and the other would be submitted to the Medical Officer incharge PHC. The PHC form-3 would be prepared in duplicate by the Medical Officer incharge PHC. He would send one copy to the concerned Chief Medical Officer/District Health Officer and retain the other copy with him.

PHC Level

The Medical Officers incharge of PHCs identified for the purpose of guineaworm disease eradication programme would convene a meeting of all the peripheral health workers and their supervisors who are to be engaged in the programme activities after the district level meeting ince the workers and the supervisors would be needed for short periods only, most of the existing health personnel can be utilised for this purpose.

In the meeting the activities related to the programme would be explained by the M.O. in detail. For each worker and supervisor, PHC form-1 i.e. "Workers/Supervisors Case Search Schedule" would be prepared by the Medical Officer. In doing so care should be taken that all the villages/hamlets are listed accurately.

Use of PHC form-2 i.e. "Workers Case Search Report" would be explained to them thoroughly. They should be told that in each village/hamlet they should enquire from the residents and prominent persons residing there about patients suffering from guineaworm disease. If anyone is found having the disease, his full particulars should be noted. If no case is found, information be elicited from the village/hamlet headman/leader about the occurrence of any case during the last three years. Through the case(s) and/or community leaders infective water sources should be identified and recorded. Note should also be made by him of the particulars of other water sources. The entries about these should be recorded in PHC form-2 i.e. "Workers Case Search Report". When the survey is over, PHC form-2 is completed in triplicate. Its two copies are sent to Medical Officer incharge PHC. The Medical Officer of the PHC is to prepare PHC form-3 i.e. "PHC Case Search Summary Report" in duplicate. He will send one copy to the concerned Chief Medical Officer/District Health Officer and retain the other with him.

The number of workers and supervisors required would depend on population to be surveyed, approachability of village/hamlets and their distances from the headquarters of the workers/supervisors. As an example, if the population to be covered is 100,000 (one lakh) for which 10 workers are available to do the survey in 10 days, each one can visit in a day villages/hamlets with a total population of 1000. For 10 workers, two supervisors will be required—one for every five workers. Each supervisor on one day does concurrent and on the second day consecutive supervision of each of the five workers under his charge, thus spending two days with each worker during the 10 days search period. If the villages/hamlets are far flung and the terrain is difficult, the period of survey and/or number of workers/supervisors may be increased accordingly.

11.2 Measures for Eradication

The basic principles of any measure adopted for the eradication of guineaworm disease has to take into consideration (1) provision of alternative safe water supply, (2) making infective water source safe, (3) prevention of water source from getting infected and (4) personal prophylaxis. These are discussed in the following pages.

11.2.1 Provision of Alternative Safe Drinking Water

The objective of the Sixth Plan is to provide safe and assured drinking water to all the problem villages/hamlets as identified by the State. The Government of India have fixed norms for identifying villages with difficulty for water supply. The norms fixed on the recommendations made by the Joint Water Board are :

1. villages where no water source existed within a distance of one mile (1.6 km) or where water was not available within a depth of 50 ft. (15 metres). In case of hilly areas villages where water sources were available at an elevation difference of more than 300 ft. (100 metres) from the habitation could also be considered;
2. villages which were exposed to the risk of water borne diseases such as cholera, guineaworm, etc., and
3. villages where the water sources were having excessive salinity, iron, fluorides and/or other toxic elements hazardous to health.

The State Governments have been continuing the survey and at the beginning of the Sixth Plan when complete information was called for, it was reported from the State Governments that a total of about 3.24 lakh villages existed as per norms already laid down and that nearly 2.31 lakh villages with about 18.65 crores population (1971 census) were still to be provided with safe drinking water supply arrangements.

Financial Requirements and Provision

While working out the requirements of funds for providing assured safe water supply to these villages it has been estimated that the total requirement would be of the order of 2,550 crores for covering the 1971 census population with the cost factor taken as prevalent in 1978–79. In case the population at the end of the plan period, i.e. 1985 was to be considered and also allowing for a nominal cost escalation of about 20% during the plan period, the estimated requirement would be roughly Rs. 3,800 crores for covering all the 2.31 lakh villages (with the projected population of 1985). The Sixth Plan provisions for rural water supply both in the State Sector as well as for the Central Programme have already been finalised and a total of Rs. 2007.11 crores has been allocated. Though the break-up of allocation for the State Sector Programme an amount of Rs. 1407.11 crores is available, the provision of Rs. 600.00 crores made under the Central Programme is yet to be allocated on an agreed formula to the various states. However, an amount of Rs. 100 crores which was the provision in 1980–81 has been fully [illegible]

VI Plan Strategy

The various states have been requested to adopt the most economical solutions utilising as far as possible the local material for implementation of the schemes. It is expected that a major part of the programme would involve provision of spot sources, like deep tubewell fitted with hand pump. For every 250 to 300 population one such tubewell is recommended. The State Governments are to go in for the surface sources only if and when the ground water is either inadequate or not suitable for being tapped for drinking water supply purposes. Even when surface sources are adopted and piped water supply schemes are formulated, it has been recommended that the per capita water supply should be limited to about 40 litres per day and that the supply should be as far as possible made through standposts only. The plan also envisages providing specific relief to the weaker sections and minorities. Tribal villages and scheduled caste villages have to be given highest priority in the implementation of the programme. Even in the identified villages priority should be given to provide access to safe water supply to the scheduled caste community within the village. In every case where more than one tubewell is to be provided in the village, one tubewell should invariably be located in the scheduled caste habitation of the village.

In so far as the villages affected by guineaworm are concerned it has to be pointed out that it would not be a difficult task to provide safe drinking water supply to these villages. It will not be possible to suggest any one particular solution for tackling the problem. The technical requirements in so far as the provision of safe water supply to these villages is concerned would depend on the nature of sources, at present being used by the people. However, it would be very essential for the different agencies at the district level to coordinate the efforts to eradicate the disease. Though in some instances it may be necessary to continue with some recurring measures, the obvious choice would be to have a permanent solution by eliminating the contact between the guineaworm patient and the water sources. This can be achieved by either carrying out some modifications at the place or the source of water or by providing alternative source of safe water supply.

International Drinking Water Supply and Sanitation Decade

India is a signatory to the U.N. Resolution to provide the basic minimum facilities of water supply and sanitation to all its citizens during the decade 1981–1990, declared as the International Drinking Water Supply and Sanitation Decade. The Government of India and the States have accepted in principle the implementation of the decade programme and keeping in view the status of the water supply and sanitation facilities in

the various states and union territories, it has been decided to implement the programme during the decade to achieve the following :

1. Urban water supply	:	100% population to be covered.
2. Rural water supply	:	100% -do-
3. Urban sanitation	:	80% overall coverage of population
4. Rural sanitation	:	25% -do-

Assessment made in consultation with the state/union territories has brought out the requirements for the decade programme to about Rs. 14500 crores with break up as below

	Rs. in crores
1. Urban water supply	3280
2. Rural water supply	6779
3. Urban sanitation	3685
4. Rural sanitation	744
Total	14,488

In order to decide policy matters at national level and to oversee and guide the implementation of the decade programme an Apex Committee has been set up in the Government of India with Secretary, Ministry of Works and Housing as Chairman. The Apex Committee has constituted three working groups on (1) Financial Resources, (2) Material requirements and (3) Programme and Manpower to assist the committee in assessing the total decade needs for effective implementation of the programme.

The various states and union territories have already collected the necessary data and are now in the process of preparing their reports for the decade programme based on which a National Decade Document is proposed to be finalised in due course.

11.2.2 Making Infective Water Sources Safe

Use of Temephos (abate) for Chemical Treatment

Organochlorine compounds like DDT, BHC, Dieldrin and Organophosphorus compounds like malathion, fenthion, diazinon, dursban, fenitrothion and temephos (abate), are highly effective against cyclops. Of these compounds, only temephos (abate) is used because of its very low mammalian toxicity. Non target species are not adversely affected. Doses effective against cyclops have been extensively used against the vectors of malaria, onchocerciasis, epidemic typhus, filariasis, yellow fever, dengue and other arboviral diseases and found very safe.

Properties

The chemical name of temephos or abate is 0, 0 0′, 0′-tetramthyl 0,0′-thiodi-p-phenylene phosphorothioate (IUPAC) or 0,0′ (thiodi-4, 1-phenylene) bis (0,0-dimethyl phosphorothioate) (CA). Its empirical formula is $C_{16}H_{20}O_6P_2S_3$ The compound has a molecular weight of 466.5. In its analytical grade, abate is a white crystalline solid. The technical grade compound is amber coloured liquid. It is insoluble in water, hexane, methylcyclohexane, but dissolves in acetonitrite, carbon tetrachloride, diethylether, ethylene dichloride, lower alkylbetones and toluene.

Stable at 25°C for at least two years; decomposes rapidly at 120–125°C. It has good chemical stability in natural fresh and saline waters and is moderately stable to hydrolysis with aqueous alkali, shows no observed hydrolysis at pH 8 and 25°C for several weeks, or at pH 11 and 40°C for several hours; hydrolysis at higher pH (>9) for prolonged periods may be expected. A highly acidic pH (<2) can promote hydrolytic decomposition.

Formulation

Temephos is available commercially either in emulsifiable concentrate (50 per cent E.C.) or in sand granule formulation (two per cent active ingredient). Compared to other formulations, the sand granule formulation is suitable for usage against cyclops because of its longer residual effect as well as greater effectiveness. The sand granules sink to the bottom and release the active ingredient slowly.

Dosage

The recommended dose of temephos against cyclops is 1 ppm (i.e. one mg per litre). This dosage is obtained by treating the breeding places with one gram of two per cent sand granules per 20 litres of breeding waters (i.e. 50 gms per cubic metre). The sand granules are to be applied uniformly in the breeding place. Premeasured quantity of granules in shaker cans can be used for uniform application.

Example—1

A step well, measuring four metres long, two metres wide and two metres deep may be treated as a rectangle. The volume of a rectangle = area × depth; or length × breadth × depth. So the volume of water is 4 × 2 × 2 = 16 cubic metres. The requirement of two per cent sand granules is 16 × 50 = 800 grams.

Example—2

In a round well, measuring three metres in diameter (i.e. 1.5 metres radius) and 2.5 metres depth of water, the volume of water is calculated by

using the formula $\pi r^2 h$ where 'r' is the radius of the well and 'h' is the depth of water. For easier calculation the value of π may be taken as 3.1 rather than 22/7. Thus the volume of water will be 3.1 × 1.5 × 1.5 × 2.5 = 17.4375 cubic metres. The requirement of two per cent sand granules is 870 grams.

Example—3

In a small round pit, measuring 80 cm in diameter and 20 cm in depth, the volume of water may better be calculated in litres since the breeding place is small. Thus the volume of water is :

$$\frac{3.1 \times 40 \times 40 \times 30}{1000} = 148.8 \text{ litres.}$$

The numerator gives the volume in ml and the same when divided by 1000 gives the volume in litres. The requirement of two per cent sand granules is 7.4 grams.

For uneven depths of water, the mean depth may be taken for calculating the volume. Similarly, the volume for irregularly shaped breeding places may be calculated first by calculating the surface area which may then be multiplied by the mean depth.

Frequency of Application

The treatment of breeding places may be taken up before the transmission period i.e. the dry months before the onset of monsoon. The frequency of applications may be determined depending upon the local conditions and the species of cyclops. Before each application of the insecticide, the volume of breeding waters, must be determined since the volume vary due to climate and usage. Generally the frequency of application is four to six weeks. The first application should be made one month before the beginning of transmission season. During the period of transmission it is recommended that the water sources may be treated every four to six weeks unless warranted by the presence of cyclops. However, no breeding place shall receive more than four applications during one transmission season.

11.2.3 Personal Prophylaxis

For individual protection the simple measure of sieving drinking water through a double-folded fine muslin cloth is advocated. This will filter out the cyclops and thus make the water safe. In all endemic villages adoption of this measure should, therefore, be given wide publicity. Boiling of water though effective is usually cumbersome and unpractical. In addition, through health education the community should be advised to use only safe drinking water for domestic purposes and from preventing persons suffering from guineaworm disease for coming into contact with water in tanks, ponds and step wells.

For the selection of areas in the implementation of disease eradication measures, priority should be given to places currently having cases of the disease. Areas with past history of cases should have the next priority. In the determination of priority of measures to be adopted, provision of safe water supply undoubtedly would have the first priority. However, so long as safe water is not made available infected water sources can be made safe by the use of temephos.

11.2.4 Health Education

Eighty per cent of people in India live in villages and vast majority of this population is poor, illiterate and lives under highly unhealthy conditions. Their ignorance about simple rules of health and hygiene is further aggravated by widely prevalent superstitions, prejudices and false notions about causation of disease. Simple knowledge about what, why, and how of the disease should reach the people so that they develop the will to fight disease and are able to work together with other health agencies. This is precisely what is aimed to achieve through health education. Primarily health education is concerned with bringing about a favourable change in the knowledge, attitude and behaviour of the people in respect of different health problems faced by the community.

The ultimate goal in health education is to elicit willing and enlightened participation of the people to achieve health through their own efforts by means of development of sound health practices.

Health Education in Guineaworm

Health education is to be imparted not only by the medical/para-medical workers alone, but the entire community—teachers, voluntary agencies, community leaders, the patients and their relatives must all be actively involved in this process.

The population at risk must be associated with all phases of the programme i.e. during search operations, identification of infective water sources, measures to prevent contamination of water from infected persons, simple remedial measures and treatment, etc. Even they should be made conversant with the common signs and symptoms of guineaworm disease. Questions like, how blister is formed? Why is it more commonly present on the feet? Why man with blister should not be allowed to put that part in drinking water source? appear very simple, but are very essential to make the people understand the different actions we want them to

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follow later on. Simple knowledge as to how female guineaworm comes out of the blister and lays embryos in the water which cause further spread of disease can indeed be very interesting. The methods of prevention like boiling of water before drinking, sieving it through double folded cloth, treating it with chemical, the rationale of conversion of step wells into draw wells, etc. can all easily be connected for the education purpose for the workers when they go to visit these villages.

Media

The following media are available for health education :

1. *Projected media* : These include films, T. V., film strips, and cinema slides. The message when heard as well as seen through the different senses leaves a deeper imprint upon the mind.

2. *Written media* : These include pamphlets, booklets, handbills posters, news-papers, etc.

3. *Miscellaneous* : Under this sub-group, we can include diverse type of media like radio, exhibitions, puppet shows, dholak parties, etc Radio has a distinct advantage over other media because of immediate dispersal of information to a large number of people in far off places.

Selection of a medium for health education will depend upon the availability of local resources for its production and use, etc. Cost will be another important factor for selecting any media.

Approaches

To convey the content of health education in any disease through the different media listed above, three different approaches can be adopted by the health worker.

Individual Approach

During their home visits, Community Health Guide (CHG) and health workers follow this approach. This approach is useful while discussing certain personal aspects, such as of family planning programme.

Group Approach

In the villages the situation like gram panchayat meetings, mahila-mandal, balwaries, etc. are the examples of effective group discussions which rely mainly on communication through word of the mouth. Aids like films, film strips, flash cards, etc. on the subject can also be used with great advantage.

Mass Approach

Mass approach is mainly carried out through press, radio, T. V. etc.

However, the different methods, media and approach discussed above do not form water tight divisions and that they can be applied in different situations in the same health programmes.

What People should know about Guineaworm Disease:

1. Blister on the skin is formed by emerging of female guineaworm.
2. Blister is caused by an irritant milky *fluid* secreted by the worm.
3. Blisters are commonly seen on feet and other parts which are more likely to come in contact with water.
4. Guineaworm embryos can survive in clear water for about a week while in muddy water they survive for about three weeks.
5. Guineaworm embryos are ingested by water fleas, called cyclops.
6. Cyclops are generally present in stagnant water of ponds/tanks/ step wells.
7. When a patient with blister goes for bathing or taking water from the drinking source, he is likely to contaminate the source.
8. Such infected water when swallowed spreads disease to the community. It takes about one year for the embryos to develop to an adult worm inside the human body.

Prevention

1. Sieving of the infected water can help to get rid of the infected cyclops.
2. In case of doubt, boiling also renders the water safe.
3. Regular treatment with chemicals can also kill the cyclops and render the water harmless.
4. The patient should be educated not to contaminate the drinking water source.
5. Gradual conversion of step wells/step ponds into draw wells prevents further infection.

In fact, health education is probably the cheapest method available for effective control/eradication of guineaworm disease, but the people must be galvanised into action so that they work shoulder to shoulder with other health agencies in the area.

11.3 The Roles and Responsibilities of the District Level Officers

The guineaworm eradication programme will be a 100 per cent centrally assisted scheme. The responsibility for coordination, technical guidance and monitoring of the programme as well as for training of the district level officers is vested in the NICD. Under such an administrative

set up, the implementation of the programme will remain the exclusive responsibility of the state health authorities. The district level officers in the endemic districts will play a crucial role in planning, organising and monitoring the activities relating to the programme in their districts. As there is no health staff earmarked for guineaworm disease, the responsibility for programme activities will be shared at all levels by the existing staff.

The main responsibilities of the district level officers will be :—

1. assistance to the medical officers of the PHCs in organizing and implementing the operational details of the programme;
2. providing supervision, support and guidance to the PHCs.
3. organisation of one-day orientation training for the PHC officers in the district to acquaint them with all aspects of guineaworm eradication programme;
4. ensuring that the steps as planned are being taken for the eradication of the disease;
5. maintaining an inventory of the nature of water-sources in the affected PHCs and determining the priority of chemical treatment/ modification/alternative provision of the water sources in the affected PHCs;
6. maintaining of liaison with his counterparts in the district looking after the PHEEO and coordinating the activities of the health and PHEEO workers;
7. guiding the health educator of the PHC in organizing camps, meetings, talks, demonstrations, display of posters, films, etc. to educate the communities and assisting the M. O., PHC in involving the Block Development Officer and his staff and other development programme workers in the health education campaign.
8. guiding the MO, PHC in conducting the field surveys/searches;
9. ensuring the supply and regular replenishment of equipment, chemicals and health education materials to the PHC, as well as the availability of man-power resources, towards search of cases and chemical treatment of water sources;
10. reviewing the results of search and initiating necessary action
11. submitting the prescribed reports to higher echelons and ensuring the timely submission of the reports from the PHCs; and
12. providing leadership to create a spirit of healthy competition among the staff at the lower levels, promoting devotion, creativity and innovation by the individual staff members, and ensuring that their activities contribute towards the realization of the goal of the programme

11.4 The Training of PHC Doctors

The medical officers incharge of the Primary Health Centres (PHC) are the most important link between the guineaworm eradication programme and the peripheral health workers implementing it. As such he should be fully conversant with all aspects of the eradication programme including its strategy and phasing., It is, therefore, necessary that one of the M. Os of the PHC is identified to be engaged for the purpose of guineaworm disease eradication. The selected MOs of the affected PHCs will be required to undergo an orientation course to be organised by the district level health officer of each of the concerned districts, so as to be able to guide health workers and supervisors working under them and to supervise and monitor the progress of the eradication.

The guidelines provided herein encompass only the areas on which the M.O., PHC should have adequate knowledge :--

1. The general outline of the programme and its phasing.
2. Guineaworm search operations, organisation, methods and reporting. Preparation of case search schedules and workers case search report.
3. Brief life cycle of guineaworm.
4. The role of cyclops in the transmission of disease. Identification, collection, transportation and enumeration of cyclops.
5. Chemical purification of water sources. The formulation, concentration and the method and frequency of application of temephos.
6. Role and method of detection of cases and their treatment.
7. Knowledge on the targets and phasing of providing alternative safe water sources by SPHEEO in his area.
8. Health education on personal prophylaxis against guineaworm disease, such as avoidence of contact between the active case and drinking water sources (tanks, ponds and step wells) and sieving of water for drinking.
9. The role and responsibilities expected of the M.O., PHC in connection with the eradication programme such as :—

— identification of and allocation of duties to health workers and supervisors in case search operations, chemical treatment of water sources, enumeration of cyclops, etc;

— visits to villages to confirm the presence or absence of guineaworm cases;

— visits to fairs, festivals, markets and schools;

— routine village visits;

— arranging periodic meetings of health workers and supervisors; and

— treatment of cases to reduce sources of infection.

11.5 Training of Para-medicals

In most of States there is no exclusive staff sanctioned for guineaworm eradication programme at the district and lower levels. Hence all the activities under the programme which will be seasonal and for short duration have to be undertaken by the health staff working under the PHC. No prior training or experience in guineaworm eradication efforts is expected of the para-medicals. Therefore, it is necessary to impart one-day orientation to the PHC para-medical staff by the medical officer incharge to enable them for undertaking effectively all the activities under the guineaworm eradication programme. While imparting such training the PHC medical officer may use the following guidelines to make the content comprehensive :—

1. Life cycle of guineaworm.
2. Identification, collection, transportation and counting of cyclops from the water sources.
3. Nature of safe/unsafe water sources for guineaworm transmission.
4. Identification of cases with guineaworm disease and their referral to the PHC for treatment.
5. Guineaworm case search operation—methodology, organisation, reporting and supervision.
6. Chemical treatment of unsafe drinking water sources—formulation, dosage and method and frequency of application of temephos.
7. Priorities in identifying the unsafe water sources for treatment.
8. Methods and media available for health education of the community for their active participation to aim at personal prophylaxis and control.

12. Evaluation and Monitoring

Organisation

The Central Organisation with a Deputy Director and other ancilliary staff at the NICD, Delhi have been given the responsibility :

1. to plan, coordinate and evaluate the guineaworm eradication programme activities,
2. to train the district level officers and other trainees for the programme and
3. to undertake time bound research studies on epidemiology and control relevant to the programme.

Evaluation

The important function of the Central Organisation will be to regularly review the reports received from the endemic States and to periodically verify the information by field visits to the concerned areas. At the state level it is envisaged to establish :

Technical Officer (TO) in each of the seven endemic states appointed under the programme will periodically verify the information by field visits to the concerned areas. The TOs will assist their respective state programme officers to monitor, interpret and evaluate the information received from the endemic districts. State Programme officers/TOs to make field visits for supervision.

At the district, a district level officer designated to look after the Guineaworm Eradication activities would review the reports from the PHCs, analyse the information and make it available to the State Headquarters. The officer at the district will also make field visits for concurrent and consecutive supervision and confirmation of data received.

Officer incharge of the PHC would review the reports of search, chemical treatment of water sources, etc. and makes field visits to guide, check and to provide on the job supervision to the field staff.

Indices

The following indices would be collected at periodic intervals for monitoring the programme :

1. Total number of affected villages during the previous year/total number of affected villages during the current year.
2. Number of active cases during the previous year/Number of active cases during the current year.
3. Number of villages targetted to provide with alternative/modified drinking water sources and the number achieved.
4. Number of water sources targetted and chemically treated along with sample data on pre-treatment and post treatment cyclops densities.

Independent Evaluation

After the Central Organisation has satisfied itself that the country has been free from guineaworm for two consecutive years, an independent organisation comprising of experts will be invited to formally certify freedom from guineaworm infection.

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Appendix—I

PHC FORM — I **GWEP**

Guineaworm case search
(Period of search from .... to ....)

......................State

WORKERS/SUPERVISORS CASE SEARCH SCHEDULE

District.......................... PHC/BLOCK ....

Sr. No.	Name of village/ hamlet	Date of search	Name of worker	Name of supervisor	Remarks

Instructions:

1. To be prepared at presearch meeting of PHC staff and a copy to be provided to (*i*) M.O. PHC and (*ii*) District (Chief) Medical Officer (Health).
2. List all villages and hamlets.
3. Provide a supervisor for every five workers.

PHC FORM — 2

WORKERS CASE SEARCH REPORT

...me of village/hamlet* .... Date of search ....

PHC ....

District ....

State ....

Chemical treatment of water sources (dates) : Step wells............ Tanks............ Ponds............

No. of other safe water sources.............. (Draw-wells/Tube-wells/pipe water, etc).

Guineaworm cases reported in 1979 (*Yes/No*) in 1980 (*Yes/No*); in 1981 (*Yes/No*)

Particulars of guineaworm cases detected in the search

Sr. No.	Name of the patient	Head of the family	Age	Sex	Month of onset of disease	Whether visited endemic village (s) during the last two years	Remarks
						Yes**/No.	

*Each hamlet be considered as a separate village.
**If yes, duration of stay

Name of Searcher

PHC FORM — 3

...uineaworm case search
...eriod of search from .... to ....)

PHC .... District..................

State....................

PHC/CASE SEARCH SUMMARY REPORT

... *Background information* :

Total No. of villages and hamlets. .... No. of villages/hamlets searched ....

Total No. of staff used for search .... Searchers .... Supervisors........................

. *Guineaworm disease information* :

(a) No. of villages/hamlets having active cases .... No. of guinea-worm cases ....

(b) No. of villages/hamlets without cases but with history of cases in the past three years. ....

(c) Total estimated population of villages/hamlets. ....

(d) Total estimated population of affected villages/hamlets. ....

... *Water sources information* :

Total number of perennial water sources

		Step wells	Tanks	Ponds	Other safe water sources
(*i*) In affected villages	Total				
	No. chemically treated				
(*ii*) In unaffected villages	Total				
	No. chemically treated				

- D R A F T -

PROTECTION OF WATER SUPPLIES FOR THE CONTROL AND PREVENTION OF GUINEA WORM DISEASE

HUGH D. HUDGINS
HAZEN AND SAWYER, P.C.

INTRODUCTION

Due to the transmission of Guinea worm infection entirely by drinking water, its control and eventual elimination has been adopted as a major target for the United Nations International Drinking Water supply and Sanitation Decade. Accordingly, the United Nations considers the protection of drinking water sources as the best method for achieving guinea worm control and specifically recommends:

(1) Filling "step wells",

(2) Provision of piped water systems or other, new water supplies and

(3) Filtering drinking water through a double thickness cotton cloth.

In addition, the U.N. System Steering Committee for the Decade has agreed that Guinea worm prevention could serve as one indicator of the success of the Decade in affected areas.

This paper will discuss the protection of Water supplies in the context of the U.N. International Drinking Water Supply and Sanitation Decade and the target for the elimination and control of Guinea worm infection and show that

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(1) the provision of water which meets the basic criteria for a safe, adequate supply will control and eliminate guinea worm infection.

(2) the statistical evidence of Guinea worm infection should serve as a parameter for determining priorities for water supply construction, and

(3) the protection of water supplies is as much a function of the planning mechanism as the provision of physical structures.

SAFE, ADEQUATE DRINKING WATER

To be considered a safe, wholesome drinking water, the water supply must be (a) uncontaminated (thus unable to infect the user with a water-related disease). (b) free from poisonous substances, and (c) free from excessive amounts of mineral and organic matter. Raw water sources not meeting this definition may be treated and protected to the degree necessary to render them safe for consumption. This is the essence of the three recommendations of the U.N. Decade Statement of May 1981 previously listed.

In reality, to prevent the transmission of guinea worm disease, the water source need only meet the first criteria for safe drinking water.

Thus, it may be concluded that any water which meets the generally accepted definition of a safe, adequate water supply will not transmit guinea worm infection, if properly stored and used.

MECHANISMS OF WATER-RELATED DISEASE TRANSMISSION

Programs dedicated to the provision of safe drinking water must include preventive strategies appropriate to each of the three primary mechanisms of water-related disease transmission in order to attract the support and endorsement of public health and sanitation officials.

The three primary mechanisms of water-related disease transmission are

(1) water-borne (the pathogen in the water is consumed resulting in infection),

(2) water-based (infection by parasitic worms which depend on aquatic host(s) to complete their life cycle), and

(3) water-insect vectors (infection by insects which breed in water).

Guinea worm disease is transmitted by the water-based mechanism. The preventive strategies appropriate to this mechanism are:

- decrease or eliminate the need for water contact.
- control aquatic host populations.
- improve quality of drinking water.

The U.N. proposes to use statistical data of Guinea worm infection as one measure of the effectiveness of the Decade. While perhaps true, the sensitivity of the Guinea worm transmission mechanism to simple preventive measures will provide only an inaccurate, partial indication as to the degree to which the goal of providing safe, adequate water has been met.

However, the sensitivity of the Guinea worm transmission mechanism to preventive measures may be used to indicate for planning purposes, those areas where priorities for the provision of protected water supplies should be placed.

Thus the epidemiological facts of guinea worm transmission supported by statistical data of guinea worm infection become persuasive arguments to pinpoint villages with priority needs for safe, adequate water systems. Where guinea worm infects twenty to thirty percent of the population, the water supply is certainly from unprotected sources, such as, surface ponds or other sources where contact with the water permit completion of the transmission cycle.

In addition, this information may be used to pinpoint areas and villages where existing programs are not successful as Guinea worm infection persists.

Used in conjunction with other epidemiological statistics, the investigator may be able to determine whether physical protective mechanisms have failed or whether protected supplies have been bypassed due to sociological factors.

WATER SUPPLY SYSTEMS

Generally, water supply systems may be divided into two broad categories; urban and rural.

For our purposes, urban water supplies will have piped water distribution systems with the raw water receiving treatment prior to introduction into the distribution system. The distribution system should deliver water, under constant positive pressure to the consumer at standpipes or house connections. A properly designed urban water supply system will generally provide treatment as required, by clarification, filtration and/or disinfection. In addition to the elimination of infectious matters from the water destined for public consumption, the piping of treated water assures the removal of the general population from the raw water source.

The presence of slums or fringe zones of urban developments present special water supply problems which are compounded by socio-economic conditions. Most progressive governments extend, as a social service, the urban water system into these areas through public standpipes. Otherwise, these people may seek water from unprotected sources which, in some instances may also be the raw water source for the public water supply system. Naturally, contamination of the raw water source results.

Public standpipes or water vendor services generally serve lower income groups in urban areas. Distribution system design criteria must insure the provision of an adequate number of standpipes to properly serve the population. In addition, provisions should be made at all standpipes to properly drain spillage. In neighborhoods of the lowest income levels, the use of water vendors should be avoided, as these groups may seek alternate water sources of questionable quality when they are without the means to pay for vendor sold water or to purchase the water in adequate quantities to maintain hygiene.

Rural water supplies may be classified as either piped water, with or without prior treatment, or unpiped water. The points previously mentioned with regard to piped water in urban areas, pertains likewise to piped water supplies in rural areas. This must be qualified by noting that the quality of treatment as well as the reliability of distribution will reflect directly the possibilities of the community or the responsible government agency to maintain and operate the facility.

Most improved water supplies for rural villages consist of a hand dug or bore wells using traditional lifting systems or hand (or foot) operated pumps. Many villages are served with dug wells primarily designed for livestock watering with little or no consideration being given to the protection of the water source for human consumption.

Where improved water supplies do not exist, the village will use its traditional water sources which may vary from unlined dug wells to water ponded in depressions during the rainy seasons.

PROTECTION OF WATER SUPPLIES

To protect any water source normally found in developing countries, there are no particular technical problems to be overcome. This is especially true with regard to preventing the transmission of guinea worm infection whether we are considering the design of a new water source or the improvement of an existing source; surface or groundwater. Major constraints to the designer are all too often of a socio-economic nature. These very constraints may circumvent the all physical efforts to protect new or improved water supply systems. Considerable amount effort is being expended by researchers to improve existing technology and to incorporate the use of economical, local materials to improve and lower costs of equipment. One major goal is to develop equipment which may be manufactured and repaired by local artisans.

The first consideration in ensuring an adequately protected water system is to correctly select the water source. Surface or groundwater sources subject to a multitude of uses, such as bathing, laundry, irrigation, waste disposal, livestock watering, etc, should be avoided if at all possible. The rule is to utilize the purest, or, as often termed, the most "innocent" source for drinking water. In following this rule most planners rely on groundwater resources as the collection, transmission and treatment of surface waters is generally outside the

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technical possibilities and economic resources of most rural populations in developing countries. In this manner we may rely on the movement of water through the soil and into the ground water table to provide adequate treatment.

The removal of pollution as water travels through solids and water-bearing formations depends upon the mechanical removal of microorganisms and other suspended matter by filtration and sedimentation as well as the natural "die-away" of bacteria and intermediate hosts in the unfavorable conditions found in soils.

Accordingly, protective measures for dug and bore wells consists of providing

(1) protective linings to adequate depths,

(2) protection from surface drainage using concrete aprons and covers,

(3) Adequate, well designed water delivery systems, and

(4) proper operation and maintenance during its service life.

No improved water source may be considered as fully protected no matter how well it may be physically constructed unless steps are taken to insure that the water supply is

(1) technically viable, that is, the water produced by the well or source is safe and wholesome, adequate to meet the requirements of the community, and readily available to the population it must serve,

(2) maintained and operated during its service life in a satisfactory manner, and

(3) The users are educated in the proper handling and use of the water.

The economic implications of these protective measures may be considerable. For example, the addition of a reinforced concrete apron to a dug lined well designed primarily for livestock watering could increase construction material costs from 16 to 30% depending upon the depth of the well. Upgrading the water lifting devices to provide adequate protection to the well for human consumption will raise the cost even higher. The costs associated with health education and other social programs aimed at assuring the consumption of safe water are harder to pinpoint but, nevertheless, represent real impacts on economic resources.

PLANNING FOR WATER SUPPLY PROTECTION

The ultimate protection of all water supplies must be initiated at the national or regional planning level. This first level of influence in the planning process will establish the rules and the lines of action for all governmental agencies with regard to the priorities for the allocation of water resources, the construction of water supplies, the cooperation between resource sharing agencies, the distribution of manpower and economic resources, and the determination of planning mechanisms that influence the character and nature of the water supply service delivered to the local rural areas.

Planning functions at the highest level must be influenced early to insure the inclusion of individuals with the knowledge and experience necessary to identify public health problems related to water supplies as well as other individuals involved in the allocation of resources. The inclusion of public health and sanitation officials will insure that epidemiological facts and statistical data will be properly used in the decision process to determine priority areas for water supply development.

The planning at national level must enforce cooperation between agencies to realize maximum use of available resources.

Despite attempts to limit water supplies to single purpose use, water supplies constructed in rural areas of developing countries will be for multi-purpose use due to limited resources. A well constructed for livestock watering will also be used as a source of water for human consumption. Thus, planners must make provisions to protect these sources from contamination. In addition, provisions should be made to ease collection of water for domestic purposes. Domestic water collectors often receive low priority at wells where water is drawn for other purposes. The individual seeking domestic water is discouraged and will often abandon a potentially safe source to seek water from contaminated ponds or unprotected traditional sources.

Over-standardization of design and construction criteria will inhibit the adoption of criteria and designs to suit local conditions. Of particular concern is the adequacy of improved water supplies using hand (or foot) pumps to deliver sufficient flows to meet the needs of the village during peak demand periods. All too often we see protected wells being abandoned for traditional sources because flow is not adequate to meet demands when water collection is confined to a small number of hours during the day. Attempting to serve two villages adjacent to each other by one single well located midway between the villages may, likewise, lead to the continued use of traditional sources by the inhabitants. These are typical examples of problems arising from inadequate planning at regional and national level.

The final decision on any water supply should follow an extensive local survey. Accordingly, the local planning function should commence with preliminary field investigations at the village level to determine:

A. The best water sources to meet present and projected water use patterns of the village for

   a) domestic

   b) livestock

   c) agriculture

   d) local artisans

B. Sanitation and water use practices of the local population

C. Local disease patterns to identify

   a) water-related diseases

   b) health education requirements

D. Local possibilities for construction, maintenance and operation of water supplies.

   a) local materials

   b) local willingness to support construction and maintenance through provision of labor

   c) education level of village

   d) specialized village workers (village health worker, mid-wife, agriculture specialist, religious leaders, public school teachers, traditional healers, maternal and child health workers, etc.)

E. Identify the individual within the village who will be responsible for the maintenance and operation of the water supply to assure his ear[illegible]sion in regional and national training programs.

F. Inventory of the activities, both on-going and planned of other government and private agencies in the village to ascertain where combined efforts are feasible.

G. Experience of adjacent villages who have experience with improved supplies as well as "feed-back" from other areas to extract lessons from successes or avoid failures.

The composition of the survey team will be determined by the lead government agency which may or may not be oriented to public health. Although it may be ideal to conduct the local survey using a multidisciplinary team, this is seldom possible. Investigators should receive training and guidelines from all concerned agencies.

SUMMARY

In summary, a resume of the principal points raised for the consideration, discussion and recommendations of the working groups of the workshop follows:

1) The provision of systems to supply water meeting the basic definitions of safe drinking water will meet the goal of elimination of Guinea worm infection.

2) Although a less than safe source may with elementary precautions meet goals to eliminate Guinea worm infection no lowering of standards for rural water systems should be endorsed.

3) Epidemiological facts and statistical data on Guinea worm infection should be used by the planner to identify priority areas for water supply programs as well as the success of water programs.

4) The protection of water supplies is a direct function of the

   - national, regional and local planning function
   - physical construction of the water system
   - possibilities of the national, regional and local agencies to properly operate and maintain the water
   - system and
   - training of local populations in the proper handling and use of domestic water in the homes, and
   - follow-up surveys and feedback systems to extract lessons on both successes and failures for continuing programs

The above points, provide the workshop with opportunities to develop recommendations to international and national agencies for the realization of adequate water supply programs which will target as first priority Guinea worm infected populations and ensure a safe, adequate drinking water supply.

On Correlations Between Dracunculiasis and Malnutrition:

The Use of Nutritional Indicators In The Evaluation of Dracunculiasis Abatement Programs

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Such errors as remain are exclusively the author's.

From antiquity Dracunculiasis has been known as a painful and temporarily disabling disease. However, low mortality rates and the concurrent presence of more clinically significant life-threatening illnesses have obscured the recognition of the disease's impact on agricultural production and subsequent chronic seasonal malnutrition.

Using an interdisciplinary approach to regional health care planning, the paper seeks to identify existing correlational data pertaining to Dracunuliasis and chronic malnutrition in the arid and semi-arid zones of sub-Saharan Africa.

Observing the interaction between incapacitation caused by the pathogen and the agricultural cycle of the afflicted population, it will suggest a strategy by which nutritional indicators may be included in the evaluation component of any Dracunculiasis abatement effort.

Background

Since 1950, the population of Africa has more than doubled.[1] Despite an intense effort during the intervening three decades to develop Africa's quality of life by lowering mortality through allopathic health care and attaining agricultural self-sufficiency, high fertility coupled with significantly lowered death rates have resulted in the creation of a demographic pyramid in which population continues to outstrip production at the same time the pressures of more people on an environment with limited resources lead to

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[1] P. Ady. Regional Economic Atlas:Africa. London: Oxford University Press, 1965, p. 8, (and) T. Dolmatch (ed.) Information Please Almanac 1982. New York: Simon & Schuster, 1981, p. 457.

degradation of soil and water which increase peasants' marginality and vulnerability.

Regional health advances, such as smallpox eradication, have therefore been both a boon and a problem as agricultural productive capacity has failed to keep pace with the needs of those whose lives have been spared from disease - nor for their progeny.

Unlike previous regional health efforts to control diseases with high mortality rates, the prospect of curtailing Dracunculiasis promises increased agricultural production and a consequently better nourished (and more disease resistant) population without placing any additional burdens on the environment.[2] Dracunculiasis abatement will not only relieve immediate severe and recurring suffering, but - as importantly - will release a significant agricultural labor constraint at the most critical labor input points during the short monsoon-linked crop cycle. Availability of this manpower resource, without the addition of any scare capital inputs such as agro-chemicals or mechanization, should produce sizeable increases in crop yields.

As this linkage is stressed and the relationship between improved health and economic development is made tangible, regional

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[2] The Pocket Book of Health Statistics of India, CBHI, Delhi, reports that of 85,304 cases of Dracunculiasis reported between 1973 and 1977, only 313 cases (or, <.004) resulted in death. Mortality, when it does occur, is linked to secondary infection (usually tetanus) associated with sepsis.

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health planners will increase the commitment of host governments and funding agencies, not to mention the cooperation of afflicted populations.

Current Literature on Socio-Economic and Nutritional Effects

Because Dracunculiasis is rarely fatal, there has been little research on measureable economic effects and no research on nutritional effects on afflicted populations. Most research has been limited to clinical, epidemiological and pharmacological reporting.

Prior to the 1978 Conference on Seasonal Dimensions of Rural Poverty, conducted by the Institute for Development Studies at the University of Sussex, economic considerations of Dracunculiasis were limited to remarks by Bildhaiya (1969), Raffier (1966) and Lamontellerie (1972) and to Belcher, et al.'s epidemiological perspective of the infection's impact on agricultural productivity.

Bildhaiya's investigation demonstrated an average labor loss of 60 - 90 days per victim. Though he made no further calculations of his own, Bildhaiya reported the Director of Health Services' 1956 estimate of Rs. 2/- per day as the nominal value of lost labor per farmer. He noted, "the effects are so incapacitating that the (Division's) agricultural operations may be interfered with owing to the scarcity of labor."[3]

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[3] G.S. Bildhaiya and S.R. Patidar. "An Epidemiological Assessment of Dracontiasis," Journal of the Indian Medical Association, Calcutta, LII, Jan. 16, 1969, p. 71.

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Raffier's 1966 report on the "Activity of Niridazole," anecdotally estimated that the Ivory Coast alone had up to 50,000 victims annually with agricultural operations in 35-50 percent of the villages "immobilized." Lamontellerie's 1972 analysis of filarial infections near Banfora, Upper Volta concluded,

> "Il apparait qu'a l'heure actuelle... la dracunculose soit la filariose humaine qui joue, sur le plan economique, le role le plus important, puis qu'elle rend temporairement inactive une importante fraction de la population." /4

The most significant work, however, was Belcher et al.'s 1975 study because it quantitatively confirmed the pattern suggested by Bildhaiya, Raffier and Montellerie. Explaining how afflicted farmers coped with illness to minimize the impact of the disease, he concluded that, despite efforts to substitute family or hired labor,

> "because guinea worm is seasonal, coinciding with peak agricultural activities, and few alternative (uninfected) labor sources are available for the incapacitated farmers, marked reduction in agricultural output occurs." /5

Though crop losses were not reported in cash or harvest yield equivalents, and no comparison was made between yield or nutritional status in infected versus non-infected villages, the correlational links between the seasonality of Dracunculiasis, labor constraints

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[4] M. Lamontellerie. "Resultats d'enquetes sur les filarioses dans l'Ouest de la Haute Volta (Cercle de Banfora)," Annales de Parasitologie (Paris), 1, 47, 1972, No. 6, p. 827.

[5] D. Belcher, F. Wurapa, W. Ward and I. Lourie. "Guiea Worm in Southern Ghana: Its Epidemiology and Impact on Agricultural Productivity," The American Journal of Tropical Medicine and Hygiene, XXIV, 1975, 2, p. 243.

and agricultural production were unequivocally established. Though Dracunculiasis studies since then (See, Kale,1977; Bhatt,1978 and Craun,1978) have looked more closely at demographic analyses of incidence rates and labor incapacitation, to date no systematic analysis has done more than to point out these correlations.

Based on these observations, the epidemiological literature on Dracunculiasis was reviewed. Table I summarizes labor losses, per individual on a per infection basis from twelve epidemiological studies.

By the 1978 IDS conference, the linkages made by Belcher et al., in terms of the seasonality of Dracunculiasis and its effect - through incapacitation - on crop production, had been considerably broadened. Data from a variety of disciplines coalesced to suggest a wide range of correlations between disease, cultural practices, the agricultural crop cycle, nutrition and the onset of the monsoon rains.

In his work, "Health, Agriculture and Rural Poverty: Why Seasons Matter," Chambers (1979) provided a holistic view of the linkages between health, agriculture and rural poverty and the onset of the rainy season, arguing that,

> for agriculturalists in the tropics, the worst times of the year are the wet seasons, typically marked by a concurrence of food shortages, high demands for agricultural work, high exposure to infection..., loss of body weight, low birth weights, high neo-natal mortality, poor child care, malnutrition, sickness and indebtedness. In this season, poor and weak people, especially women, are vulnerable to deprivation and to becoming poorer and weaker.... /6

Table I

Selected Findings Of Dracunculiasis Infection Data

Author	Date	Country	Incidence Gen. Rate	Incidence Farmer %	Time Labor Incapacitated	Notes
Lyons	1972	Ghana	26.1%	30.0% (age 15-39)	n.a.	
Reddy	1969	India	22.4%	n.a.	45%>4wks; 35%>8wks	
Kale	1977	Nigeria	13.5	n.a.	100 days	range 3wks-9mos
Belcher	1975	Ghana	n.a.	80.0% (age 25-44)	37 days	
Bhatt	1978	India	23.4%	40.05 (age 16-45)	n.a.	
Lindberg	1936	Iran	15-20%	n.a.	n.a.	reported Muller,'70
Wennen	1966	Nigeria	n.a.	50.0% (age 15-40)	70 days	reported Muller,'71
Datta	1964	India	n.a.	n.a.	male 119.8 days female 78.1 days	reported Muller,'71
Bildhaiya	1969	India	n.a.	n.a.	60 - 90 days	@Rs. 120-180/yr
Craun	1978	Nigeria	13.5%	n.a.	100 days	
Lamontellerie	1972	U. Volta	n.a.	n.a.	n.a.	48.3% villages
Raffier	1966	Iv Coast	n.a.	n.a.	n.a.	35-50% villages

Though much of Chambers' work extends beyond the scope of our immediate concern, the salient point is the direct relationship between the nutritional shortfall during the pre-harvest season and the occurence of Dracunculiasis (particularly acute amongst the farming segment of rural populations) that annually coincides with the onset of the monsoonal rains at the most critical labor input points of the crop cycle.

It is not possible at this time to quantitatively isolate the agricultural and subsequent socio-economic and nutritional impacts of Dracunculiasis resulting from lost labor due to physical incapactitation. However, the compilation of scattered crop production and epidemiological data does permit the portrayal of the qualitative effects of the disease.

The absence of any paradigm by which to measure the impact of guinea worm on Sahelian pastoral populations constrains us to look only at sedentary farmers. However, pastoralists' marked need for grain (usually millet) in their traditional diets makes them, despite their transhumance, nutritionally dependent on the success of sedentary farmers' production of surplus stocks. That they represent a significant grain demand reservoir was demonstrated by Swift:

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[6] R. Chambers. "Health, Agriculture and Rural Poverty: Why Seasons Matter," Discussion Paper 148, Institute of Development Studies, Sussex, December, 1979, p. 2.

Table II
Sahelian Pastoral Economies' Composition of
Household Food Consumption (percent of total kcals).

	milk	meat	millet	dates
pure pastoralists:				
- Moor (Mauritania 1940s)	76	4	20	-
- Twareg (Niger 1960s)	51	3	47	-
- Fulani (Niger 1960s)	39	2	58	-
pastoralists practicing some agriculture:				
- Twareg (Niger 1960s)	33	2	65	-
- Annakaza/Tubu (Chad 1950s)	22	-	35	43
- Fulani (Niger 1960s)	24	2	74	-
- Fulani (Mali 1958)	25	-	75	-

Source: Swift, J.J. An Overview of Sahelian Pastoral Production Systems. University of Michigan , Ann Arbor: Centre for Research on Economic Development, 1978. /7

Benchmark millet production studies conducted by Nigeria's National Accerated Food Production Project (NAFPP) were analyzed by Knipscheer, Menz and Khadr (1980) of the International Institute of Tropical Agriculture to provide descriptive observations and measurements to help understand West African farming systems. From this data, collected in 1975/76, Table III develops a first approximation of the nutritional marginality found in the savanna zone:

[7] J. Swift, "The Role of Seasonality in a West African Pastoral Economy," paper presented at the conference Seasonal Dimensions to Rural Poverty, Institute of Development Studies, University of Sussex, 1978, p. 4.

Table III
Gross Per Capita Yield Among Nigerian Millet Farmers, 1975

1. Avg. farm yield: heads		1,540.3 kg./ha.[8]
2. Threshing factor	(x)	0.65[9]
3. Avg. farm yield: grain		1,001.2 kg./ha.
4. Avg. size farm (ha.)	(x)	3.70[10]
5. Gross grain yield: farm		3,704.4 kg.
6. Hired labor (37%)	(-)	1,370.6 kg.[11]
7. Gross family yield		2,333.8 kg.
8. Avg. household size	(*)	11.5 people[12]
9. Gross per capita yield		202.9 kg.

This, though meager, appears to provide basic nutritional needs to those for whom millet is a staple crop. According to FAO figures quoted by the Voltaic government (1972) this would assure 2,150 calories/day.[13] As 94 percent of the millet farmers studied by NAFPP also grew some sorghum, groundnuts and/or cowpeas[14]

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[8]H. Knipscheer, K. Menz and F. Khadr. (eds.) Benchmark Surveys of Three Crops in Nigeria. Ibadan, Nigeria: International Institute of TropicalAgriculture, 1980, p. 41.

[9]Ibid.

[10]Ibid., p. 40.

[11]Ibid., p. 38.

[12]Ibid., p. 29.

[13]Ministere du Plan. Plan Quinquennal de Developpement Economique et Social, 1972-1976, Ouagadougou, 1972, (microfilm, n.p.).

[14]Knipscheer, Menz and Khadr, Op. Cit., p. 37.

and 78 percent engaged in at least some other part-time employment during the year,[15] it would seem as if their basic nutrition was secure.

However, the gross per capita yield does not reflect grain transfers to cover credit (10-15% of those studies received in-kind credit of agricultural inputs),[16] costs of directly purchased agricultural inputs, taxes, purchased commodities (salt, clothes, kerosene, etc.) or cash expenses associated with social obligations. What's more, this figure ignores both post-harvest storage losses due to pest and/or bacterial crop degradation and the traditional barter of grain for services with pastoral populations.

Ideally, we should like to be able to compare longitudinal agricultural and general nutritional data among similar ethnic groupings within the same ecological/ agronomic zone -- the only variable being the presence or absence of Dracunculiasis. If such data existed one might be able to postulate nutritional relationships with some confidence.

In the absence of such direct data from the semi-arid sub-Sahelian zone, we must look to indirect indicators. The NAFPP/ IITA northern Nigeria millet benchmark survey provides as accurate a description of the time allocated to the various production tasks of

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[15]Ibid., p. 31.

[16]Ibid., p. 36.

the crop cycle as currently exists. Fortunately, additional data on monthly weaning distribution, live birth distribution and hospitalizations for pediatric malnutrition are also available, from other sources, for this region. Unfortunately, though Dracunculiasis is endemic in this area, the literature search revealed no existing epidemiological studies.

On the other hand, while Lyons' 1972 study in north-western Ghana near the Upper Volta frontier correlates monthly data on Guinea worm incidence and prevalence to rainfall distribution, it lacks data on the complementary phenomena of interest to us.

Nevertheless, while annual variations in localized rainfall may exaggerate or minimize the effects of pathogen transmission in a given year, long-term comparison of monthly rainfall figures in northern Nigeria and north-western Ghana suggests, if not environmental similarity, at least parallel rainfall and agricultural labor task distribution. See Figure 1.

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[17] Lyons reports (1972:601) that average annual precipitation in the Wa district of north-western Ghana is 1105 mm., based on observations from 1917 - 1957. However, he provided no monthly rainfall distribution figures.

The nearest location for which longitudinal monthly precipitation figures are available was the Bobo-Dioulasso reporting station, approximately 100 air miles NW of Wa. Average annual precipitation, based on 10 years' observation during the pre-drought period of the late 50's to 60's was 1179 mm. (converted from English measurement at 1" = 25.4 mm.). As the ecological zone, ethnic composition and crop mixture on both sides of the Voltaic-Ghanian frontier are similar, the Bobo-Dioulasso monthly precipitation table is considered regionally accurate.

U.S. Department of Commerce. Climates of the World, Environmental Service Administration, Washington, D.C., 1979, p. 20.

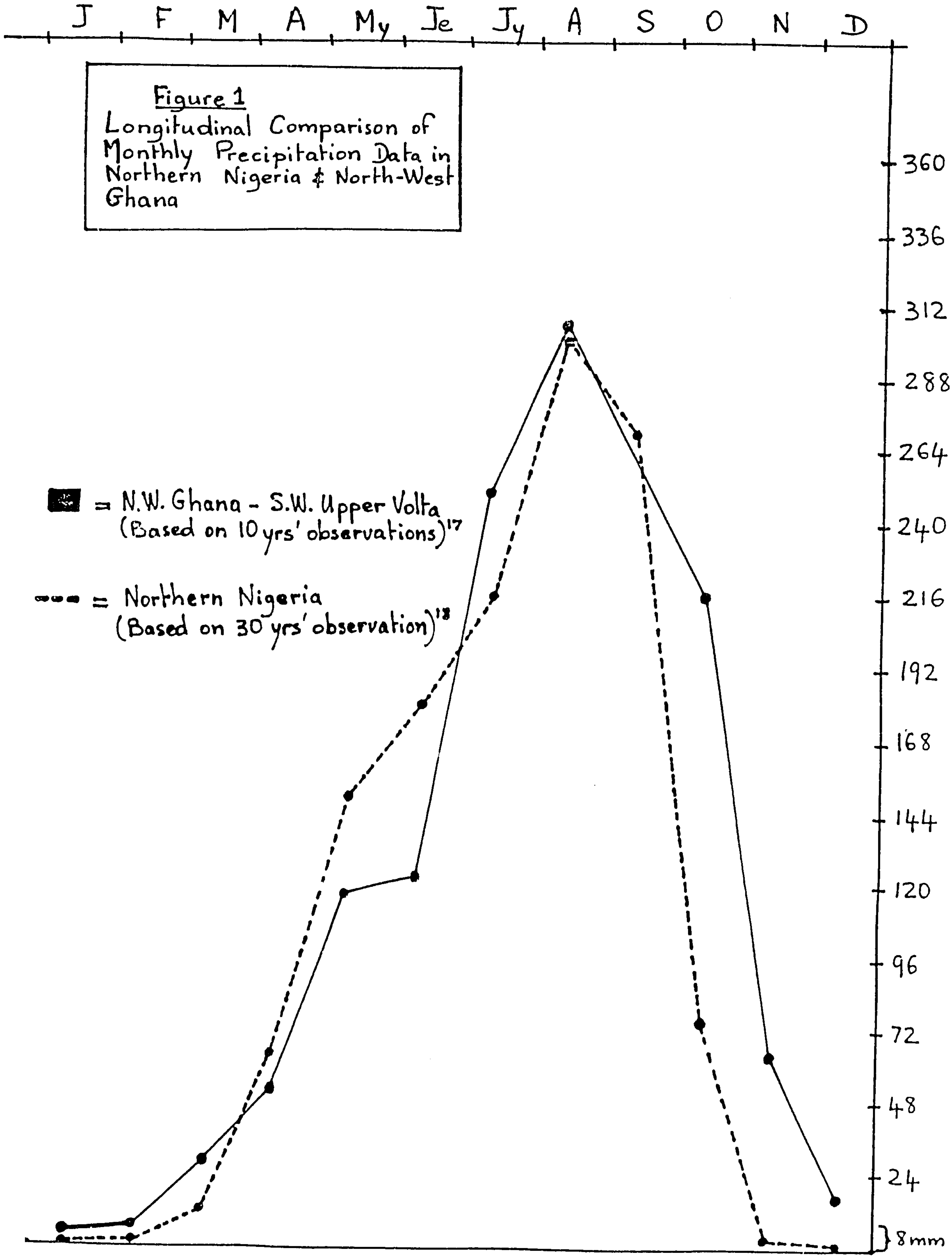
J F M A My Je Jy A S O N D
Figure 1
Longitudinal Comparison of Monthly Precipitation Data in Northern Nigeria & North-West Ghana
= N.W. Ghana - S.W. Upper Volta (Based on 10 yrs' observations)17
= Northern Nigeria (Based on 30 yrs' observation)18
360
336
312
288
264
240
216
192
168
144
120
96
72
48
24
8mm

Figure 2 juxtaposes data on the millet crop calendar in northern Nigeria with monthly precipitation and selected vital statistics. Note the relationship between rainfall and the sequence and length of the various agricultural tasks of the millet season. (Of course, additional labor is required for soudure and secondary crop cultivation.)

If we examine the correlation between rainfall, the crop cycle and our vital statistics, we note that (even though northern Nigeria is a Moslem society where women are frequently confined to household compounds by the rules of purdah) increased household labor requirements at the onset of the rainy season to support male productive activities occur.[19] This sudden labor reallocation correlates to a 400 percent increase in the weaning rate. In fact, 40 percent of the preceding year's live births are weaned within two

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[18] J. Ruffner and F. Beir (eds.) The Weather Almanac, 3rd Edition, Detroit, Michigan: Gale Research Co., 1981, p. 318.

[19] Most epidemiological data and labor allocation patterns suggest that men are at greater risk to Dracunculiasis than women. While this is undoubtedly true in many cultures, it should be pointed out that this is an artifact of cultural patterns, not gender-based biological differentiation and susceptibility.

In regions where female allocation to total energy input of agricultural labor is dominant, we may expect to find higher incidence of Dracunculiasis among the female agriculturalists. (See, for example, Haswell, 1953 which shows that 68.3 percent of labor in Genieri sample compounds in The Gambia is being provided by women.)

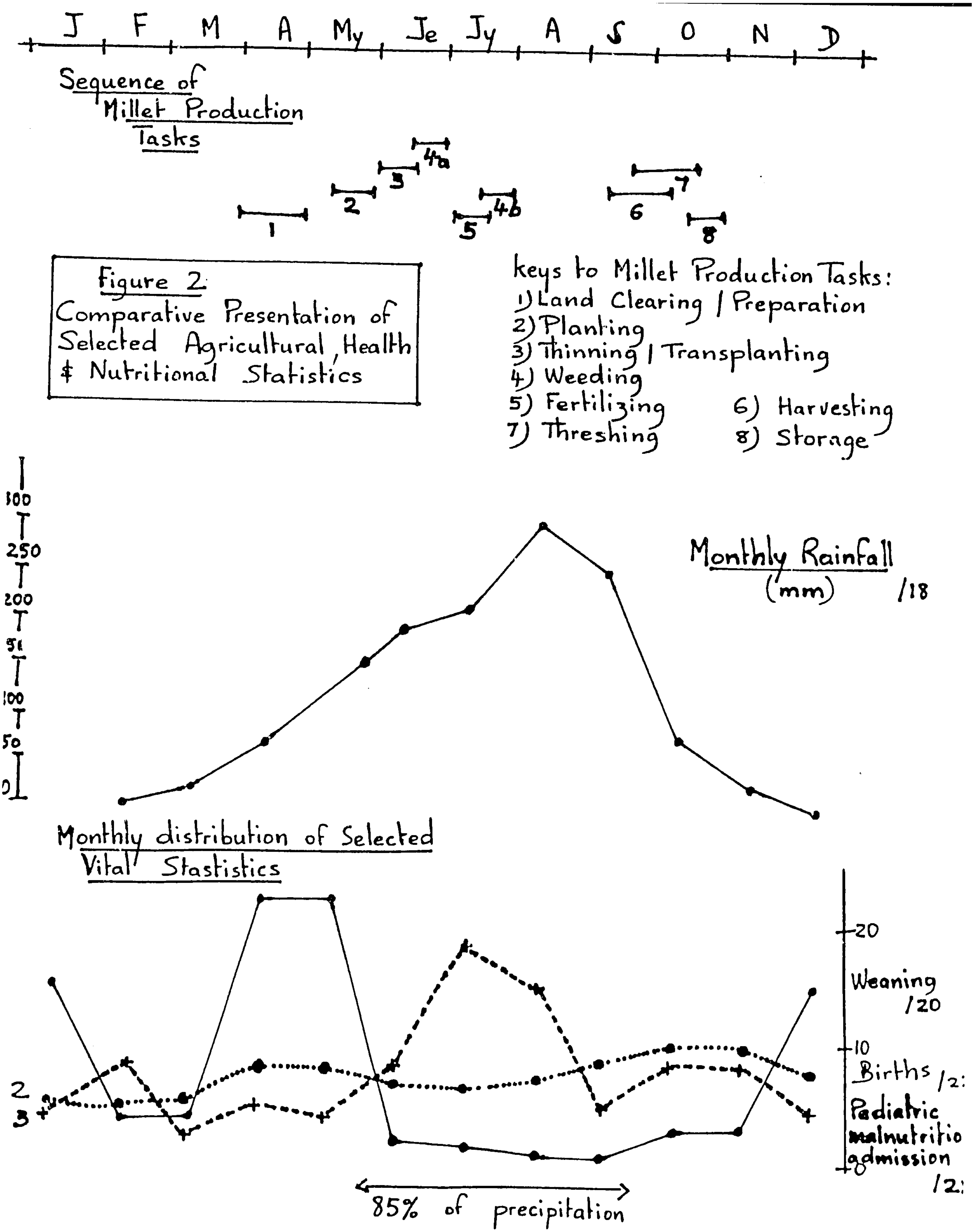

Figure 2: Comparative Presentation of Selected Agricultural, Health & Nutritional Statistics

months of the onset of monsoonal rains.[20]

By the time the heaviest rains arrive 6 - 8 weeks later, local hospital admissions for pediatric malnutrition jumped by almost 75 percent.[21] It is believed that this is due to the combination of (a) pre-mature weaning of infants and women's increased labor requirements which preclude time to prepare adequate toddler meals, and (b) changes in food allocation practices during times of high adult energy demands when children eat last and least.

Finally,the relatively stable monthly birth distribution climbs by 25 percent during the harvest season.[22] Though scientific data is lacking, many in the field believe that this reflects seasonal fertility levels resulting from variations in nutritional and general health status. This not only reflects on differential food reserves due to pre-harvest shortages, but also suggests a correlation between poor maternal nutritional levels in the last trimester and high neonatal mortality.[23]

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[20] A. Tomkins, B. Draser, A. Bradley & A. Williamson, "Nutritional Status and Water Supply in Rural Northern Nigeria," Proceedings of the Royal Society of Tropical Medicine and Hygiene, 1978 (quoted in) A. Tomkins, "Defining Health Problems of a Rural Savanna Zone - Zaria," paper presented at the conference on Seasonal Dimensions to Rural Poverty, Institute for Development Studies, University of Sussex, July 1978, p. 15.

[21] J. Possetor. "The Pattern of Malnutrition in Zaria," Tropical Paediatrics and Environmental Child Health, 1975, Feb. (Suppl.) (quoted in) A. Tomkins, Op. Cit., p. 16.

[22] A. Tomkins, Op. Cit., p. 16

As Figure 1 illustrated, the monthly distribution of precipitation between northern Nigeria and north-western Ghana is quite similar, especially at the onset of the rainy season. Figure 3 shows the relationship of the monthly totals of self-reported guinea worm cases from Lyons' (1972) most heavily infected villages over three years (1968-69, 1969-70 and 1970-71) and the area's average monthly rainfall, calculated on a ten year base.

Though there are undoubtedly differences in the crop mix and labor task cycles between northern Nigeria and north western Ghana, there is no escaping the relationship of field preparation in the two months prior to the rains, nor planting at the onset of the rains nor initial weeding shortly thereafter.

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[23] One can only speculate regarding correlations between season variation in fertility and improved female nutritional status in the months immediately following completion of harvest and storage tasks. What is clear, however, is the wide cross-cultural geographical distribution of this phenomenon of elevated numbers of live births towards the end of the rainy season / agricultural harvest.

Should this correlation be sustained by further investigation, one might then wonder if larger harvest yields and the resulting improvement in female nutritional status would not also affect a more even distribution of conceptions, thereby avoiding - for some pregnant women at least - fetal nutritional stress that occurs in the last trimester of pregnancy during the pre-harvest time of food shortages.

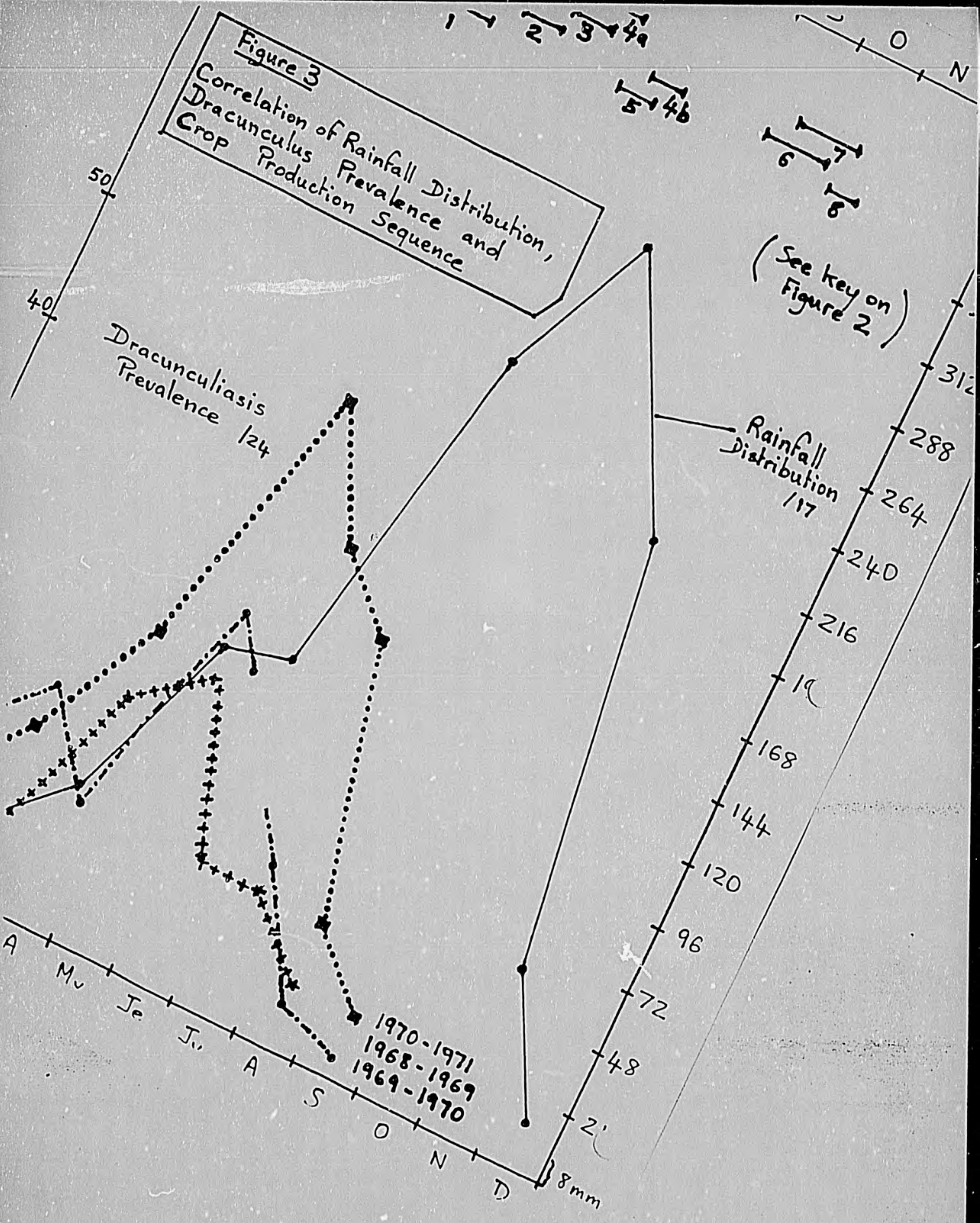

Figure 3
Correlation of Rainfall Distribution, Dracunculus Prevalence and Crop Production Sequence

Summary of Literature Findings

The interaction of Dracunculiasis, seasonal precipitation and food production may, according to the literature, be summarized in three dimensions:

> (1) Agricultural cycle - The period of highest labor input demand in the study area runs from April (when field preparation and early planting begin in earnest) to July (when the second weeding and fertilization have been completed) at which point crops should be adequately established;
>
> (2) Dracunculiasis cycle - The period of highest self-reporting of the onset of the patent stage of Dracunculiasis runs from April to July. This period accounted for 75 percent of the cases annually reported in the study area; and
>
> (3) Precipitation - Almost 85 percent of the annual rainfall in the study area occurred between May and September. Not only does the onset of monsoon rains govern the crop cycle, but a positive correlation has been demonstrated to exist between any year-to-year fluctuations in precipitation distribution and the onset of Dracunculiasis.

Though no one has definitively established data on the average length of physical incapacitation suffered by guinea worm victims, whether one uses lower range (i.e.- 30 days) or high range (i.e.- 90 days) estimates, the qualitative impact of such labor losses on crop production and, therefore, on carryover grain stores is staggering.

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[24] G.R.L. Lyons. "Guineaworm infection in the Wa district of north-western Ghana," Bulletin of the World Health Organization, 1972, 47, Fig. 2 (c), p. 605.

Implications

Though it is quite clear that there is no immediate 1:1 causal link between Dracunculiasis and chronic seasonal malnutrition, the preceding data suggests a direct causal ecological chain between labor losses due to Dracunculiasis-related physical incapacitation and the production of adequate staple food supplies resulting in (a) annual seasonally-linked chronic malnutrition, and (b) resultant reduced resistance to infection.

Given the demonstrated seasonal fluctuations in weaning rates (also linked to increases in domestic and agricultural labor demands during the food-short pre-harvest period), seasonal variations in food consumption patterns affecting the adequacy of child nutrition (linked to re-allocation of limited food supplies to "productive" agriculturalists), and seasonal variations in hospitalizations for pediatric malnutrition, one must consider the linkages between the effects of Guineaworm incapacitation and community nutritional levels.

This is not to suggest that the elimination, or significant abatement, of Dracunculiasis will result in the eradication of chronic seasonal malnutrition among afflicted populations.[25]

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[25] Moreover, in cases where the Dracunculus-oriented interventions involved improvement of water supply sources (e.g. - parapets, pulley draws, community filtration, etc.), improvement in nutritional and general health status will not only reflect success in Dracunculiasis suppression, but also be linked to reduced transmission of other water-borne pathogens - notably those related to gastro-enteritis.

However, it may be expected that increased labor availability in the agricultural sector due to Dracunculiasis suppression will result in improved crop yields which will be reflected, over time, in improved nutritional status. Thus, any Dracunculiasis abatement program should include community nutritional indicators among its evaluation parameters. In fact, should the program be a pilot project, such data may yield findings quite important to the expansion of the project area.

Evaluation Options

As the recent World Bank handbook on monitoring and evaluation makes clear, because of the complex of physical, social, economic and health variables on the population's crop yields and subsequent nutritional status, any Dracunculiasis abatement program's evaluation component should consider the following categories of indicators:[26]

1) Output indicators - In this case, these would be standard pre- and post-intervention epidemiological survey data.

2) Socio-economic indicators - In this case, these would include not only longitudinal shifts in crop yield data, but also pre- and post-intervention patterns of male and female labor allocation and incapacitation.

3) Quality of life indicators - In this case, these might reasonably include general health levels, family food consumption, education, shelter, life expectancy and access to essential services. /27

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[26] D.J. Casley and D.A. Lury. A Handbook on Monitoring and Evaluation of Agricultural and Rural Development Projects (Washington, D.C.: World Bank, November 1981), p. 39.

[27] Ibid., p. 43.

Because others in this workshop are already considering the first two categories, discussion will be limited to the quality of life indicators of project success/failure; why community nutritional status merit inclusion in a Dracunculiasis project's evaluation component and how such inclusion might be framed.

Nutritional indicators for adults based on gender and age are problemmatic. While data on weaning and delivery patterns would be useful indirect indicators, one must be aware of the constraints to collect such data. Research design would have to consider culturally-variable norms related to the impact of questions directed to women about fertility. In addition, pre-testing would have to be done for each culture group. However desirable, given project constraints this does not appear to be cost effective.

As chronic malnutrition is most easily recognized in, and has its greatest impact on young children, it may be more productive to avoid the problems associated with collecting data about adult nutritional status. Moreover, limited time, financial and trained manpower resources, not to mention opportunity costs, make it imperative that collection of base-line and post-intervention data be clearly relevant and cost-effective.

> Nutritional status merits consideration as a proxy composite indicator (both) for health and food consumption... The measurement of age, height and weight of young children enables a set of three indicators to be calculated (weight for height, weight for age and height for age), which taken together and assessed against the now widely accepted (Gomez and WHO) standards, is a good

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> yardstick of the general nutritional status of the child population. In effect, such anthropometric indicators are proxies for the nutritional status of the child population and these, in turn, are used as proxies for reflecting the general levels of health and food consumption of the population under study. The great advantage of anthropometric indicators lies in the ease of collection of the necessary data on large samples and their reasonable sensitivity to change in the underlying variables of interest. /28

Limited time, financial and trained manpower resources, not to mention opportunity costs, make it imperative that collection and analysis of base-line and post-intervention data be clearly relevant and cost-effective. Two approaches to collecting such data deserve consideration:

1) The program may seek to "capture" existying data collected by other agencies conducting on-going maternal and child health programs in target areas. Linkages may be sought with these agencies to perform longitudinal cross-sectional nutritional monitoring throughout and beyond the Dracunculiasis abatement project, or

2) The program may include measurements of nutritional status within its own annual household and village-level monitoring and evaluation samples.

Each of these strategies has its distinct advantages and particular set of problems.

An effective place to begin, therefore, would be to determine what nutritional data is already being collected and whether such data is amenable to being re-examined for our purposes. Fortunately, for the evaluation planner, longitudinal studies on maternal and

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[28] Ibid.

child health care have been carried out for at least a decade in Sahelian Africa. Prime among these have been adaptations of the "Road to Health" approach which involve mothers in recording data to visually depict their children's nutritional progress during the first 3 - 5 years of life.

The major advantage of the "capture" approach to data collection is that it avoids the administrative and financial costs incumbent in establishing and operating an indigenous infrastructure. Agencies operating maternal and child health programs have already identified, hired and trained their own local community health monitors. As the Dracunculiasis abatement project conducts its epidemiological base-line data collection study (case histories, water sources, cyclops concentrations, etc.) one may use existing health care agencies to collect nutritional information on children.

As these programs generally limit nutritional surveillance to the first five years of life, a longitudinal study of individuals' nutritional status may not be feasible. However, evaluation planners might consider a series of cross-sectional studies examining longitudinal variation and trends in nutritional status of age-classed children (i.e. - from weaning to five years of age).

However, Dracunculiasis abatement program evaluators would confront significant problems using the "capture" approach. First, they would face variability in agencies' data collection methodologies (e.g. - arm circumference, weight-to-age, height-to-weight and/or age-to-height).[29] Second, they would have to consider variability in the accuracy of anthropometric measurements, reliability of recording, transcribing and maintaining data among agencies and among between agency sites. Third, the question of variability in clinic outreach effectiveness (i.e. - Is there a bias towards measuring those children with lower nutritional status?) will have to be considered as one interprets the data. Finally, one would have to question whether the distribution of existing MCH agency data collection points would provide data representative of the general population currently at risk to Dracunculiasis.

The major advantage of the Dracunculiasis project's conducting its own nutritional surveillance inventory is the assurance of consistency in data collection methodology, recording of measurments, data transcription and interpretive analysis between sites chosen for their representativeness of the population at risk.

Yet, in addition to the added administrative and fiscal costs, such monitoring may face the difficulty of achieving representative participation from village populations who have not experienced weighing and measuring programs.

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[29] For a full discussion of methodological alternatives and constraints, see <u>Methodology of Nutritional Surveillance</u>, Report of a Joint FAO/UNICEF/WHO Expert Committee, Technical Report Series # 593, Geneva: WHO, 1976.

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Recommendations and Conclusion

Changes in the nutritional status of children from weaning to five years of age appear to be the best proxy indicator not only for the nutritional status of the population at large, but also the clearest indicator of changes in the overall quality of life of the target population. As existing data suggests that children in the Sahelian zone are at greatest nutritional risk during the three month period following the onset of the rainy season, annual age-based cross-sectional analyses of their nutritional status should be collected during this period based on age, height and weight.

Specific recommendations regarding data collection methodologies ("captured" non-project vs. project collected data) require more precise delineation of the ecologic and ethnic environments to be served by the Dracunculiasis abatement program (e.g. - Will the program be regional or pilot? Will educational efforts be primarily directed to ethnically and/or linguistically similar communities showing the highest prevalence of the disease, regardless of the demographic importance of the afflicted ethnic group, or at a geographical region with much ethnic and linguistic diversity?).

Yet, regardless of the area to be served or the technical intervention(s) selected to combat Dracunculiasis (i.e. - vector control, improvement of water sources and/or hygiene and water consumption behavior), longitudinal cross-sectional examination of children's nutritional status may be expected to reflect success in elimination or significant reduction in Dracunculiasis transmission.

E.F. Quashie

WATER SUPPLY AND OTHER ENVIRONMENTAL ASPECTS OF GUINEA WORK CONTROL INCLUDING OBSERVATIONS ON THE OPPORTUNITIES FOR IMPLEMENTATION OF CONTROL ACTIVITIES IN GHANA

STATISTICAL INFORMATION ON REPORTED CASES OF DRACUNCULIASIS IN GHANA:

Dracunculiasis is posing a serious health problem in Africa, Asia and Middle East, and in Ghana records indicate that it occurs in almost all the poor rural areas of the country.

In Ghana attempts have been made to compile information on the occurrence of dracunculiasis and also information of the disease as related to sources of water supply. There had been the need for such information on water borne disease for planning of water supplies and health measures for control of water borne diseases. The report compiled therefore set out to provide an organized presentation of existing records and recordings of observed incidence of water borne diseases and places of occurrence of those diseases in Ghana.

In order to make the report as useful as possible for planning purposes information was provided on district basis. Accordingly, each of the nine regions in Ghana were divided into survey areas. The Medical Statistics and other information on water borne diseases in each survey area depict the problems of water borne diseases as related to sources of water supply. Hospital records were also studied and for each survey area recorded cases of various water borne diseases were presented. Where no figures were provided for any given disease, it only meant that there were no cases recorded and not necessarily the absence of the disease in the survey area.

The analysis of the compiled information on water supplies and water borne diseases provided observations and conclusions considered important for initiation and justification of government policy on water supplies and sanitation programmes.

From the data the following critical observations were made:

Where treated pipe-borne water was provided as in the urban towns and communities there was virtually elimination of Dracunculiasis.

The District Survey indicated that the diseases were prevalent in almost all rural communities where there was no safe water supplies.
This actually confirmed the known fact that the disease is transmitted entirely by drinking contaminated water.

The above observations lead to the conclusion that Dracunculiasi can be completely eliminated by the provision of safe water supplies.

What is essential now is for the country to develop the basic information available about the incidence of the infection geographically and numerically and to institute continuous surveillance and also document the benefits of its control.

In the Southern Ghana, guinea worm disease was found to occur in villages which depended on pond water during the dry season, and recent occurrence of the disease in the survey area indicates that the disease is spreading and this is attributable to the fact that almost half of the 159 villages surveyed use pond water and the residents frequently travel to endemic areas.

The impact of Guinea Worm on a community is serious as the Guinea Worm disease incapacitates the farmers, school children and other villagers and thus affecting the agricultural productivi in the community. In Southern Ghana, the survey established that male farmers were at the greatest risk of being infected. It can be concluded that the disease has had effect on Cocoa production in the country. Cocoa farms are normally cultivated in the remote areas where invariably water sources are grossly polluted and farmers have no alternative but to use the sources for drinking purposes. Incidentally, these remote areas in the country do not have access to health posts and clinics and hospitals so that there cannot be recorded cases of the diseases. Health agencies then must attempt to study the prevalence of Guinea Worm particularly in the farming remote areas. In the meantime public health education must be embarked upon for simple preventive measures by boiling and filtering.

The basic needs then is to consider giving high priority to its control, reduction and elimination of the disease.

CONTROL OF DRACUNCULIASIS:

The most effective preventive measure is the provision of safe water supplies, and attempts are being made to provide low-cost systems to the affected communities. The type of water supply system to be selected would vary from one community to the other. And the various water supply systems to be considered are as follows:-

(a) Wells and springs (protected) to avoid contamination.
(b) Rain harvesting
(c) Wells fitted with hand pumps
(d) Deep boreholes mechanised (i.e. fitted with submersible pumps
(e) Conventional treatment (i.e. surface water) (preferably selecting water treatment systems incorporating slow sand filteration).

Water Source Selection:

The process of choosing the most suitable source of water for development into a public water supply largely depends on the local conditions. Where Springs are not available, the best option is exploring groundwater - digging wells and drilling a tube well. If groundwater is not available, it will be necessary to consider surface water from sources such as rivers, streams, or lakes and they almost always will require treatment to make it safe for human consumption.
Where the rainfall pattern permits rain-water harvesting and storage during dry periods can be provided. This may serve well for household and small community supplies only.

The main objective is to promote practicable measures to free domestic water supplies from the cyclops which harbour the embryo parasites and also to promote practicable measures to keep infected people from contaminating water supplies. Boiling of drinking water that is not known to be safe is a good measure for control since the cyclops are killed by heating to 65°C. Simple filtration will remove cyclops and excess lime will kill them but they are resistant even to comparatively large doses of chlorine.

Public education, however, is a vital ingredient in the prevention campaign.

CONTROL OF DRACUNCULIASIS IN GHANA IN THE CONTEXT OF THE IDWSSD :

Since Guinea Worm prevention is an official Decade target, provision of safe drinking water in the rural communities in the country continues to receive the support of the Ghanaian Government, so that the disease can be reduced and eliminated in the early part of the decade.

The Present Sector Status and Policy (Water Supply):

(1) Ghana Water and Sewerage Corporation (GWSC) is responsible for water supply in both urban and rural communities.

(2) Urban communities are always provided with pipe borne water supply. House to house connections are encouraged and public standpipes are provided wherever necessary.

(3) In the rural areas pipe-borne water through standpipes is provided for communities between 2,000 and 5.000 people. For those with less than 2,000 population, water is provided from drilled wells fitted with hand pumps.

(4) In 1975, 92.49% of the population had access to potable water supply while only 16.6% of the rural population enjoyed this benefit. And with most of the urban population having access to potable water the emphasis has now greatly shifted to the rural areas.

(5) The Ghanaian Government has shown concern and its social objective in promoting and protecting people's health is reflected in the increased expenditure which it has been making over the past years. For instance, over the five year period 1975 - 1980, the total population enjoying potable water supply increased from 38.2% to 48.3%. The percentage of the urban and rural population served with potable water in 1980 are 94.1% and 29.9% respectively. And over the five year period, the percentage increases are 1.61% for the urban and 13.3% for the rural.

This is a clear indication of the shift of the Government's attitude towards the provision of safe drinking water to the rural communities; and this to a large extent has brought about improvements in the health of the people.

NATIONAL SECTOR PLAN FOR THE DECADE (WATER SUPPLY)

The Decade target is to:-

(i) provide pipe borne water to 71 communities with over 2,000 inhabitants and 250 communities with between 500 and 1,999 inhabitants which are en route or close to pipe lines.

(ii) provide water from drilled wells fitted with hand pumps for 790 communities in the 500 - 1,999 population range.

(iii) up-grade and extend existing water supply systems to the urban fringes.

It is expected that this target will make it possible for 72% of the total population to enjoy potable water supplies by the end of the Decade in 1990 and the rural population to enjoy potable water supplies will be 61%. And although, the target for providing everyone in the country with access to a safe supply of drinking water would not have been achieved, guinea worm diseases in the rural areas would be reduced quite considerably.

At present the largest rural water supply scheme which is located in the Upper Region of Ghana has a public education component aimed at creating an awareness of the value of hand pump fitted systems.

This will encourage the population to ignore their polluted water sources and appreciate the value of good drinking water. A similar programme will be incorporated in a rural water supply programme currently underway in the Central and Southern Ghana.

The two major projects on-going in Ghana which will have a tremendous impact on the health of the people in the rural communities by eliminating dracunculiasis are the drilling of wells and fitting them with hand pumps. These projects are assisted by bilateral agencies, namely Federal Republic of Germany and CIDA (Canada).

This covers 3,000 wells in the Central and Southern part of Ghana (2,000 have already been completed under phase one of the programme), and 1,500 wells in the Upper Region of Ghana, all already completed and are in operation. The projects are estimated to be completed before the middle of the decade i.e. early 1983.

There ought to be very close co-operation between Ghana Water and Sewerage Corporation (GWSC) and the Ministry of Health (MOH) so that high priority is given to the construction of safe water supply schemes in areas where guinea worm diseases occur.

It is expected that Dracunculiasis will be reduced drastically in most areas of Ghana during the Water Decade, although some difficulties exist in the implementation of the decade programmes.

MAJOR CONSTRAINTS - WATER SUPPLY IN THE DECADE:

(1) There is shortage of professional staff in GWSC to carry out efficienty planning, design and supervision of development projects, and the operation and maintenance of the systems.

(ii) Financing through the Government is inadequate; and foreign exchange for the importation of plant and equipment is also inadequate.

(iii) Supply of constructional material i.e. reinforcement steel, cement etc. is inadequate.

(iv) Inability of local pipe manufacturers to supply pipes (asbestos cement and plastic) on schedule due to shortage of imported raw materials).

HYDRAULIQUE VILLAGEOISE ET LA LUTTE CONTRE LA DRACUNCULOSE

par

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I. INTRODUCTION :

La population du Togo s'estime à environs 3 millions d'habitants dont les 85 % vivent dans les zones rurales, regroupées en 2 579 centres de peuplement. Les villages dont les populations sont comprises entre 100 et 500 habitants, regroupent plus de 49 % de la population rurale totale.

- Les conditions climatiques se résument en une pluviométrie modérée avec une évaporation intense, des saiseons sèches bien marquées surtout dans le nord du pays.

- Les conditions géologiques du Togo dont le bedrock est constitué de roches cristallines situées à faible profondeur, sur la majeure partie du territoire, rendant très difficile la réalisation de puits creusés à la main.

C'est ainsi que dans la majeure partie du pays, les populations en soient réduites aux sources traditionnelles d'approvisionnement en eau: marigot, mares, impluvium, puits traditionnels mal construi et mal protégés etc... Il n'est pas superflu de mentionner que ces sources d'eau traditionnelles sont polluées, infestées etc. Les statistiques sanitaires montrent que les maladies rattachées directement ou indirectement à l'eau prévalent dans la pathologie togolaise. Parmi ces maladies d'origine hydrique figurent les filariose dont la dracunculose.

II. QUELQUES CONSIDERATIONS EPIDEMICLOGIQUES :

L'homme s'infecte en absorbant de l'eau contenant des cyclops, petits crustacés d'eau douce porteurs de parasites. Ces derniers se développent pendant 8 à 12 mois avant d'atteindre la forme adulte, male (3 cm) ou femelle (70 à 120 cm).

Les conditions de transmission de la maladie sont liées à l'environnement et aux mauvaises habitudes hygiéniques.

- Environnement:

Une longue saison sèche favorise un étroit contact de l'homme avec des points d'eau peu abondants: c'est le cas des régions suivantes du Togo Tsévié, Notse, Bassar, Niamtougou, Dapaong etc.

- De mauvaises habitudes hygiéniques:

Absorption d'eau non filtrée ou non bouillie, séjour plus ou moins prolongé du malade dans l'eau permettant au ver femelle de libérer des embryons infectants qui sont ingérés par les cyclops dans lesquels ils se développent pour assurer la perennisation de la maladie.

III. MOYENS DE LUTTE :

D'une façon générale, il faut aménager les points d'eau, les puits, les sources, pour fournir de l'eau en permanence et aussi empêcher les usagers d'être en contact direct avec les sources d'eau.

- Traiter l'eau avant consommation: ébullition ou tout au moins filtration sommaire sur une étoffe assez serrée; désinfecter à la chaux ou au chlore les mares qui fournissent l'eau de boisson.

- Introduire dans les mares des poissons mangeurs de cyclops (tels que les Gambusias Affinis, et les Poecilia "GUPPY" qui ont été déjà expérimentés au Togo).

Comme mentionné plus haut, les conditions climatiques propres au Togo (pluviométrie modérée avec évaporation intense, saisons sèches bien marquées 3 à 5 mois) conduisent les autorités administratives à se préoccuper activement du problème d'alimentation en eau des populations.

"Dans la stratégie du 3è plan, l'eau constitue la priorité numéro un autour de laquelle graviteront tous les programmes car elle constitue le besoin primordial dans la satisfaction duquel tous les autres programmes sont plus ou moins voués à l'échec". La justification de cette politique ne réside pas seulement dans l'amélioration sanitaire et d'alimentation. Elle peut être également prouvée par un calcul économique faisant apparaître les énormes gaspillages de temps pour toute activité économique ou éducative; cette politique s'est soldée par l'alimentation en eau potable de presque toutes les agglométations urbaines, et la dynamisation de l'hydraulique villageoise incluant un certain nombre de projets dont le principal objectif est d'aménager un point d'eau pour 500 habitants.

La réussite du programme permettra d'une façon générale d'élever le niveau de vie de l'homme togolais, et d'améliorer sa santé. La réussite de ce programme d'hydraulique villageoise permettra à coup sûr de réduire, voire éliminer les incidences de dracunculose, cause de longues absentéismes au travail de bon nombre de paysans togolais dans les régions lourdement infestées.

Le principal goulot d'étranglement d'un tel programme d'hydraulique villageoise est bien entendu l'insuffisance de sources de financement. En p[illegible] de l'effort du gouvernement togolais, les apports extérieurs d'ordre bilatéral ou multinational sont nécessaires pour aboutir à l'objectif fixé.

Pour mésurer les résultats obtenus quant à la réduction ou l'élimination du ver de guinée parallèle au programme de l'hydraulique villageoise, certains centres de peuplement doivent être choisis dans les régions lourdement infectées pour y éffectuer des études épidémiologiques, avant, pendant et après la réalisation du programme.-

ANNEXE I

~~CASRE~~ cas de DRACUNCULOSE EN 1979

LOCALITES	NOMBRE DE CAS
LOME	27
ANEHO	3
VO	
TSEVIE	204
TABLIGBO	12
KLOTO	62
NOTSE	87
ATAKPAME	18
AMLAME	-
BADOU	-
SOTOUBOUA	-
TCHAOUDJO	19
BAFILO	4
TCHAMBA	
Bassar	98
LAMA - KARA	25
NIAMTOUGOU	412 *
KANDE	-

* DRACUNCULOSE + onchocercose
ONCHOCERCOSE

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L'homme s'infecte en absorbant de l'eau contenant des cyclops, petits crustacés d'eau douce porteurs de parasites. Ces derniers se développent pendant 8 à 12 mois avant d'atteindre la forme adulte, male (3 cm) ou femelle (70 à 120 cm).

Les conditions de transmission de la maladie sont liées à l'environnement et aux mauvaises habitudes hygiéniques.

- Environnement:

Une longue saison sèche favorise un étroit contact de l'homme avec des points d'eau peu abondants: c'est le cas des régions suivantes du Togo Tsévié, Notse, Bassar, Niamtougou, Dapaong etc.

- De mauvaises habitudes hygiéniques:

Absorption d'eau non filtrée ou non bouillie, séjour plus ou moins prolongé du maladeʂ dans l'eau permettant au ver femelle de libérer des embryons infectants qui sont ingérés par les cyclops dans lesquels ils se développent pour assurer la perennisation de la maladie.

III. MOYENS DE LUTTE :

D'une façon générale, il faut aménager les points d'eau, les puits, les sources, pour fournir de l'eau en permanence et aussi empêcher les usagers d'être en contact direct avec les sources d'eau.

- Traiter l'eau avant consommation: ébullition ou tout au moins filtration sommaire sur une étoffe assez serrée; désinfecter à la chaux ou au chlore les mares qui fournissent l'eau de boisson.

- Introduire dans les mares des poissons mangeurs de cyclops (tels que les Gambusias Affinis, et les Poecilia "GUPPY" qui ont été déjà expérimentés au Togo).

Comme mentionné plus haut, les conditions climatiques propres au Togo (pluviométrie modérée avec évaporation intense, saisons sèches bien marquées 3 à 5 mois) conduisent les autorités administratives à se préoccuper activement du problème d'alimentation en eau des populations.

"Dans la stratégie du 3è plan, l'eau constitue la priorité numéro un autour de laquelle graviteront tous les programmes car elle constitue le besoin primordial dans la satisfaction duquel tous les autres programmes sont plus ou moins voués à l'échec". La justification de cette politique ne réside pas seulement dans l'amélioration sanitaires et d'alimentation. Elle peut être également prouvée par un calcul économique faisant apparaître les énormes gaspillages de temps pour toute activité économique ou éducative; cette politique s'est soldée par l'alimentation en eau potable de presque toutes les agglométations urbaines, et la dynamisation de l'hydraulique villageoise incluant un certain nombre de projets dont le principal objectif est d'aménager un point d'eau pour 500 habitants.

La réussite du programme permettra d'une façon générale d'élever le niveau de vie de l'homme togolais, et d'améliorer sa santé. La réussite de ce programme d'hydraülique villageoise permettra à coup sûr de réduire, voire éliminer les incidences de dracunculose, cause de longues absentéismes au travail de bon nombre de paysans togolais dans les régions lourdement infestées.

Le principal goulot d'étranglement d'un tel programme d'hydraülique villageoise est bien entendu l'insuffisance de sources de financement. En p[de l'effort du gouvernement togolais, les apports extérieurs d'ordre bilatéral ou multinational sont nécessaires pour aboutir à l'objectif fixé.

Pour mésurer les résultats obtenus quant à la réduction ou l'élimination du ver de guinée parallèle au programme de l'hydraulique villageoise, certains centres de peuplement doivent être choisis dand les régions lourdement infectées pour y éffectuer des études épidémiologiques, avant, pendant et après la réalisation du programme.-

ANNEXE I

cas de ~~CADRE~~ DRACUNCULOSE EN 1979

****

LOCALITES	NOMBRE DE C..S
L O M E	27
A N E H O	3
V O	
T S E V I E	204
T A B L I G B O	12
K L O T O	62
N O T S E	87
A T A K P A M E	18
A M L A M E	–
B A D O U	–
S O T O U B O U A	–
T C H A O U D J O	19
B A F I L O	4
T C H A M B A	
Bassar	98
L A M A - K A R A	25
N'I A M T O U G O U	412 •
K A N D E	–

DRACUNCULOSE + ONCHOCERCOSE
ONCHOCERCOSE

HYDRAULIQUE VILLAGEOISE ET LA LUTTE CONTRE LA DRAGUNCULOSE

par

KLOUTSE Fo-Kodjovi
Ingénieur Sanitaire M.Sc.

I. INTRODUCTION :

La population du Togo s'estime à environs 3 millions d'habitants dont les 85 % vivent dans les zones rurales, regroupées en 2 579 centres de peuplement. Les villages dont les populations sont comprises entre 100 et 500 habitants, regroupent plus de 49 % de la population rurale totale.

- Les conditions climatiques se résument en une pluviométrie modérée avec une évaporation intense, des saiseons sèches bien marquées surtout dans le nord du pays.

- Les conditions géologiques du Togo dont le bedrock est constitué de roches cristallines situées à faible profondeur, sur la majeure partie du territoire, rendent très difficile la réalisation de puits creusés à la main.

C'est ainsi que dans la majeure partie du pays, les populations en soient réduites aux sources traditionnelles d'appròvisionnement en eau: marigot, mares, impluvium, puits traditionnels mal construi et mal protégés etc... Il n'est pas superflu de mentionner que ces sources d'eau traditioonelles sont polluées, infestées etc. Les statistiques sanitaires montrent que les maladies rattachées directement ou indirectement à l'eau prévalent dans la pathologie togolaise. Parmi ces maladies d'origine hydrique figurent les filariose dont la dracunculose.

II. QUELQUES CONSIDERATIONS EPIDEMIOLOGIQUES :

L'homme s'infecte en absorbant de l'eau contenant des cyclops, petits crustacés d'eau douce porteurs de parasites. Ces derniers se développent pendant 8 à 12 mois avant d'atteindre la forme adulte, mal̃e(3 cm) ou femelle (70 à 120 cm).

Les conditions de transmission de la maladie sont liées à l'environnement et aux mauvaises habitudes hygiéniques.

- Environnement:

Une longue saison sèche favorise un étroit contact de l'homme avec des points d'eau peu abondants: c'est le cas des régions suivantes du Togo Tsévié, Notse, Bassar, Niamtougou, Dapaong etc.

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Absorption d'eau non filtrée ou non bouillie, séjour plus ou moins prolongé du malades dans l'eau permettant au ver femelle de libérer des embryons infectants qui sont ingérés par les cyclops dans lesquels ils se développent pour assurer la perennisation de la maladie.

III. MOYENS DE LUTTE :

D'une façon générale, il faut aménager les points d'eau, les puits, les sources, pour fournir de l'eau en permanence et aussi empêcher les usagers d'être en contact direct avec les sources d'eau.

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PART ONE

APPENDIX E

EPIDEMIO-GEOGRAPHIC DATA ON THE DRACUNCULOSIS IN FRENCH SPEAKING WEST AFRICA

(by PROD'HON J. and DESFONTAINE M.)

1. The Popular Republic of Benin

The only data we have here are fragmentary and mainly composed of results of surveys and reported cases analysed by some writers.

In Benin, in 1972, 1480 cases of dracunculosis were registered (FADO, 1973-1974) alone and 1000 cases came from the Province of Zou. In 1974, 820 cases were registered and 510 cases were found in the Province of Zou (FOURN, 1977). In another survey carried out in the Dassa-Zoumé district (population : 78,000 inhabitants) over four divisions picked at random, 1309 patients were examined and the survey led to the following conclusions :

- 351 patients were carriers of *Dracunculus medinensis* (VELSH, 1674)
- 87 patients had caught the dracunculosis in the year

which means a prevalence of 26.8 % in the work sample and an annual incidence of 33.5 %. Another survey (AMOUSSOUGA, 1975) undertaken in the districts of Savalou and Dassa-Zoumé (Province of Zou) gave the following results :

- Among the 784 schooled children we questioned 76 of them had the disease at the beginning of the year (annual incidence of 9.7 %).

Provinces	Reported cases	
	1972 (FADO, 1973-1975)	1974 (FOURN, 1977)
Ouémé	90	50
Atlantique	100	90
Mono	70	30
Zou	1000	510
Borgou	130	50
Atakora	90	90
TOTAL	1480	820

Table 1 : The dracunculosis in the Popular Republic of Benin (number of reported dracunculosis cases in each region in 1972 and 1974. Figures reused by FADO and FOURN according to the Public Health Department).

2. <u>Ivory Coast</u>

Our data on Ivory Coast are more complete and come from various sources :

- data from specific surveys carried out in different parts of the country ;
- statistics from the General Direction of Public Health (reported cases).

In 1965, a mass treatment (MEL W) was carried out by MACARIO in the Korhogo focus and in 1971 RAFFIER drew up the first distribution-map of the dracunculosis in Ivory Coast.

More recently (SILBERSTEIN, 1979) a survey undertaken in the Kanaso-village (32 kms in the south of Odienne, north-west region of Ivory Coast) revealed that half of the village population (about 500 inhabitants) was heavily hit by the disease, with cases of reactions and overinfections in the legs around the worm or worms. In fact, two thirds of the number of patient had more than one "Guinea-worm". The reason is that the population refuse to drink the water from the wells which according to them, "does not quench their thirst", and they would rather drink the pond-water, often infected with *Cyclops*.

In 1980, a survey carried out in a village near Gagnoa revealed a very high prevalence of the dracunculosis : 46.5 % (317 patients over a village population of 680 inhabitants) (PNUD, 1981).

From 1971 to 1979, the General Direction of the Public Health registered an annual average of 5,822 reported cases in Ivory Coast (the population of Ivory Coast : 6,672,000 inhabitants, result of the census taken in 1975).

More than 80 % of the cases detected from 1975 to 1978 were found in the areas of Bouaké, Bouaflé, Dimbokro, Tiassalé, Bondoukou and Séguéla.

.../...

In the Rural Health Sector of Dimbokro, the well-drilling programme reduced the prevalence of the disease from 30 % down to 1 % approximately (Ivory Coast Rural Health Head-Doctors'meeting, 1978).

At present, there is a spread of the dracunculosis in the forest-zone. One of the reasons could be the massive immigration of the savanna-régions - inhabitants towards the forest zones : the Voltaïc immigration which brings in 500,000 persons is one of the most important and represents the most important part of the foreign settlement in the South-East rural areas of the country (MARGUERAT, 1979). The Malians, less numerous (207,000 people) are widely scattered in the cities but their fellow rural immigrants can be found peculiarly in the rich forest regions (MARGUERAT, 1979).

Year	Number of reported cases
1971	8,399
1972	6,348
1973	4,891
1974	4,654
1975	6,283
1976	4,971
1977	4,656
1978	5,207
1979	6,993
TOTAL	52,402

1980 6,712
1981 8,009

Table 2 : The dracunculosis in Ivory Coast (Cf. appendix II).
(number of reported cases per year from 1971 to 1979 ;
Population : 6,672,000 inhabitants, 1974 census).

.../...

3. Upper Volta

In 1963, PIRAME *et al.* reported a frequent combination of dracunculosis and tetanos in Upper Volta. In 1967, a survey was carried out by the Parasitology Department of the Centre Muraz, OCCGE (LAMONTELLERIE, 1972) in the district of Banfora which included the areas of Comoe-Leraba and the South-East region of Upper Volta. The survey dealt with 113 villages over six territorial divisions (or cantons). The villages were unevenly infected : the southern zone (the low-Komono area) was badly hit when the dracunculosis was practically unknown in the North. The striking fact here is that the disease was essentially localised in the low lands rather far from the important rivers. The reason for this localisation is the fact that in the low-lands the drinking water supply proceeds from still-waters fed with water from the residual ponds or, more seldom from wells, both often infected with *Cyclops*. The important rivers on the contrary are fed with running waters and are far less infected with *Cyclops*. Fifty two villages were found seriously infected, with a maximum prevalence among the patients during the rainy season.

The author pointed out the important socio-economic impact of the disease in the most infected villages.

A present, the dracunculosis is severe in all Rural Health Sectors : from 1971 to 1979 (table 3), an annual average of 3,776 cases was registered. The most infected areas are Banfora, Dori, Koudougou, Ouagadougou, Ouahigouya, Yako and Tenkodogo.

The visible incidence is slightly lower than that of the Ivory Coast and it could be of interest to notice the fact that there is an important migratory current between the Mossi-country (which is highly infected with dracunculosis) and the Ivory Coast dracunculosis forest zones.

.../...

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Year	Number of reported cases
1971	5,822
1972	4,404
1973	4,008
1974	6,277
1975	1,557
1976	Not available
1977	2,885
1978	2,694
1979	2,565
TOTAL	30,212

Table 3 : The dracunculosis in Upper Volta (cf. Appendix III).
(Number of reported cases per year from 1971 to 1979 ; population : 5,657,000 inhabitants, 1975 census).

4. Mali

Beside the information collected in the Malian Monthly Bulletins on sanitary information ("Bulletins mensuels d'Information Sanitaire du Mali"). we also got some complementary information from the partial surveys carried out in the regions of Yelimane, Nioro of Sahel and Nara (PROD'HON, 1978) and in the Dogon-country (district of Bandiagara, DEGOGA, 1977).

A general study (by RANQUE *et al.*, 1979) specified the geographic distribution of the dracunculosis in Mali. From the bio-climatic point of view, the dracunculosis is limited in the North by the barren steppe. It is widely spread over the isohyetes 200 mm and 1000 mm in the sahelian steppe and the bushy savanna, particularly in places where there is an outcrop of underground water. Within that zone, the inside delta of the Niger river seems unsuitable for a spread of the disease because of its immense and easily flooded plains.

.../...

In the woody savanna of the South, there are a few scattered focuses but they have become localised. Most of the cases reported there could have been imported from Upper Volta and Ivory Coast.

The drought that took place in the southern Sahara and in Mali, apart from its catastrophic economic consequences, must have been a limiting factor to the endemic character of the disease. Not only did it dry up the usual ponds of water supplies, but it also forced the populations to get their drinking water from very deep wells : in the village of Ghirel (in the North of Nara) for example, the disease disappeared completely because the pond had been dried up for two consecutive years (PROD'HON *et al.*, 1978). The survey undertaken in 1977 (cf. Methodology in Appendix) in the North of Mali (regions of Yelimane, Nioro of Sahel and Nara) over 24 localities (with 10,052 subjects examined) revealed a mosaic pattern of focuses with uneven endemic levels. Here each locality or even village-district can be considered as an epidemic entity by itself. It is centered either on the vectorial strata / namely on water supplying spots more or less infected with *Cyclops*.

The prevalences and parasitism vary according to the regions and villages. In the region of Yelimane, the dracunculosis is hypoendemic to the limit of mesoendemicity (28.7 %). The percentage mentioned here varies according to the villages (10 villages were visited). The intensity of the parasitism is low in most of the cases but we noticed that in some villages, some patients had an important poly-parasitism : up to 25 worms with only one woman in Guemou- Kasse. In that village, the subjects with 11 worms or more concentrated 50 % of the parasites and represented a little more than 10 % of the subject who had the disease.

In the region of Nioro-of-Sahel, the dracunculosis is hypoendemic in 5 (of the 6) villages examined (with a prevalence inferior to 10 %). In Youri, the dracunculosis is mesoendemic with an important degree of polyparasitism : one subject had 32 worms and those with 9 worms or more concentrated a little less than 50 % of the parasites and represented about 20 % of the patients.

.../...

In the Nara-region, the dracunculosis evolves from hypoendemicity (7.1 %) to hyperendemicity (74.2 % of the persons examined). As we mentioned above, the dracunculosis has disappeared from the village of Ghirel, as a result of the fact that the pond had been dried up. The parasitism-rates are closely bound up with the prevalences : in the hyperendemic village of N'Gbakoro, the subjects with 8 worms or more concentrated more than 50 % of the parasites and represented almost 25% of the sick subjects. Let's mention well-drilling programme in that region : the northern Nara operation. DEGOGA (1977) revealed in two villages of the Dogon-country, the prevalence-rates of 50 % approximately (209 persons were examined).

Here (fig. 1) is the distribution-map of the dracunculosis in Mali (by RANQUE *et al.*, 1979) and in table 4, the number of reported cases every year from 1972 to 1978. The number of reported cases per year is rather low (an average of 712 cases).

Year	Number of reported cases per year	Year	Number of reported cases per year
1972	498	1976	452 (total over 11 months)
1973	668	1977	760 (total over 11 months)
1974	786	1978	1084
1975	737		
TOTAL			4,985

Table 4 : The dracunculosis in Mali (cf. appendix IV)
(number of reported cases per year from 1972 to 1978 ; population : 6,035,272 inhabitants, 1975 census).

5. The Islamic Republic of Mauritania

In 1952, ROUSSET reported an important disease-focus where some years, about half of the population was unable to work because of the dracunculosis. That focus is at present eradicated and can be considered as historical. The data concerning Mauritania are seldom :

.../...

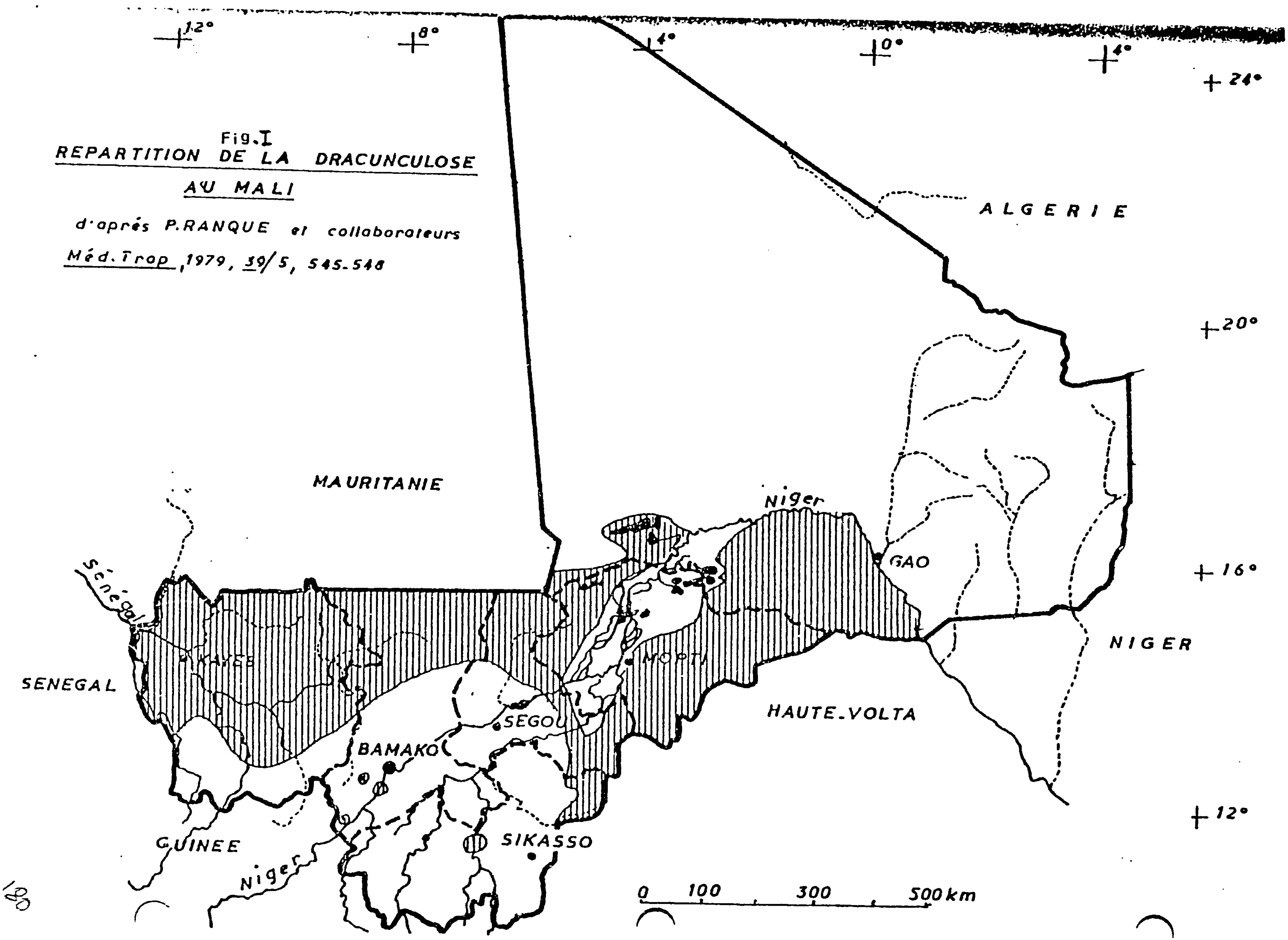

Fig. I
REPARTITION DE LA DRACUNCULOSE AU MALI
d'aprés P. RANQUE et collaborateurs
Méd. Trop, 1979, 39/5, 545-548

- we have the results of an epidemic survey directed by the National Center for Hygiene of the Islamic Republic of Mauritania ; the center reported a focus found in the region of Mouguel in 1980 ;

- there is a focus around the city of Nema (Oriental Hodh) and another one in the city of Kankossa in the South of Assab (Dr. MUSTAPHA SIDATT, Director of the National Center of Hygiene, *loc. cit.*) ;

- we have also the results of a survey carried out (by PROD'HON *et al.*, 1978) in November 1977 in the South of Mauritania (the region of Selibaby) here five villages were visited ; the degrees of endemicity vary from 1.1 % to 24.2 % ; 127 cases of dracunculosis were detected among 1189 inhabitants examined (that is an incidence of 10.7 % over the whole examined population).

6. Niger

In 1977, the most important focus was found in the Subdivision of Tera which reports more than half of its registered cases.

With more than 5000 reported cases in 1978 and 1979, Niger is one of the first West African Francophone countries, as far as the dracunculosis is concerned. In 1978, 80 % of the cases were found in three focuses :

- Niamey-city ;
- Tera-subdivision (North-West Niger) ;
- Myrriah-subdivision (South-East of the city of Zinder).

Number of cases	1976	1977	1978	1979	TOTAL
Over the whole country	2,600	3,000	5,560	5,305	16,465
Niamey-city	-	700	1,614	3,037	5,351
Myrriah-subdivision	90	32	1,574	352	3,744
Tera -subdivision	-	1,533	1,145	1,915	4,613

Table 5 : The dracunculosis in Niger.
(Number of reported cases per year from 1976 to 1979).

The results of a survey (PROD'HON *et al.*, 1977) carried out by the Centre Muraz (OCCGE) in the region of Torodi revealed very low rates of endemy among the 2,231 subjects examined in the 11 villages we visited : 4.7 % (5.6 % of the 1,080 men examined and 3.8 % of the 1,151 women examined). The incidence varies from one village to another, and is between 13.8 % and 2.5 %.

The determination of the collected *Cyclops* (DUSSART *in* PROD'HON, 1978) revealed eleven different species of *Cyclops* of which fourth are undoubtedly human-dracunculosis intermediate hosts in Africa (ONABAMIRO, 1952).

7. Senegal

With only an average of 164 reported cases per year (source of information : Annual Reports of the Ministry of Public Health), Senegal offers the lowest rates among the countries we studied. The disease is certainly endemic all over the country but its importance is not properly acknowledged.

The 1975 annual report specifies the origin of the 65 (sixty five) reported cases :

- 57 cases were found in the region of the Senegal-river
- and 8 cases in Casamance.

Year	Number of reported cases per year
1971	79
1972	-
1973	334
1974	208
1975	65
1976	137
TOTAL	823

Table 6 : The dracunculosis in Senegal (number of reported cases per year from 1971 to 1976 ; population : 4,869,000 inhabitants ; 1974 estimate).

.../...

8. Togo

We have only the results of two surveys carried out by the Entomology Center of Cotonou (OCCGE) in the Administrative Divisions of Haho and Bassari (AMOUSSOUGA, 1976 and 1977). The epidemiological informations collected in those two surveys enable us to evaluate the number of reported cases in the dispensaries of the two divisions.

The epidemiological data analysed in the Health Centers of both divisions reveal a very high number of reported cases :

- 1,602 cases in 1974 and 505 from January to August 1975 over 19 villages (8,000 inhabitants) in the division of Haho ;
- 1,246 cases in 1975 and 1057 in 1976 in the division of Bassari (estimated population : 95,577 inhabitants).

Other annual reports from the Ministry of Public Health of Togo reveal 3,261 cases in 1974 ; 1,648 in 1975 ; 2,617 in 1977 and 2,673 in 1978; and 981 in 1979.

9. The situation in neighbour-countries

9.1. Tchad :

In 1978, Tchad reported 172 cases in the monthly Bulletins of Sanitary Information.

9.2. Guinea-Bissau : (data collected from literature)

In 1948 in the North-East region of Guinea-Bissau, a survey (FEREIRAS *et al.*, 1948) figured out 186 cases of dracunculosis (of which 28 subjects were polyinfected) over the 1,011 persons examined in five villages.

CONCLUSION

Although the dracunculosis can be considered as a real economic flail when it's widely spread, its precise distribution and socio-economic impact are not properly known. The eradication and the study of the dracunculosis do not raise great interest because the disease is not "spectacular" and does not lead to death. This lack of interest prevents the West African Francophone countries from being aware of the real effects it may have in the health of the people and on the economy of the villages where it is an endemic disease.

Therefore, it is difficult to evaluate the real importance of the dracunculosis in French-speaking West Africa. Here we give the distribution of the dracunculosis in West Africa (fig. 2). This map which has been drawn up with some official sources of information, often underestimated, or with the results of some surveys, can only give a fragmentary idea of the distribution of the disease : on top of a basis of endemicity, a few local epidemic focuses can be seen. But there is no general study. Besides, the epidemiological characteristics of the disease make a general study difficult : in fact there is an important local variety in the degrees of endemicity of the disease. Each infected spot can be referred to as an epidemiological entity by itself. It is centered on the water-holes which are infected with *Cyclops*. If the dracunculosis can be considered as present everywhere in Francophone West Africa, its territorial distribution can be described as a mosaic pattern of disease-focuses with uneven degrees of endemicity.

The gaps in the sources of information which represent the most important factor, are not the only elements which hinder a proper appreciation of the importance of the dracunculosis.

Another factor lies in the fact that some patients very rarely have recourse to the existing sanitary units, unless they have serious complications. The number of reported cases can be valued at about 10 % of the infected subjects.

Nevertheless, the socio-economic impact of the dracunculosis is very important :

- DEGOGA (1977) reported that in a Malian village 30 % of the patients were immobilised for more than one month ;

- the infected farmers, sometimes, must stay in bed for three months in a period of intensive agricultural activities (sowing or harvest); this situation leads to a decrease of about 30 % of the agricultural production (PNUD, 1981).

We have tried to contrast the economic repercussions of the dracunculosis with those of the malaria. For each malaria reported case, the waste can arbitrarily be valued at a 3 days'loss in the patient's work (International Center for Childhood, 1979) ; in the same way, each dracunculosis reported case could be valued at a 30 days' loss or more in cases with complications. For example in Upper-Volta :

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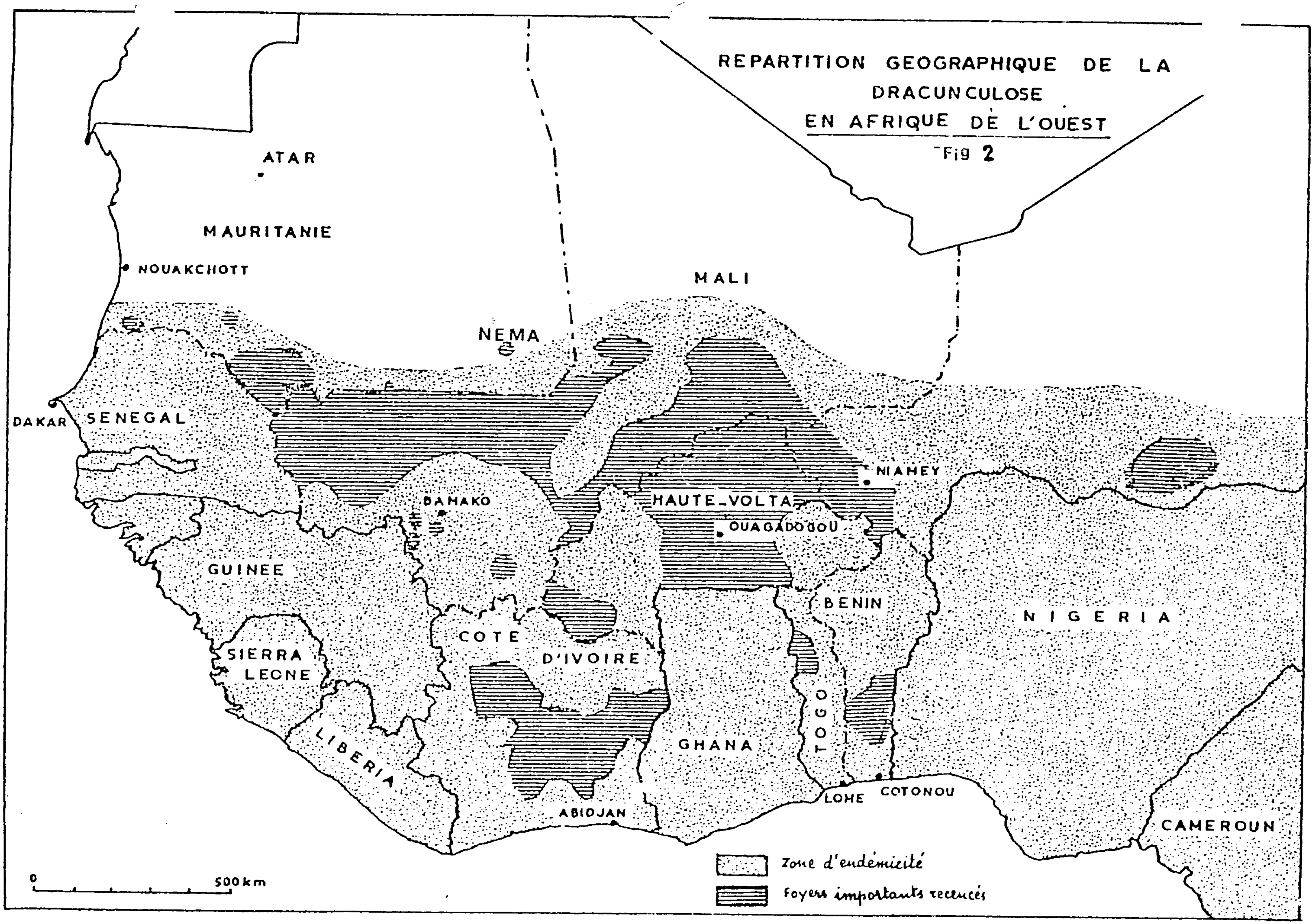

REPARTITION GEOGRAPHIQUE DE LA DRACUNCULOSE EN AFRIQUE DE L'OUEST

Fig 2

- Malaria : about 300,000 (average) reported cases per year, from which 300,000 x 3 = 900,000 work-days' loss.
- Dracunculosis : about 4,158 (average) reported cases per year ; the number of wasted work-days varying from 58,212 (no complicated cases) to 127,740 (cases with complications).

But those results are to be rectified if we take into account the frequency of the declarations. In fact, in rural sectors, the malaria-patients go to the health personnel more easily and therefore are more likely to receive effective medical treatments ; which is not the case for the dracunculosis - patients who, quite often, resort to traditional therapy.

In conclusion, we may say that the whole Francophone West Africa is hit by the dracunculosis. Some focuses still persist in Benin, Mauritania, Senegal and Togo, whereas in Upper-Volta, Ivory Coast and Mali, the disease can pratically be found everywhere in the country. In Niger, over the last few years, some disease focuses have been registered of which the urban-focus of Niamey.

The fight against the disease is possible, although there is no effective and specific medical mass-treatment. This fight which will have to be considered as an important priority, must be preceded by a study of the exact distribution of the dracunculosis, its prevalence and its socio-economic impact.

The fight will mainly be preventive :

- the health education is the simplest, the most effective but also the most difficult means to put into practice. The mere information is not enough because it will surely be impeded by the deeply-rooted habits of the village-populations (the villagers would rather drink the pond-water because it tastes). The curative element, which is only meant to relieve pain, should precede the educational action in order to make the villagers confiding. In any case, and this is true to any country, the health education remains the most effective but also the most difficult means by which we can defeat a disease ;

.../...

- improvement of drinking-water, either through simple hygienic measures (use of filter or boiling the water) or by carrying out some rural water-programmes (such as well-driving, protecting and dressing up some water-holes ...). The fight against the vector, which is often constraining (organization-problems, repeated treatments of beds), will come in the first time, as a temporary substitute for the simple hygienic measures and the improvement of water-holes.

Once more, we would like to emphasize the fact that absolute priority should be given to the health education which remains the only means by which we can keep the dracunculosis-endemic under control effectively and definitly It's clear that the dracunculosis is a real sociological disease. The curative action (in our present knowledge) the chemical fight against the vector, the piped-water buildings are certainly indispensable, but they can only be considered as a substitute meant to palliate the total lack of health education. In fact, the villages often prefer the *Cyclops*-infected pond-water to the protected and safer well-water because its taste. We even discovered, to our amazement, that in a village located in the North of Mali, the villagers filled up a well with whatever they could find, simply because they would not give up drinking the pond-water.

SUMMARY

Our analysis here is partly based on some official epidemiological sources (Annual reports from Public Health Departments) and on some results of surveys carried out either by the OCCGE (Centre Muraz and the Entomology Center of Cotonou). "L'Ecole Nationale de Medecine ou de Pharmacie de Bamako" proved very helpful. We also made the best of a few specific and isolated surveys in our study of the distribution of the dracunculosis in the French-speaking West African Countries. Guinea has been left out because we didn't get the information we needed about the country.

The dracunculosis is endemic in any of the countries we studied. The numbers of reported cases are more or less important and depend on the countries. The most important numbers of reported cases are found in Ivory Coast (6,933 cases in 1979), Upper-Volta (2,565 cases in 1979) and Niger (5,560 cases in 1978). The distribution of the disease is clearer in Mali, thanks to the surveys carried out in the North of the country by the OCCGE, and to the general study carried out all over the country by l'Ecole Nationale de

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If as a rule, the dracunculosis can be considered as present in all those French-speaking West African countries, we must underline the fact that its territorial distribution is a mosaic pattern of focuses with uneven endemic degrees.

Here we have two maps of distribution on the dracunculosis ; the first refers to Mali and the second one to West Africa.

Another striking fact is the presence of an important migratory current starting off in the savanna-countries (Upper-Volta and Mali for its greater part) and moving towards Ivory Coast where some spreading focuses have now appeared.

Besides, in Niger, an urban-focus has come out in Niamey (1,600 reported cases in 1978).

The problem of the socio-economic repercussions of the dracunculosis is also discussed here. The importance of the socio-economic impact of this endemic disease of which the incidence is largely underestimated, should lead to some preventive measures. Those measures should enable us to eradicate the disease completely or at least reduce its endemic degree to a negligeable rate. The prevention we are talking about here will mainly be based on :

- the developpement of health education associated (or not) with a curative element
- water-works programmes to prevent contamination and make the source of drinking water cleaner.

PART TWO

ESSAY ON THE CORRELATION BETWEEN BIO-CLIMATIC VARIATIONS AND THE TRANSMISSION OF THE DISEASE

(by DESFONTAINE M. and PROD'HON J.)

It's typical to consider the dracunculosis as an endemic and epidemic disease which crops up and spreads around the water-sources only during the rainy season, in the hot and dry zones of Africa. However, many dry season-cases (emergency of the worms) with even a maximum of frequency in that dry season have been reported by numerous writers.

We have tried to bring out the correlation between the bio-climatic variations and the intensity of the incidence of the disease-transmission.

We have contrasted the different data* concerning some Sahelian zones (Northern Upper Volta and Nothern Mali), a few savanna-zones (Upper Volta, Northern Ivory Coast and Togo), and some forest-zones (Southern Ivory Coast) of the French-speaking West Africa (the map of the average annual isohyetes in West Africa can be found in Appendix V).

1. The Sahelian zone (Annual rainfall inferior to 600 mm)

The correlation between the maximum rainfall and the maximum transmission-frequency is quite clear. In Mali (cf. fig. 3), there is full agreement between the maximum registered on the rain-gauge (registered in Bamako, 1977) and the maximum average of reported cases, between 1972 and 1977, in the rainy season, that is when the ponds are filled with water. In the dry season, the ponds having dried up, particularly in the greater part of the Northern area, the water-supplies come from very deep wells (20 m) which, because of their depth, are thus protected against any kind of contamination. Some residual pond-waters can also be found in Mali during the dry season. Those waters keep up the disease-transmission all along the year with a maximum in dry season through a concentration of the vector.

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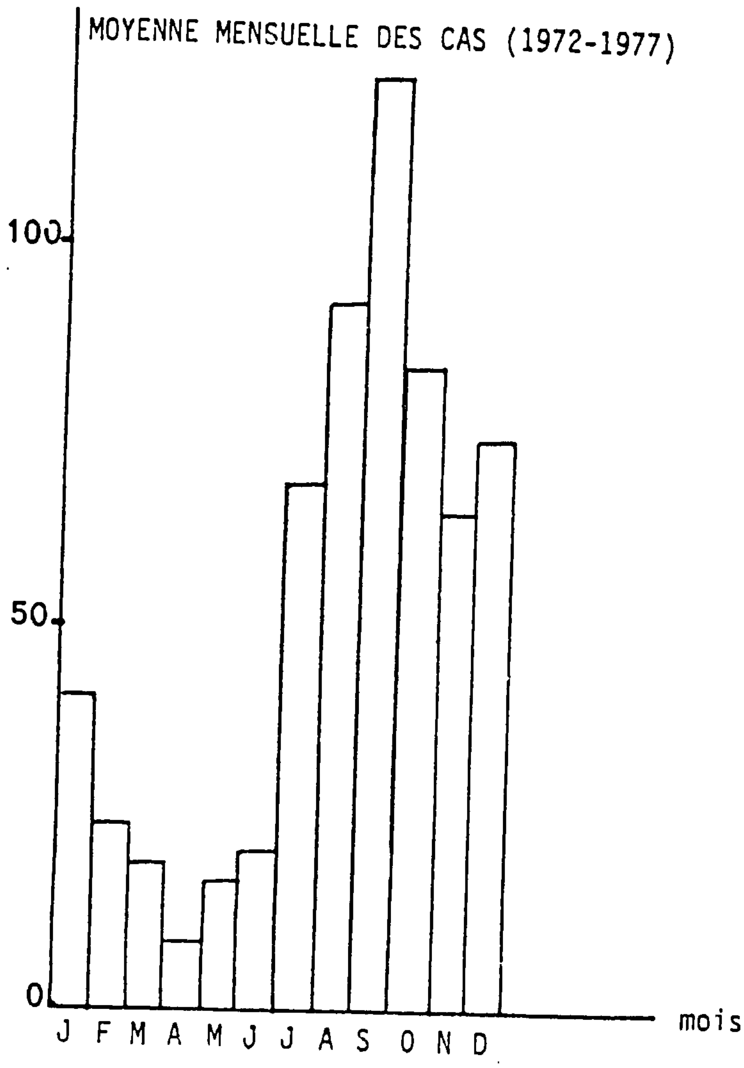
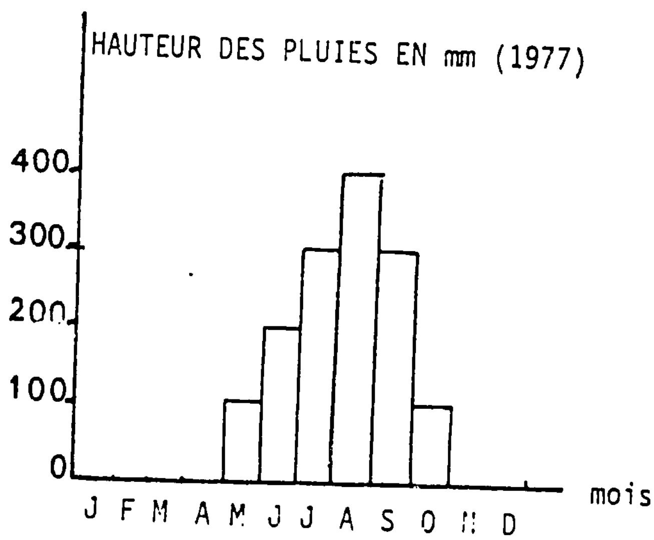
* Origin of the data : reports from General Health Departments of Ivory Coast, Upper Volta and Mali ; results of the AMOUSSOUGA survey, 1977 (concerning Togo).



DRACUNCULOSE



REGIME DES PLUIES
(BAMAKO, 1977)

It from a general point of view, we can say that in Upper Volta (fig. 4), there is a maximum transmission in the rainy season, we must not forget the fact that the phenomenon is more striking in the Northern part of the country (region of Dori, fig. 5) and that it is far less visible in the savanna zone in the South of the country.

2. The savanna-zone

There is a maximum of cases between the beginning and the end of the dry season, but it varies in accordance with the regions and it depends on other factors such as more or less important rainfalls, ponds drying up either too early or too late and the persistence of the ponds themselves. In the savanna regions, except in a few areas, the intensity of the disease-transmission is minimum at the end of the dry season which is the period when the ponds have completely dried up.

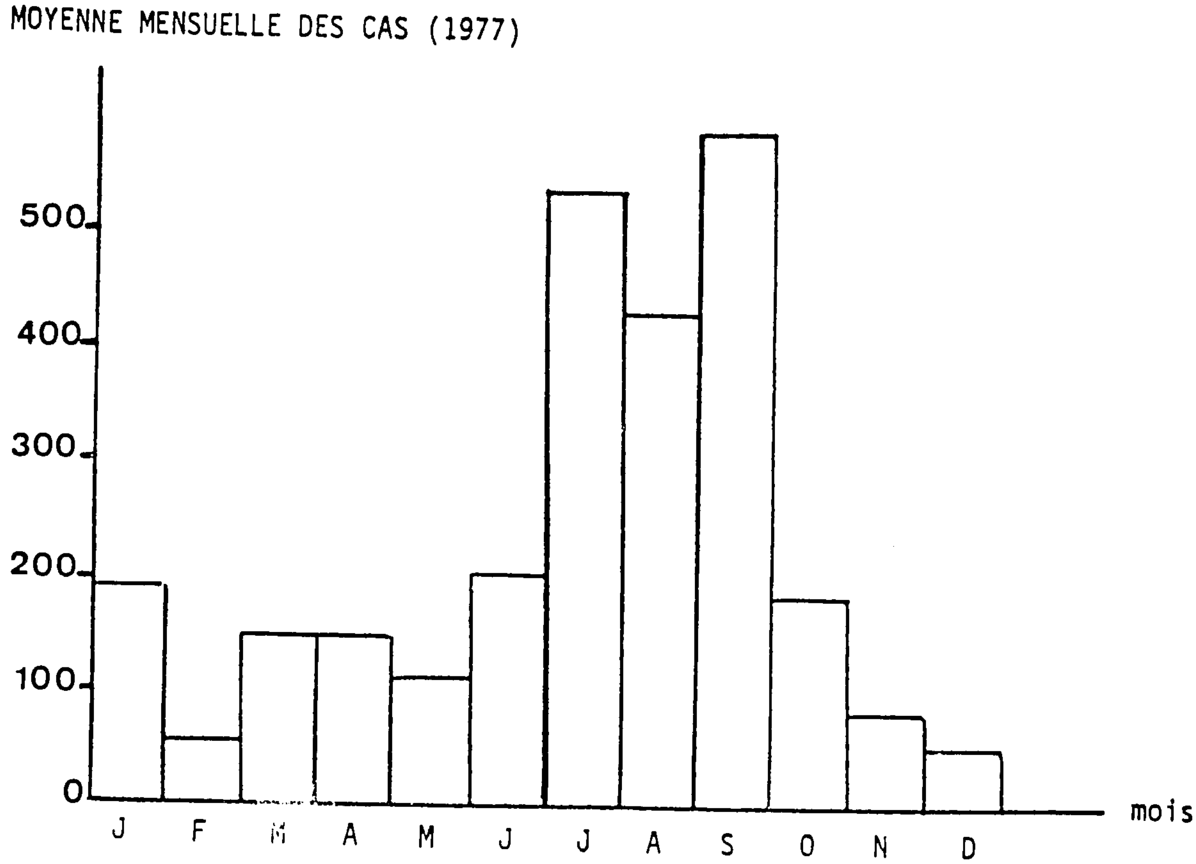
As for Upper Volta (fig. 5), in the sudanian-zone (annual rainfall varying from 600 mm to 1000 mm), the maximum intensity of the disease transmission shifts from the rainy season to the beginning of the dry season and the minimum intensity coincides with the end of the dry season.

In the zone of sudano-guinean savanna of Upper Volta (fig. 5), Togo (fig. 6) or Ivory Coast (fig. 7), the annual rainfall is above 1,000 mm and in general, there is a maximum intensity of transmission in the dry season, either at the beginning (region of Bobo-Dioulasso in Upper Volta ; region of Korhogo in Ivory Coast), or at the end of the dry season (region of Odienne in Ivory Coast and the subdivision of Bassari in Togo). In Bondoukou (eastern part of Ivory Coast), the two peak-points of maximum intensity of the dracunculosis transmission coincide with the two dry seasons.

Schematically, in the savanna-zone, there is a maximum intensity of transmission in the dry season : at the end of the rainy season aud at the beginning of the dry season in the soudanian zone and full dry season and at the end of the dry season in the sudano-guinean zones. There is a minimum intensity in the rainy season and, but that depends on the isohyets, at the end of the dry season.

.../...

FIG. 4 - DRACUNCULOSE ET PLUVIOMETRIE EN HAUTE-VOLTA



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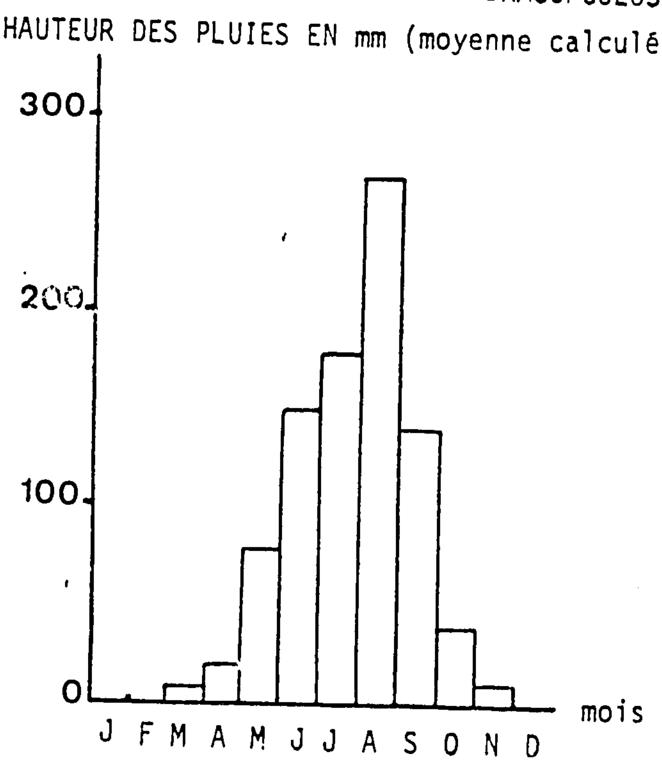


REGIME DES PLUIES
(OUAGADOUGOU, Aéroport)

FIG. 5 - DRACUNCULOSE ET PLUVIOMETRIE EN HAUTE-VOLTA

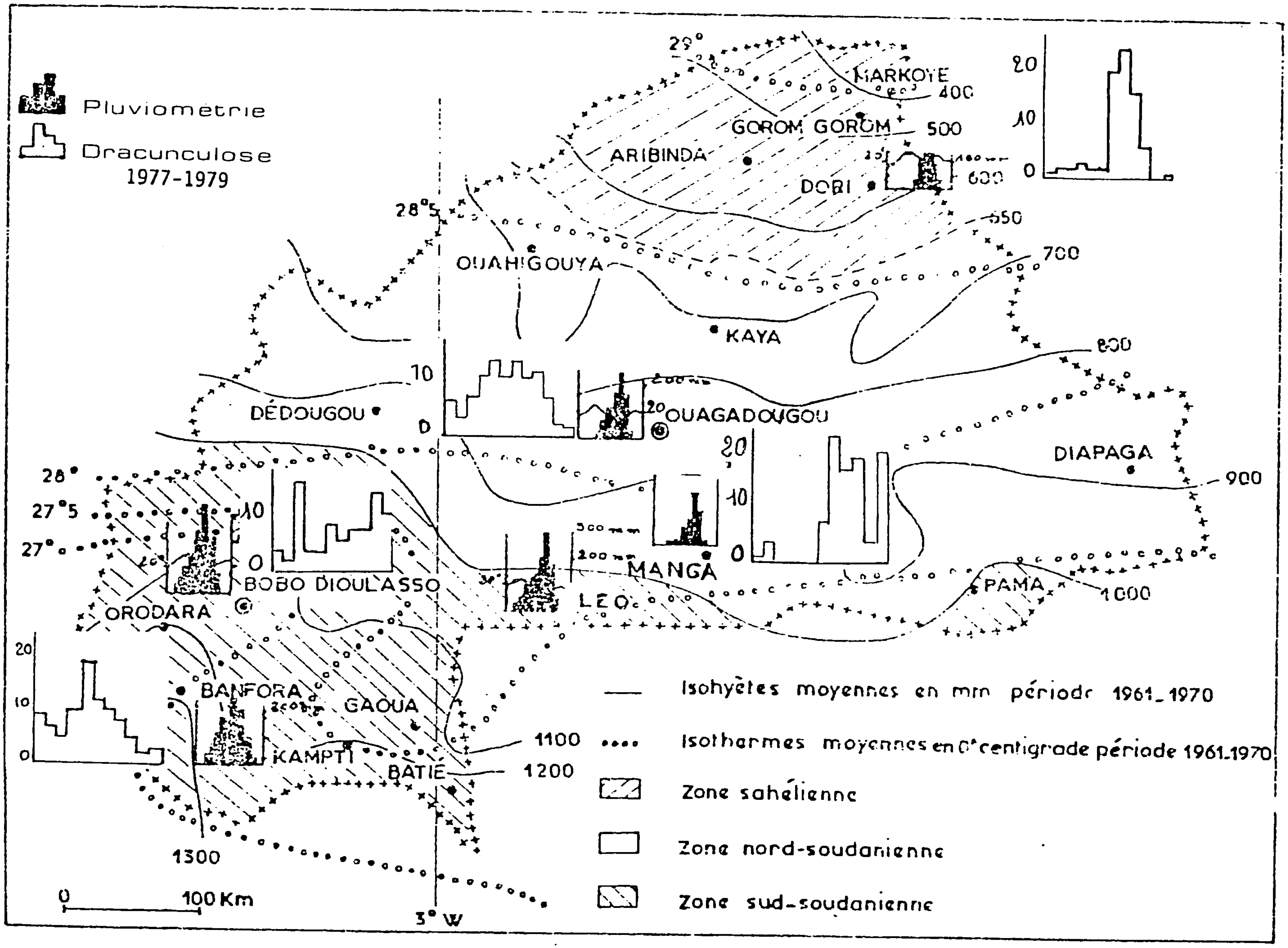
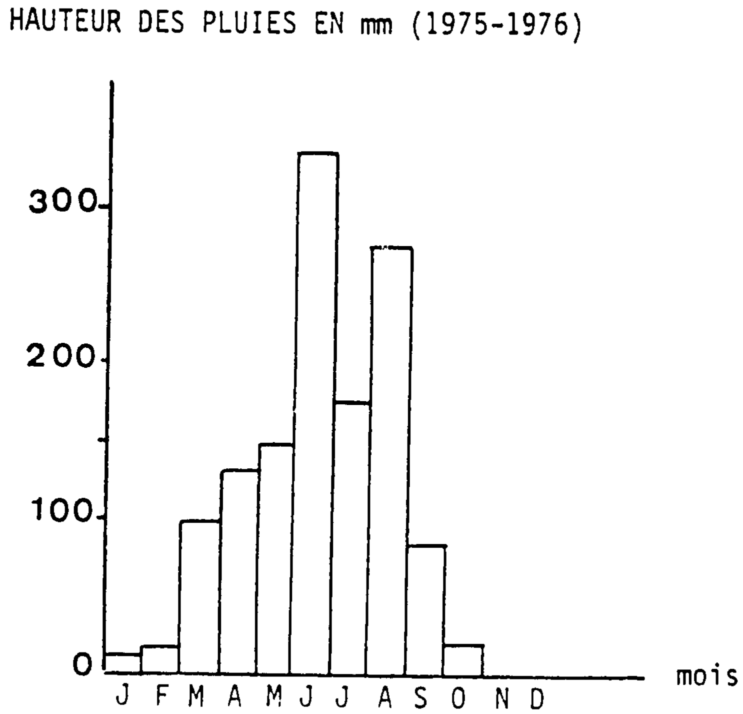


FIG. 6 - DRACUNCULOSE ET PLUVIOMETRIE AU TOGO
(Circonscription de Bassari)



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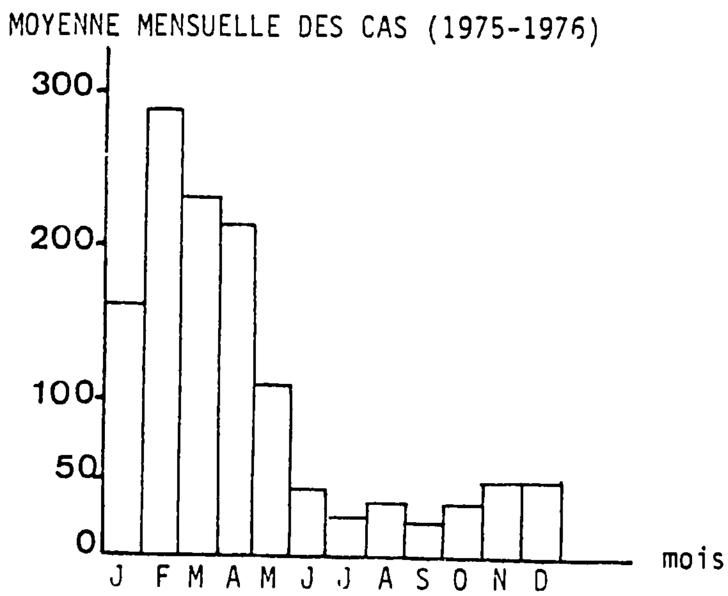


DRACUNCULOSE

3. The forest-zone

The transmission of the dracunculosis here is more or less persistent all along the year and is related to the high and more or less regular rainfalls (South of Ivory Coast, fig. 7).

The maximum transmission-intensity we found in some regions of Ivory Coast (Daloa, Dimbrokro and Adzope) is more or less important and can be seen only in the dry season, particularly, when the ponds have not dried up completely because they become a comfortable bed for the *Cyclops* concentration, the minimum number of reported cases generally appears in the rainy season.

4. Conclusion

A sketch-plan on the correlations between the annual rainfalls and the annual incidence of the dracunculosis transmission could be as follows ::

- in the sahelian zone there is a maximum incidence of transmission in the rainy season which is the period when the ponds are supplied with water and when the waters are contaminated by the patients ; on the contrary, the transmission disappears almost completely in the dry season which is the period when the ponds have completely dried up and when the water-supplies generally come from the underground water through very deep wells ;

- in the forest-zone, the transmission is more or less persistent all along the year and is closely related to the persistence of the pond-waters; there is an increase of transmission at the end of the dry season which is the period when the ponds, partly dried up, contain high concentrations of the vector. In general, the minimum intensity can be seen in the rainy season (because of the dilution of the vector) ;

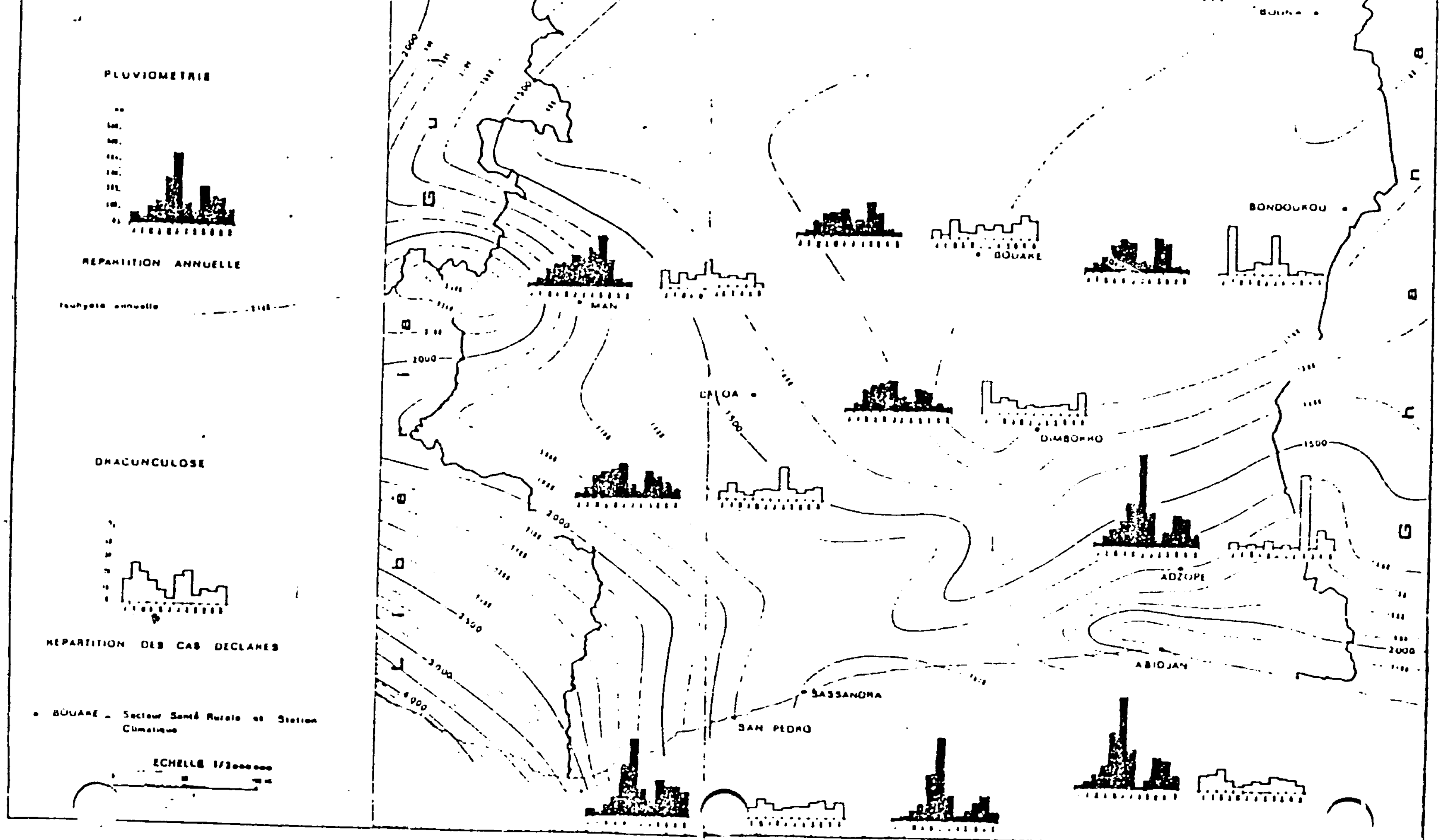
- The savanna offers some intermediary situations, half-way between those two extremes; in general, there is a maximum transmission intensity at the beginning and in the middle of the dry season and there is a minimum intensity at the end of the dry season.

From the Sahel to the forest, that is from the less watered zones to the more irrigated zones, the period of maximum transmission of the dracunculosis shifts from the rainy season to the end of the dry season. It is closely related to the persistence or non-persistence of the ponds from which the villagers get their drinking water. The minimum transmission follows a reversing process : the phenomenon here can be seen in the sahelian zone during the dry season and in the rainy season in regions with a greater quantity of rainfalls.

Fig.7
DRACUNCULOSE

HISTOGRAMME DES POURCENTAGES DES MOYENNES MENSUELLES DES CAS DECLARES DANS CERTAINS SECTEURS DE COTE D'IVOIRE DE 1975 à 1979

COMPARAISON AVEC L'HISTOGRAMME DE LA REPARTITION ANNUELLE DE LA PLUVIOMETRIE



In an anti-vectorial control programme those different situations will require different strategies.

SUMMARY

The study of the annual distribution of the dracunculosis reported cases in some West African Francophone countries (Ivory Coast, Upper Volta, Mali and Togo) enabled us to work out a correlation between some bio-climatic zones and the maximum intensity of the disease transmission.

In the sahelian zone (annual rainfall inferior to 600 mm , there is a maximum transmission in the rainy season (ponds full of water) and a minimum transmission or none at all in the dry season (ponds almost dried up and drinking-water coming up from underground-water which is often burried deep down).

In the forest zone where there is an important annual rainfall, the transmission is more or less persistent all along the year, with a possible maximum in the dry season and at the end of the dry season, because ponds have partly dried up and have high concentrations of vectors. In general, the transmission is minimum during the rainy season or seasons.

There is an intermediary situation in the savanna-zone. Here, the maximum of transmission shifts from the rainy season to the dry season and follows the rainfall-variations : end of the rainy season - beginning of the dry season in the sudanian-savanna (annual rainfall between 600 and 1,000 mm) dry season and sometimes end of dry season in the sudano-guinean savanna (annual rainfall superior to 1,000 mm).

In an anti-vectorial control-programme, different strategies will be required for those situations which have been sketched out of one of the dracunculosis epidemiological characteristics closely bound up with the rainfall variations.

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ANNEXE.I
METHODOLOGIE DES ENQUETES DRACUNCULOSE

par

PROD'HON J. et DESFONTAINE M.

1. But de l'enquête :

- Evaluer l'importance de l'endémie sur le plan clinique en dépistant les malades actuels et en évaluant l'incidence annuelle par une enquête rétrospective,
- Réaliser un inventaire des points d'approvisionnement en eau et rechercher la présence des copépodes infestés dans chacun de ces points.

2. Choix de l'échantillon.

Suivant les circonstances épidémiologiques on peut être conduit à réaliser une enquête au niveau d'un village, d'une circonscription ou d'une région.

2.1. Au niveau d'un village on peut, suivant les moyens disponibles, effectuer une enquête exhaustive ou une enquête sur un échantillon représentatif :

2.1.1. Enquête exhaustive : sur l'ensemble de la population en dénombrant si possible les absents.

2.1.2. Echantillon représentatif de la population, on pourra réaliser les enquêtes sur un échantillon de 10% ou 20% de la population recensée. L'échantillon est obtenu par tirage au sort à l'aide d'une table de nombres au hasard (tableau I).

Par exemple dans un village de 1000 habitants auxquels on attribuera des numéros de 000 à 999, on examinera les 100 ou 200 sujets dont le numéro aura été lu dans la table de nombres au hasard.

TABLEAU II : Youri (République du Mali)

Population recensée : 2500 h. Répartition des sujets examinés, porteurs de vers et étude de la prévalence.

Tranches d'âge		0-4	5-9	10-14	15-29	30-49	50 & +	TOTAL	Prévalence ajustée
Examinés	H	24	42	77	36	23	22	224	
	F	27	28	37	60	42	20	214	
	T	51	70	114	96	65	42	438	
porteurs de vers (nombre et Prévalence)	H	1 (4,2%)	17 (40,5%)	40 (51,9%)	27 (75%)	16 (69,6%)	7 (31,8%)	108 (48,2%)	48,2% (50,9%)
	F	4 (14,8%)	14 (50%)	26 (70,3%)	38 (63,3%)	25 (59,5%)	3 (15%)	110 (51,4%)	51,4% (49,5%)
	T	5 (9,8%)	31 (44,3%)	66 (57,9%)	65 (67,7%)	41 (63,1%)	10 (23,8%)	218 (49,8%)	49,8% (50,5%)

TABLEAU III : Echelle de standardisation.

AJUSTEMENT POUR L'AGE DANS CHAQUE SEXE		TRANCHE D'AGE	AJUSTEMENT POUT L'AGE ET LE SEXE	
H	F		H	F
0,127	0,123	0 - 4	0,064	0,061
0,161	0,136	5 - 9	0,080	0,068
0,158	0,133	10 -14	0,079	0,067
0,227	0,241	15 -29	0,113	0,121
0,117	0,255	30 -49	0,108	0,128
0,110	0,112	50 et+	0,055	0,056
1,00	1,00		0,499	0,501

A partir du premier groupe de 3 chiffres (dont le premier est déterminé, les yeux fermés, à la pointe d'un crayon) on obtient de proche en proche, (horizontalement ou verticalement), des groupes de 3 chiffres correspondant aux numéros à retenir.

Lorsqu'un numéro sort une 2ème fois il n'est pas retenu. Si un numéro tiré correspond à un absent, il faut tirer un numéro supplémentaire pour compléter l'échantillon à la valeur choisie.

2.1.3. <u>Villages approvisionnés par un seul point d'eau.</u>

Dans la dracunculose on doit considérer comme unité épidémiologique le point d'eau et la population qui s'y ravitaille. Dans le cas d'un seul point d'eau on pratique le tirage au sort sur l'ensemble de la population (absents compris).

2.1.4. <u>Villages approvisionnés par plusieurs points d'eau, dont certains sont sains et d'autres contaminés.</u>

On tentera de scinder le village ou l'agglomération en autant d'unités que de point d'eau différemment contaminés. Par exemple :

- pas de copépodes : puits 1, 3, 6
- quelques copépodes infectés : puits 2,3,4 ;
- nombreux copépodes infectés : mare 7.

Les habitants de chaque unité sont numérotés en série continue, et le tirage au sort sera pratiqué au prorata de chaque groupe.

2.2. <u>Pour les subdivisions ou circonscriptions</u> les mêmes règles peuvent être utilisées, à condition d'avoir une petite unité géographique.

Les villages seront considérés comme unités épidémiologiques et le tirage au sort peut toucher 10% (par exemple) de la population recensée de chaque village.

2.3. <u>Au niveau d'une région</u>, ou d'une circonscription très peuplée il sera nécessaire de prévoir un plan d'enquête plus complexe :

- stratification en fonction de la taille des agglomérations,
- tirage au sort des villages à enquêter...

Ce plan devra être étudié par une équipe spécialisée.

.../...

3. Examen de la population.

3.1. Examen clinique

- mise en évidence du ver au point d'émergence ;
- cordon vermineux sous cutané palpable ou visible à l'oeil nu ;
- cicatrices des orifices de perforations antérieures ;
- localisation et numération des orifices de sortie actuels et antérieurs.

3.2. Interrogatoire.

- Déterminer la période d'émergence d'une contamination antérieure.
- Noter éventuellement l'historique de la Dracunculose dans le village ; apparition, disparition en fonction :
  - des années (pluviométrie, mouvement de population)
  - des variations de l'approvisionnement en eau(aménagement des puits...)
  - des saisons (déterminer la période d'émergence maximale, liée à la contamination de l'année précédente).

4. Examen des points d'eau.

4.1. Inventaire des points d'approvisionnement en eau :

Cet inventaire doit être le plus exhaustif possible, à réaliser avec la participation de la population.

4.2. Examen d'un point d'eau.

En fonction du volume du point d'eau on prélèvera un ou plusieurs échantillons de 10 litres à l'aide d'un seau.

Cette eau sera filtrée dans un deuxième récipient à travers une toile de percale ou un pagne en double épaisseur. Il est recommandé de ne pas verser l'eau trop rapidement pour éviter l'élargissement des mailles. Il est nécessaire de rincer souvent le filtre. L'eau de filtration ne sera pas utilisée. Le produit de filtration, contenant éventuellement les copépodes, sera versé dans un flacon numéroté contenant le liquide fixateur et examiné ultérieurement.

Afin de récupérer plus facilement ce produit de filtration il est préférable d'utiliser un filtre en forme d'entonnoir

.../...

et de taille moyenne.

4.3. Examen des produits de filtration

Le dénombrement des copépodes est facile à la loupe binoculaire et un microscopiste entraîné peut éventuellement constater par transparence la présence de larves infectantes dans les copépodes

4.4. Liste du matériel nécessaire à la prospection des points d'eau.

- 1 seau ou récipient gradué de 10 litres ;
- 1 récipient de 10 à 15 litres, pouvant être emprunté sur place ;
- 1 morceau de percale monté en entonnoir de taille moyenne pour la commodité de la récupération du produit de filtration ;
- 1 flacon numéroté par point de prélèvement (pilulier de 50 cm3 environ)
- liquide de fixation (alcool à 70° ou mieux formol 5% neutralisé du commerce glycériné à 4 ou 5%

- 1 loupe binoculaire pour dénombrement des copépodes sur place, le cas échéant, peut être utilisée comme moyen d'éducation sanitaire en montrant les copépodes à la population.

5. Expression des résultats (RAFFIER, 1971 et SCHWARTZ, 1974).

5.1. Etude de la prévalence de la maladie.

La première estimation de la prévalence est donnée par le rapport du nombre de sujets malades sur le nombre de sujets examinés (P1). On peut considérer la population globale comme un ensemble dans lequel se distinguent deux sous-ensembles :

- le sous-ensemble des présents, répertoriés et étudiés,
- le sous-ensemble des absents, seulement répertoriés.

Les absents n'interviennent pas, soit qu'ils doivent être considérés comme infectés de la même façon que les présents dans le cas d'une enquête exhaustive, soit que l'enquête est effectuée sur un échantillonnage (tous présents) représentatif.

La prévalence est P1 $\left(P1 = \dfrac{\text{Malades}}{\text{examinés}}\right)$

.../...

Nombres de vers	Hommes	Femmes	TOTAL	Population totale		Personnes atteintes		Fréquence cumulée des vers		
				Nombres cumulés	% cumulés	Nombres cumulés	% cumulés	ni xi	* Sommes cumulées des ni xi	% cumulée
0	116	104	220	220	50,2 %	-	-	-	-	-
1	16	13	29	249	56,8 %	29	13,3 %	29	29	2,2 %
2	21	11	32	281	64,2 %	61	27,0 %	64	93	7,1 %
3	19	10	29	310	70,8 %	90	41,3 %	87	180	13,7 %
4	12	12	24	334	76,5 %	114	52,3 %	96	276	21,04 %
5	11	8	19	353	80,6 %	133	61,0 %	95	371	28,3 %
6	11	11	22	375	85,6 %	155	71,1 %	132	503	38,3 %
7	6	7	13	388	88,6 %	168	77,1 %	91	594	45,3 %
8	2	3	5	393	89,7 %	173	79,4 %	40	634	48,3 %
9	3	5	8	401	91,6 %	181	83,0 %	72	706	53,8 %
10	1	6	7	408	93,2 %	188	86,2 %	70	776	59,1 %
11	-	3	3	411	93,8 %	191	87,6 %	33	809	61,7 %
12	-	2	2	413	94,3 %	193	88,5 %	24	833	63,5 %
13	1	1	2	415	94,7 %	195	89,4 %	26	859	65,5 %
14	-	4	4	419	95,7 %	199	91,3 %	56	915	69,7 %
15	2	-	2	421	96,1 %	201	92,2 %	30	945	72,03 %
16	-	-	-	421	96,1 %	201	92,2 %	0	945	72,03 %
17	1	2	3	424	96,8 %	204	93,6 %	51	996	75,9 %
18	-	2	2	426	97,3 %	206	94,5 %	36	1032	78,7 %
19	1	3	4	430	98,2 %	210	96,3 %	76	1108	84,5 %
20	-	1	1	431	98,4 %	211	96,8 %	20	1128	86,0 %
21	-	2	2	433	98,9 %	213	97,7 %	42	1170	89,2 %
22	-	1	1	434	99,1 %	214	98,2 %	22	1192	90,9 %
23	-	-	-	434	99,1 %	214	98,2 %	0	1192	90,9 %
24 à 31	1	-	1	435	99,3 %	215	98,6 %	24	1216	92,7 %
32	-	3	3	436	100 %	218	100 %	96	1312	100 %

TABLEAU IV : **YOURI** Région de NIORO du SAHEL (Mali

Etude de la concentration des vers

* ni est le nombre de personnes atteintes dans la série
et xi le numéro de la série.

Dans une enquête exhaustive cette prévalence P1 sera exprimée telle quelle; tout au plus sera-t-elle modulée en tenant compte des absents. La prévalence sera étudiée par classes d'âge pour mettre en évidence d'éventuelles différences d'infection en fonction de l'âge. La prévalence totale devra être ajustée en fonction du poids de chaque tranche d'âge :

- au niveau de la population globale en cas de recensement détaillé ;
- au niveau de l'échantillonnage ;
- par la méthode de standardisation directe à l'aide d'une population standard · nous donnons à titre d'exemple l'échelle de standardisation (tableau III) utilisée par le Programme de lutte contre l'Onchocercose dans la Région du Bassin de la Volta et l'Organisation de Coordination et Coopération pour la lutte contre les Grandes Endémies dans l'ajustement de l'indice microfilarien au cours des enquêtes sur l'endémie onchocerquienne. Cette méthode peut-être utilisée en cas d'impossibilité soit d'enquête exhaustive soit de constitution d'un échantillonnage représentatif parfois mal accepté par les populations.

Cette prévalence ajustée est calculée en multipliant la prévalence de chaque classe par le pourcentage qu'elle représente au niveau de la population de l'échantillon représentatif ou de l'échelle de standardisation et en faisant la somme de ces différentes prévalences pondérées par classe d'âge. La pondération des résultats permet leur comparaison dans l'espace ou dans le temps.

La précision de la prévalence pourra être déterminée dans chaque classe d'âge par le calcul de l'intervalle de confiance(au risque 5% habituellement, soit qu'il y aura seulement 5 chances sur 100 pour le pourcentage observé s'écarte du pourcentage réel de plus de deux écarts-type).

La mise en évidence de différences d'infection en fonction de l'âge pourra être utilisée ultérieurement en augmentant le nombre d'examinés dans les tranches d'âge les moins touchées car c'est à ce niveau que l'on observera la plus mauvaise précision.

5.2. Etude de la localisation et de la concentration des vers.

Nous avons décompté le nombre de vers par individu et étudié leur répartition en fonction de la localisation.

La fréquence élevée du polyparasitisme qui entretient

.../...

d'autant plus l'endémie, nous amène à l'étude de la concentration des vers chez les malades et dans la population totale, la fréquence cumulée des vers étant en liaison directe avec la fréquence cumulée des individus.

Pour chaque village nous noterons le niveau 50% de concentration des parasites (fréquence cumulée des vers) chez les malades et dans la population totale.

5.3. Exemple de résultats obtenus au cours d'une enquête.

Les deux tableaux (II et IV) donnés en exemple ont été tirés du rapport de PROD'HON et coll. 1978 (1).

5.4. Etude de vecteur.

Pour chaque point de prélèvement on exprimera le résultat en :

- nombre de copépodes observés pour 10 litres d'eau.
- nombre de copépodes infestés pour 10 litres d'eau.
- proportion des copépodes infestés par rapport aux copépodes récoltés.

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Tableau I - *Nombres au hasard*

03 47 43 73 86	36 96 47 36 61	46 98 63 71 62	33 26 16 80 45	60 11 14 10 95
97 74 24 67 62	42 81 14 57 20	42 53 32 37 32	27 07 36 07 51	24 51 79 89 73
16 76 62 27 66	56 50 26 71 07	32 90 79 78 53	13 55 38 58 59	88 97 54 14 10
12 56 85 99 26	96 96 68 27 31	05 03 72 93 15	57 12 10 14 21	88 26 49 81 76
55 59 56 35 64	38 54 82 46 22	31 62 43 09 90	06 18 44 32 53	23 83 01 30 30
16 22 77 94 39	49 54 43 54 82	17 37 93 23 78	87 35 20 96 43	84 26 34 91 64
84 42 17 53 31	57 24 55 06 88	77 04 74 47 67	21 76 33 50 25	83 92 12 06 76
63 01 63 78 59	16 95 55 67 19	98 10 50 71 75	12 86 73 58 07	44 39 52 38 79
33 21 12 34 29	78 64 56 07 82	52 42 07 44 38	15 51 00 13 42	99 66 02 79 54
57 60 86 32 44	09 47 27 96 54	49 17 46 09 62	90 52 84 77 27	08 02 73 43 28
18 18 07 92 46	44 17 16 58 09	79 83 86 19 62	06 76 50 03 10	55 23 64 05 05
26 62 38 97 75	84 16 07 44 99	83 11 46 32 24	20 14 85 88 45	10 93 72 88 71
23 42 40 64 74	82 97 77 77 81	07 45 32 14 08	32 98 94 07 72	93 85 79 10 75
52 36 28 19 95	50 92 26 11 97	00 56 76 31 38	80 22 02 53 53	86 60 42 04 53
37 85 94 35 12	83 39 50 08 30	42 34 07 96 88	54 42 06 87 98	35 85 29 48 39
70 29 17 12 13	40 33 20 38 26	13 89 51 03 74	17 76 37 13 04	07 74 21 19 30
56 62 18 37 35	96 83 50 87 75	97 12 25 93 47	70 33 24 03 54	97 77 46 44 80
99 49 57 22 77	88 42 95 45 72	16 64 36 16 00	04 43 18 66 79	94 77 24 21 90
16 08 15 04 72	33 27 14 34 09	45 59 34 68 49	12 72 07 34 45	99 27 72 95 14
31 16 93 32 43	50 27 89 87 19	20 15 37 00 49	52 85 66 60 44	38 68 88 11 80
68 34 30 13 70	55 74 30 77 40	44 22 78 84 26	04 33 46 09 52	68 07 97 06 57
74 57 25 65 76	59 29 97 68 60	71 91 38 67 54	13 58 18 24 76	15 54 55 95 52
27 42 37 86 53	48 55 90 65 72	96 57 69 36 10	96 46 92 42 45	97 60 49 04 91
00 39 68 29 61	66 37 32 20 30	77 84 57 03 29	10 45 65 04 26	11 04 96 67 24
29 94 98 94 24	68 49 69 10 82	53 75 91 93 30	34 25 20 57 27	40 48 73 51 92
16 90 82 66 59	83 62 64 11 2	67 19 00 71 74	60 47 21 29 68	02 02 37 03 31
11 27 94 75 06	06 09 19 74 66	02 94 37 34 02	76 70 90 30 86	38 45 94 30 38
35 24 10 16 20	33 32 51 26 38	79 78 45 04 91	16 92 53 56 16	02 75 50 95 98
38 23 16 86 38	42 38 97 01 50	87 75 66 81 41	40 01 74 91 62	48 51 84 08 32
31 96 25 91 47	96 44 33 49 13	34 86 82 53 91	00 52 43 48 85	27 55 26 89 62
56 67 40 67 14	64 05 71 95 86	11 05 65 09 68	76 83 20 37 90	57 16 00 11 66
14 90 84 45 11	75 73 88 05 90	52 27 41 14 86	22 98 12 22 08	07 52 74 95 80
68 05 51 18 00	33 96 02 75 19	07 60 62 93 55	59 33 82 43 90	49 37 38 44 59
20 46 78 73 90	97 51 40 14 02	04 02 33 31 08	39 54 16 49 36	47 95 93 13 30
64 19 58 97 79	15 06 15 93 20	01 90 10 75 06	40 78 78 89 62	02 67 74 17 33
05 26 93 70 60	22 35 85 15 13	92 03 51 59 77	59 56 78 06 83	52 91 05 70 74
07 97 10 88 23	09 98 42 99 64	61 71 62 99 15	06 51 29 16 93	58 05 77 09 51
68 71 86 85 85	54 87 66 47 54	73 32 08 11 12	44 95 92 63 16	29 56 24 29 48
26 99 61 65 53	58 37 78 80 70	42 10 50 67 42	32 17 55 85 74	94 44 67 16 94
14 65 52 68 75	87 59 36 22 41	26 78 63 06 55	13 08 27 01 50	15 29 39 39 43
17 53 77 58 71	71 41 61 50 72	12 41 94 96 26	44 95 27 36 99	02 96 74 30 83
90 26 59 21 19	23 52 23 33 12	96 93 02 18 39	07 02 18 36 07	25 99 32 70 23
41 23 52 55 99	31 04 49 69 96	10 47 48 45 88	13 41 43 89 20	97 17 14 49 17
60 20 50 81 69	31 99 73 68 68	35 81 33 03 76	24 30 12 48 60	18 99 10 72 34
91 25 38 05 90	94 58 28 41 36	45 37 59 03 09	90 35 57 29 12	82 62 54 65 60
34 50 57 74 37	98 80 33 00 91	09 77 93 19 82	74 94 80 04 04	45 07 31 66 49
85 22 04 39 43	73 81 53 94 79	33 62 46 86 28	08 31 54 46 31	53 94 13 38 47
09 79 13 77 48	73 82 97 22 21	05 03 27 24 83	72 89 44 05 60	35 80 39 94 88
88 75 80 18 14	22 95 75 42 49	39 32 82 22 49	02 48 07 70 37	16 04 61 67 87
90 96 23 70 00	39 00 03 06 90	55 85 78 38 36	94 37 30 69 32	90 89 00 76 33

ANNEXE 2

DRACUNCULOSE EN COTE D'IVOIRE

Nombre moyen de cas par an et par secteur pour la période 1975-1979

Secteur de Santé rural	Nombre moyen de cas/an	Population x 100 000 h	Incidence annuelle pour 100 000 hbts
Abengourou	73	1.8	40.6
Abidjan	264.9	11.3	23.4
Adzopé	112	3	37.3
Bondougou	530.2	4	155.6
Bouaké	898	6	149.7
Bouaflé	682.3	4.3	158.7
Bouna	---	---	---
Boundiali	32	1.3	24.6
Daloa	76	3.7	20.5
Danané	---	---	---
Dimbokro	926.3	4.7	205.4
Gagnoa	---	---	---
Korhogo	329.7	3	109.9
Man	41.6	3.6	11.6
Odienne	60.8	1.2	50.7
Séguéla	232.3	1.5	156.8
Sassandra	-	---	---
San Pedro	112.8	1.9	59.4
Tiassalé	665.8	2.4	277.4
Touba	102	0.8	127.5
Yamoussokro	265	3.5	75.7

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ANNEXE.3

DRACUNCULOSE EN HAUTE VOLTA

Nombre moyen de cas par an et par secteur pour les années 1975 1977 1978 et 1979.

Secteurs et sous secteurs	Nombre moyen cas/an	Population* x 100 000 hbts	Incidence annuelle par 100 000 hbts
1 OUAGADOUGOU	481,8	8,2	58,3
3/1 MANGA	46	2,9	15,6
2 FADA N'GOURMA	154,3	4,2	36,7
3 GAOUA	84,0	3,7	22,6
4 OUAHIGOUYA	431,8	5,3	80,6
5 KOUDOUGOU	381,0	7,2	52,5
[illegible]/5 YAKO	112,8	2,2	51,3
[illegible] DEDOUGOU	21,3	6,6	3,3
7 BOBO-DIOULASSO	21	4,1	5,1
[illegible]/7 BANFORA	94	2,0	47,0
[illegible] KAYA	288,7	6,5	44,3
[illegible] DORI	272,3	3,7	73,4
10 TENKODOGO	147,3	4,1	35,4

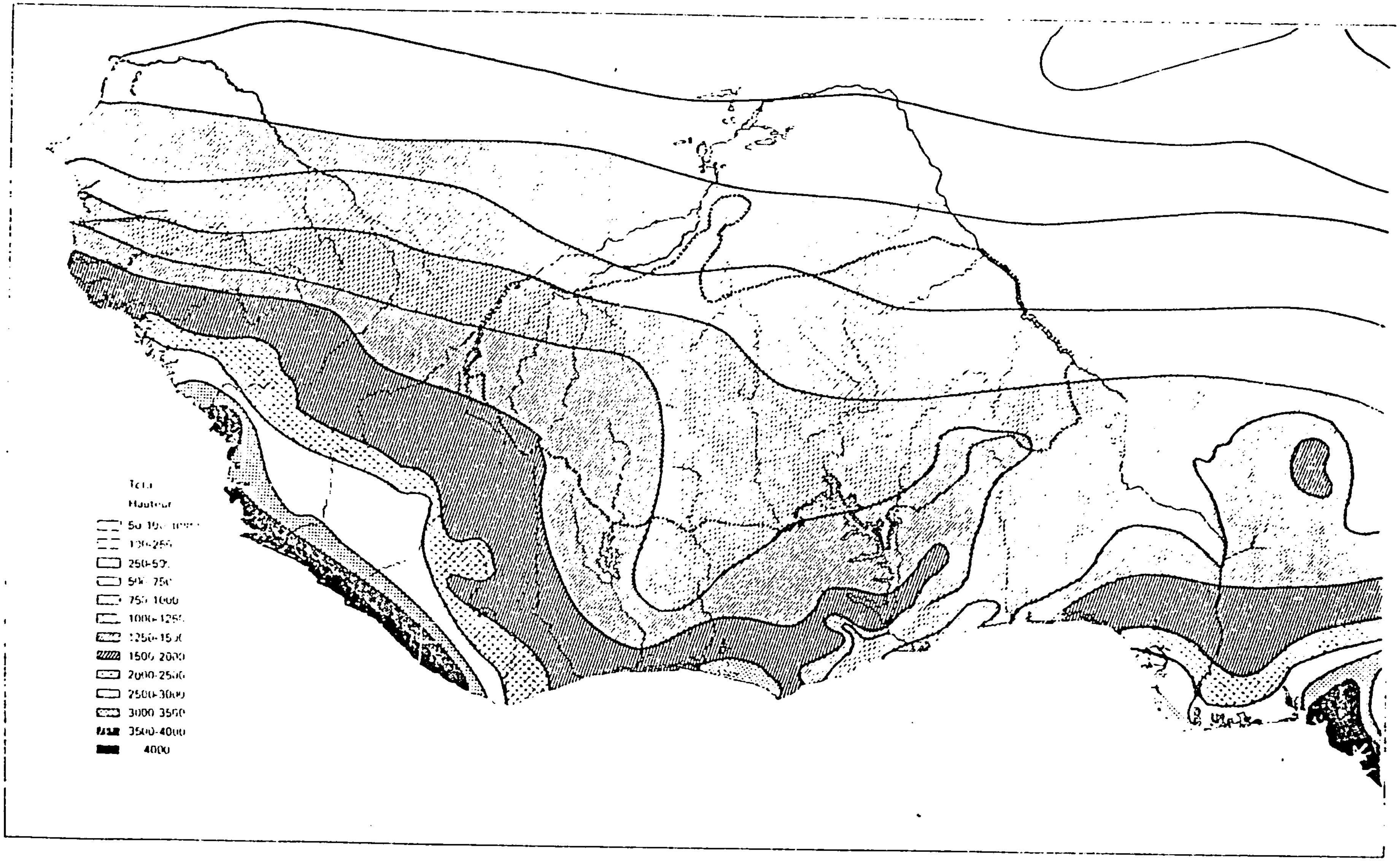
* Estimation de la population en 1977

ANNEXE 4 - DRACUNCULOSE AU MALI

Nombre moyen de cas par an et par région de 1972 à 1978

Région	Nombre moyen cas/an	Population x 100 000 hbts	Incidence annuelle par 100 000 hbts
KAYES	148,7	8,5	17,5
BAMAKO	76,1	12,9	5,9
SIKASSO	6,5	11,0	0,6
SEGOU	27,4	9,6	2,8
MOPTI	424,6	12,2	34,8
GAO	47,9	7,0	6,8

ANNEXE V - PLUVIOMETRIE : CARTE DES ISOHYETES ANNUELLES MOYENNES EN AFRIQUE OCCIDENTALE (emprunté au rapport OCP/73-1 "Programme de Lutte contre l'Onchocercose dans la Région du Bassin de la Volta).



EPIDEMIOLOGY OF DRACUNCULIASIS IN NIGERIA

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EPIDEMIOLOGY OF DRACUNCULIASIS IN NIGERIA

INTRODUCTION

The data on which this paper is based are derived from two main sources: (1) articles that have been published in learned scientific journals and (2) information extracted from a brief postal questionnaire conducted earlier this year throughout the 19 states of the Nigerian federation.

Apart ffom an isolated report by Ramsay[1] in 1935 in which he conducted field trials of an intradermal test for the diagnosis of dracunculiasis in northern Nigeria all other epidemiological surveys reported in medical literature have been conducted in the south western part of the country. This can be attributed to two factors. Firstly the disease appears to be more prevalent in south western Nigeria which is mainly in the rain forest belt, than in any other part of the country, apart from a 'hyperendemic' zone in the Abakaliki district of Anambra State in eastern Nigeria. Secondly methodical and systematic disease surveillance are more likely to originate from centres of higher learning staffed with scientists who have the expertise and possess the motivation that would impel them to publish their findings in scientific journals. A sine qua non for their academic and professional advancement.

Such higher educational institutions are concentrated in southern Nigeria with Ibadan University, from which over 90% of all published works have emanated, not only being the premier university but also being sited in the middle of a guinea worm endemic area.

The postal questionnaire which was distributed in March 1982 was designed primarily to determine the extent of the disease and its seasonality throughout the country rather than its intensity. The questionnaire was sent to all the Chief Health Officers and the heads of the epidemiological units in all the Ministries of Health of 19 states of the federation; all doctors (post-internship) undergoing the compulsory one year national youth service (NYSC) and deployed to all the 19 states of the federation; all the residency (post-NYSC) doctors undergoing specialist training at the University College Hospital Ibadan (UCH) and all the graduates and diplomates of the African Regional Health Education Centre of the department of Preventive and Social Medicine, UCH who have returned to their home states.

The response to the question has been very high and encouraging and much useful data on the geographical distribution of the disease have been obtained. At the time of writing this paper there have been returns from all the 19 states and completed questionnaires (a total of 538 were distributed) are still arriving, daily, by post.

EPIDEMIOLOGY

(a) Geographical distribution

Dracunculiasis has been reported from 16 of the 19 states of Nigeria. These are, in alphabetic order: Anambra, Bauchi, Bendel, Benue, Borno, Gongola, Imo, Kaduna, Kano, Kwara, Niger, Ogun, Ondo, Oyo, Plateau and Sokoto. The three states which are apparently free from the disease are Cross-River and Rivers in the south-eastern corner of the country and Lagos State, in which is the capital city of the country, tucked into the extreme south-western corner of Nigeria.

A more detailed breakdown of the distribution of the disease by local government areas is not possible at present, although it can be affirmed that the disease is endemic in all the 24 local government areas of Oyo State which has been extensively surveyed over the years.

(b) Effect of climate and water sources on incidence of the disease

i. Climatic factors: In considering the effect of climate on the incidence three fairly district but overlaping climatic belts can be recognised.

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1. The <u>rain forest belt</u> extending from the Atlantic coast to a point approximately 8°N in the west and 7°N in the east, and embracing most or all of Anambra, Bendel, Cross-River, Imo, Lagos, Ogun, Ondo, Oyo and Rivers States.

2. The <u>guinea-savanna (middle) belt</u> extending from the northern edge of the rain forest belt to a point roughly corresponding to latitude 10°N and embracing most or all of Benue, Gongola, Kwara, Niger and Plateau States and the southern half of Kaduna state.

3. The <u>sudan-savanna (subsahelian) belt</u> extending from the northern edge of the guinea-savanna region to the northern border of Nigeria roughly on latitude 13.5°N, and embracing most or all of Bauchi, Borno, northern Kaduna, Kano and Sokoto States.

Reliable epidemiological data on the seasonal incidence of the disease is available only in respect of the rain forest zone particularly from Oyo State, where the peak incidence is between October and March.[2,3] This period coincides with the period of lowest rainfall - i.e. the dry season when the level of water in ponds, which are mostly perennial, is at its lowest. (Fig.2.) Data obtained from the questionnaire survey, so far, in respect of the guinea-savanna regions indicate that most cases of the disease are seen between the months of November and July and between May and October respectively. These periods coincide, in the two climatic zones, with the period of the year (the rainy season) when water is available in seasonal ponds. The almost all year round occurrence of infection in the middle belt zone is in keeping with the mixed or transitional nature of the climatic conditions which is intermediate between the two extremes of tropical rain forest and subsahelian.

The pattern of rainfall and the seasonality of available water sources are thus clearly important determinants of the seasonal fluctuations in the level of the disease.

ii. Water source: Transmission of infection is almost exclusively confined to rural populations which depend on surface water as their main, and often, only source of domestic water supply. These consists of hand dug water holes, ponds, sluggish brooks and streams which flow seasonally and in a few cases shallow wells.[2] All these water sources have one thing in common, that to obtain water the people in the areas where guinea worm is endemic have to wade into the water, or, in the case of shallow wells, are able easily to contaminate the water source.

Since the *Cyclops* is an obligatory intermediate host in the life cycle of *Dracunculus medinensis*, it must be assumed that all bodies of water from which infection is acquired by man contain these crustaceans, although the available records show that they have only been looked for and examined for infectivity in water from the south western parts of the country.[3-7]

Communities which have access to regular treated municipal water supply such as most urban centres, or sanitary wells and bore holes, or live close by a large river which flows all year round are free of infection. The provision of piped water and sanitary wells to communities where the disease has been hitherto highly endemic has resulted in total interruption of transmission and eradication of the disease.

It must be emphasised however that unless the supply of water is regular a resurgence of infection may occur. An illustrative case would serve to underscore this point.

In 1965, piped water was introduced into the Ibarapa district, including the most populous town in the district, Igboora (population about 25,000), as well as the neighbouring town of Idere (population about 7,000) some 12 km east of Igboora. Within two years the incidence of guinea worm in Igbbora which had varied around a yearly average of 13%

had diminished to virtually zero. The few cases that occurred after 1967 occurred among farmers who resorted to drinking water from ponds, located on their farms, while at work.

In Idere the picture was quite different. Although communal stand taps were located throughout the town, water seldom flowed at any time of the year from those taps that were in the northern half of the town which was on a higher geographical plane. Since 1968 there has been a sharp geographical delineation in the distribution of cases in the town. The incidence in the southern half of the town being virtually nil, while a high incidence (>34% in 1975) continued to be recorded every year in the northern half where people continued to depend on traditional sources of water - the ponds and water holes for drinking water.[8]

This pattern was maintained till 1979 when as a result of a virtual cessation in the pumping of piped water to the entire town in the preceeding year there was a sharp increase in the overall incidence throughout the town, reaching epidemic proportions in 1980 and 1981 with as many as 42% of the population being afflicted in the latter year (Ilegbodu, personal communication).

The increased demand for water in Igboora, which received electricity in 1973, coupled with grossly irregular, sporadic and less efficient pumping of water from the waterworks at

Eruwa, located about 20 km south of Igboora, effectively deprived the town of Idere which is further down the distribution line of the little piped water it had been receiving.

Thus it is obvious that the mere provision of municipal stand pipes without adequate supply of water is no guarantee against infection. Similarly unless the populace, particularly the farmers, can be persuaded to carry potable water obtained from the city with them to their farms, cases of dracunculiasis will persist in the community.

In all other towns and villages in Ibarapa district like Igangan, Tapa and Aiyete, to which piped water was not extended, the annual incidence of disease has remained at the pre- 1965 level.

A dramatic reduction in the incidence of infection in 16 out of 17 villages in the Ibadan district of Oyo State has also been reported following periodic yearly treatment of infected cases.[7] The apparent control of infection in these villages has been attributed to the reduction in the duration of infection and the intensity of contamination of water sources by infected persons consequent to treatment. However the persistence of the intermediate host, the Cyclops, in the water which villages draw for drinking purposes means that a resurgence of transmission could occur if 'imported' cases with active lesions gain direct bodily access to the pools of water. In other words, these villages can be considered as 'guineaworm receptive areas' since the conditions for resumed transmission persists.

(c) Transmission of Infection

The most extensive and detailed studies on the transmission of dracunculiasis in Nigeria have been those conducted in the late forties and early fifties by Onabamiro,[3,4] who identified the various species of cyclops that acted as natural intermediate hosts of D. medinensis. Onabamiro's studies showed that, in the town of Iwoye, in what is now Ogun State in the rain forest belt of Nigeria: (1) transmission of infection occurred only in the dry season; (2) of the eight species of cyclops found to be naturally infected with D. medinensis only the female Thermocyclops nigerianus Keifer, the density of which was highest in the dry season, was responsible for transmission of infection to the populace; (3) no Th. nigerianus were found in pools containing water-lilies and much green algae; (4) the infection rate of Th. nigerianus at the height of the dry season was 5.1%; (5) the greatest density of infected cyclops was found in the shallow end of the pond where villagers waded in to draw water; (6) there was an average of 152 cyclops in every 5 litres of water at the water-drawing spot with an average of 9.5 D. medinensis larvae in every 5 litres of water and (7) in typical guinea worm zone in south western

Nigeria, the average man, swallows, in one year, between 72-200 infected cyclops with the pond water he drinks.

(d) Reservoir of infection

Man is the only known natural reservoir of D. medinensis infection in Nigeria. The role if any of animals in the maintenance of transmission of infection has not been studied in Nigeria, and is not known.

(e) Frequency of infection in human host

i. Age and Sex distribution of cases

The age and sex distribution of persons infected with guineaworm among a study population of 4,102 in 17 villages north of Ibadan between 1971 and 1975[2] is shown in table 1 and the age/sex specific attack rates is illustrated in figure 1. The overall prevalence was 13.5% with a range of 2.2% to 58.5%. The highest incidence in both sexes occurred in the age group 40 to 49 years (32.8% for males and 27.2% for females). There are two peaks at 10-19 years and 40 to 49 years. In another study[9] the same two age specific peaks of infection were recorded except that the 10-19 year peak was much higher than the 40-49 year age group peak.

Generally however the two sexes are about equally infected. A finding which coincides with those from other parts of the world notably from India. The Ibadan survey[2] showed that significantly more boys than girls were affected, but there was no difference in occurrence of the disease between children ($<$ 15 years) and adults.

There is no evidence that protective immunity is acquired after infection and repeated infections occur often among those exposed to continuous transmission. The suggestion that gastric acidity plays a role in susceptibility to infection[10] has not been confirmed.[11] Epidemiological data from Ibadan strongly indicate that exposure, through the ingestion of infected water, is the major determinant of infection.[2]

ii. <u>Occupation</u>

The overwhelming majority of the adult males in guineaworm endemic parts of Nigeria are hoe and cutlass farmers. The womenfolk carry out such varied occupations like farming, petty trading and processing farm products into marketable forms.[2]

(a) Site of emergence of worms.

As in all surveys in other parts of the world where dracunculiasis is endemic it has been shown that in south western Nigeria majority of the adult female guinea worms emerge from the lower limbs; 89.6% by Onabamiro;[4] 93.4% by Muller[12] and 93.6% by Kale.[2]

(b) Worm burden

The average number of worms per affected person (the worm burden), is a measure of the intensity of infection. Studies in south west Nigeria have shown that the average worm burden varies from 1.2 to 2.5.[2,4,12,13] This parameter is an important one for determining the level of endemicity of infection, a subject that is discussed later in this paper.

(c) Complications of infections

A variety of complications of guinea worm infection have been reported from Nigeria.[2,11,12,15-18] These include secondary bacterial infection leading to cellutitis, pyomyositis and tetanus, arthritis (both septic and aseptic), tendon contractures, epidydimoorchitis and inguinal adenopathy. Most of the arthropathic complications occur in relation to the feet and ankle joints.[2]

(d) Duration of infection and degree of disablement

The average duration of infection (from eruption of the blister to emergence of the worm) is 5-8 weeks.[2] The period of incapacitation from work ranges from 3 weeks to 9 months with a mean of about 3 months at a time which often coincides with the farmers' planting season.

Three grades of disability have been suggested.[19] on the basis of this, Kale's study[2] in Ibadan district between 1971 and 1975 showed that out of 1,106 cases 57% had mild disability, 31% moderate disability and 12% severe disability. The duration of infection can be shortened, and the degree of disability reduced significantly by chemotherapy.[20-22]

DEGREE OF ENDEMICITY OF DRACUNCULIASIS

The interaction of the parasite with man can be expressed in terms of prevalence, incidence and intensity. These depend on a number of ecological and biological factors most of which have been referred to earlier.

In the concluding paragraphs I propose to highlight one of the most important aspects of the epidemiology of dracunculiasis, which is of considerable and vital relevance to the achievement of the objectives of this workshop, but has hitherto received little or no attention.

It is one of the fundamental principles of comparative epidemiology that there should be a set of valid parameters for assessing the impact of a health problem, in this instance a disease process, on the community under study. This would make it not only possible to make direct comparisons between different population groups but also enable secular trends to be more accurately monitored, irrespective of whether the trends evolve spontaeously or result from specific intervention as envisaged by the organisers of this workshop.

To the best of my knowledge no attempt has yet been made to describe different and specific levels of endemicity of dracunculiasis although a number of published articles have used expressions such "hyperendemic" or "low" or "high endemicity" in respect of dracunculiasis without a quantitative definition of what these expressions represent in terms of the epidemiological profile of the disease.

A review and analysis of data that have accumulated in Ibadan from epidemiological surveys conducted in Oyo State over the past 12 years is currently being undertaken.[23] Preliminary inspection of the data suggests that there are three valid parameters by which the degree of endemicity of the disease in a given community can be defined. The parameters are: the incidence rate, the worm burden and the risk of infection. These three indices reflect such diverse but interrelated and relevant aspects of the epidemiology of the disease like the spread of infection in the population, i.e. the size of the human reservoir; the intensity of infection among those affected and the probability of becoming infected.

For a disease like dracunculiasis with such marked seasonal variation in incidence, and hardly any carry over of infection from one season to the other, the incidence rate is more sensitive than the prevalence rate for measuring the impact of the disease. Indeed it has been suggested[24] that the incidence rate is a more fundamental measure for assessing the impact of a disease on a given population and comparing this impact among two or more subpopulations with different distributions of certain characteristics of exposure.

The intensity of infection with dracunculiasis is reflected in the worm burden. The lower the worm burden (i.e. the average number of worms haboured by the infected persons) in a community the less the intensity, and vice versa.

The risk i.e. the probability of infection which is a more complex index to estimate is a function of the incidence rate during the follow up period and the length of that period.[25]

The third of these parameters, risk, is subject to such variables as the frequency of human water contact that enables D. medinensis larvae to be discharged into cyclops containing water; the population density of cyclops that are suitable for and capable of transmitting infection; the proportion of water sources, to which the population at risk has access, that contains infected cyclops; the rainfall pattern; the volume and pattern of consumption of water by individuals in the community etc.

The parameter we believe is most appropriate for measuring risk in dracunculiasis is the mean age at which 50% of the study population was first infected. The mean age of first infection can be shown to be lower in guinea worm endemic areas where the infection has been present for many years, i.e. established, than in those parts where it had only recebtly been introduced.[10,26-28]

We have considered but rejected the alternative of using the proportion of infected children below a given age (e.g. 10 years) in the population. This is less sensitive and reliable than the former.

The three selected parameters which I have just described are closely related one with another and embrace all the important variables that affect the epidemiology of the disease in a given population.

When the Ibadan data is subjected to analysis using these three parameters three distinct though overlapping levels of guinea worm endemicity can be defined: (1) A level of hyperendemicity, where the annual incidence rate is consistently above 20%, the average worm burden is over 1.9 per affected person and the mean age of first infection is below 10 years. (2) A level of hypoendemicity, where the annual incidence is consistently below 5%, the average worm burden is below 1.5% and the mean age of first infection is above 15 years. (3) An intermediate level of mesoendemicity, where the annual incidence is between 5 and 20%, the average worm burden is between 1.5 and 1.9 and the average age of first infection is between 10 and 15 years.

These figures, it must be emphasised, are very tentative and subject to revision when all our data have been fully analysed. It would be worthwhile undertaking similar analysis of data from other countries to see whether the principles underlying this exercise are universally applicable and to what degree and in respect of which parameters are there significant deviations from those I have proposed.

What cannot be gainsaid is the need for a set of such fairly standard indices for measuring the impact of dracunculiasis on the health of the community, in much the same way that a set of indicators is needed to measure the social and economic impact of the disease.

There is also a need to reach agreement on what criteria to use in the diagnosis of the disease. Few published reports have given the precise criteria used for making a diagnosis, and there can be no doubt that surveys in which strict confirmatory parasitological diagnosis is used cannot be compared directly with those which permitted of more subjective criteria or those based on sero-reactivity or skin sensitivity tests. Some working guidelines already exist.[19]

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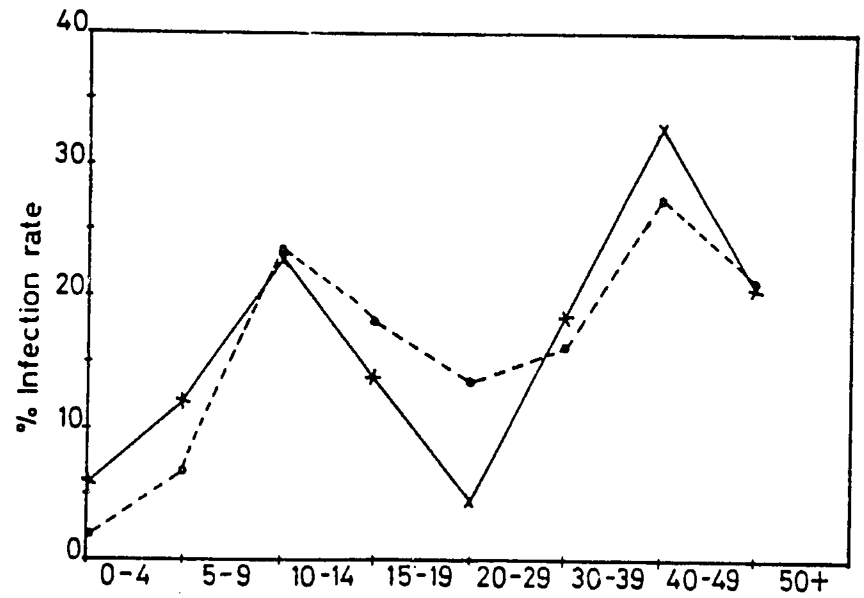
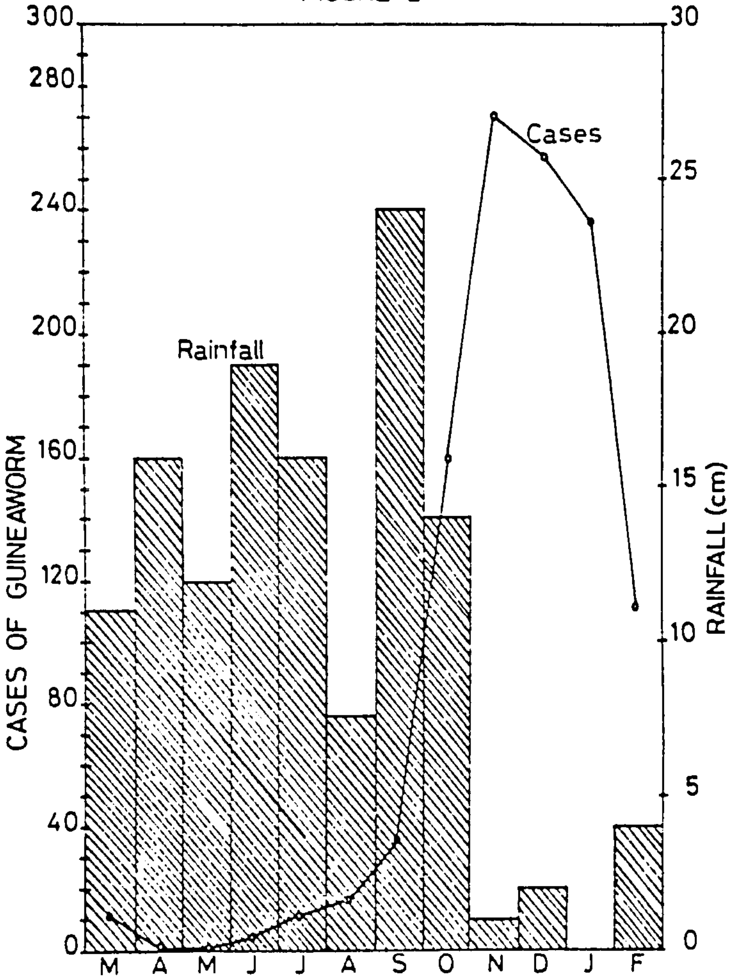
FIGURE 1



Age specific incidence of guineaworm by sex.

x——x Male
o- - - -o Female

FIGURE 2



Monthly variation in incidence of guineaworm infection(1971-75)plotted against the average rainfall in Ibadan araa(1970-1974)

TABLE 1*

AGE AND SEX DISTRIBUTION OF PERSONS INFECTED WITH GUINEA WORM IN 17 VILLAGES NORTH OF IBADAN, 1971 - 1975

Age (years)	Males			Females			Total		
		Infected			Infected			Infected	
	No. in group	No	%	No. in group	No.	%	No. in group	No.	%
0-4	724	42	5.8	728	16	2.2	1,452	58	4.0
5-9	664	79	11.9	615	42	6.8	1,279	122	9.5
10-15	481	106	22.1	396	90	22.7	877	196	22.3
15-19	353	48	13.6	410	74	18.0	763	122	16.0
20-29	783	37	4.7	988	132	13.4	1,771	169	9.5
30-39	489	90	18.4	495	79	16.0	984	169	17.2
40-49	290	95	32.8	235	64	27.2	525	159	30.3
50+	318	64	20.1	231	48	20.8	549	111	20.2
Total	4,102	561	13.7	4,098	545	13.3	8,200	1,106	13.5

* Reproduced from article by Kale, O.O. reference No. 2, by kind permission of the Editor, American Journal of Tropical Medicine and Hygiene.

WORKSHOP ON OPPORTUNITIES FOR CONTROL OF DRACUNCULIASIS

(16 - 19 JUNE, 1982)

EPIDEMIOLOGY OF DRACUNCULIASIS IN INDIA

C.K. RAO*

Dracunculiasis has been known to exist in India for the past several centuries but attention to this disease as a public health problem in India was first drawn by Stoll in 1946.

Distribution:

It was estimated in 1947 that 25 million population was living in endemic areas of India as against 23 million in the rest of the world[1]. Based on the questionnaires returned by the Directors of Health Services of States, Jaswant Singh and Raghavan[2] reported in 1952, that eleven states were endemic for guineaworm disease, and that about five million persons were living in the endemic areas. Patnaik and Kapoor[3] in 1967 estimated, based on the reports received from the Directors of Health Services of the States, that the endemic states for the disease were 12 with an average annual incidence of about 15 per 100,000 population.

Recognising that the guineaworm disease could be eradicated within the existing resources, the National Institute of Communicable Diseases (NICD) set out to delimit the problem on the basis of questionnaires circulated to all the Directors of Health Services of the 31 states and union territories in India in October, 79. The questionnaires returned by the District Medical and

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Health Officers of all the States and Union Territories by the middle of 1980 revealed that seven states and one union territory had reported the presence of guineaworm cases, between the years 1977 and 1979. Further details received as a matter of confirmation showed that 728 villages in 139 blocks of 47 districts in seven states have reported active guineaworm cases from 1977 onwards[4]. The affected population is 1.8 million. All the reported cases from the Union Territory of Goa were later found to be imported from the State of Karnataka and Goa was deleted from the list of endemic union territory.

Subsequently three active searches of every village/hamlet in the known endemic district were organized during December 1980, May/June, 1981 and October/November, 1981 with a view to estimate, as accurately as possible, the problem in terms of the number of affected villages/hamlets. Each of the subsequent searches added to their number. According to the last available information, 80 districts are now endemic for dracunculiasis spread over seven endemic states as shown in the map. The number of blocks, villages and population affected are given in the following table. The States of Orissa, Uttar Pradesh, Punjab

Table

Guineaworm endemicity in India as on 31-3-1982

Sr. No.	State	No. present				No. affected			
		Distts.	PHCs	Villages	Population in (,000)	Distts.	PHCs	Villages	Population in (,000)
1.	Andhra Pradesh	23	324	27221	53404	5	36	585	1052
2.	Gujarat	19	218	18275	33961	11	46	315	505
3.	Karnataka	20	175	26826	37043	7	55	722	1170
4.	Madhya Pradesh	45	458	70883	52132	20	113	2879	2895
5.	Maharashtra	26	296	35778	62694	11	85	932	686
6.	Rajasthan	26	232	33305	34103	23	128	5140	5858
7.	Tamil Nadu	15	374	15735	48297	3	5	9	10
	Total	174	2077	228023	321634	80	468	10582	121 = 12.2 million.

West Bengal and Andaman and Nicobar island earlier reported to be endemic by Patnaik and Kapoor[3] are free from the disease. However, these states are under re-examination to finally exclude any guineaworm focus.

Measurement of disease frequency:

For its eradication, the incidence of dracunculiasis remains the important measurement. Short duration of illness, distribution of cases round the year, easy identification of cases, reliable history about the period of onset of disease make the incidence measurement convenient provided visits to the communities are made at periodic intervals. Two active village searches for total number of cases of guineaworm are planned annually. Under the eradication programme search period would be one week duration. All PHCs in the districts would be searched simultaneously and the search would be done in the same period every year. National estimates reported earlier[1,2,3], appear to be based on prevalence data. Special studies undertaken at different points of time to determine the annual incidence have not been evaluated to determine the degree of error. Medical Institutional data for this disease do not reflect the incidence as patients rarely go to seek treatment unless there are complications. The data collected from medical institutions and through enquiries at fairs, festivals, schools and markets only help to cross check the information collected by active search in order to detect any affected village that may have been missed.

Trend:

Review of endemic areas and the extent of the population exposed to risk as reported in 1947[1], 1955[2], 1967[3], and in 1979[5] shows shrinkage in the extent of the affected areas. Analysis of reports on isolated investigations performed at different points of time also reveal reduction in the intensity of infection.

Since the population has increased considerably during the last 30 years and the methods of collection of data vary, comparison is not possible between the earlier data and the present one.

However, natural decline has been observed in specific areas examined at different points of time. A study undertaken in 1964 in an endemic district revealed reduction in the number of guineaworm affected villages when compared to the earlier reports available with the district health office[5]. Subsequent re-examination of these villages in 1978[6] revealed marked decline in the incidence during the 15 years period although no organised control measures were initiated. Health education on the relationship of guineaworm disease to consumption of tank water coincidental to survey through questionnaire, also seems to have played a part. No additional safe water sources have been added between 1964 and 1978. Yet the disease incidence was found to be reduced markedly after 14 years of initial survey.

Provision of safe water under developmental activities during the last 35 years, knowledge and practice of personal prophylaxis in some communities, perhaps, have also contributed to the reduction in quantum and intensity of infection.

<u>Sources of water supply:</u>

Consumption of water for drinking from step wells, tanks and/or pond water always associated with the disease. The disease does not exist or spread when only draw wells are the source of water. In groups whose consumption of water is dependent only on unsafe water sources the incidence remains the highest. In one of our studies no correlation was observed between the relative proportion of available safe and unsafe water sources and the incidence of the disease. In areas where both safe and unsafe water sources exist, it has been reported that people consuming water from safe sources also come down with the disease although the incidence is less. Such people are exposed to unsafe water away from their homes.

In one of the searches in Madhya Pradesh, 71 villages/hamlets have reported cases with only safe water sources. Epidemiological investigation of such situation would be undertaken in future to determine the indigenous or imported nature of cases. It is very unlikely that spread occurs in villages with only safe water sources.

Cyclops:

Both the sexes and all stages of cyclops act as vectors. Only development and no multiplication of parasite occurs in cyclops.

Several species of cyclops (water fleas) encountered in India include Mesocyclops leuekarti, Mesocyclops hyalinus, Eucyclops agilis, Tropocyclops prasinus, Ectocyclops phaleratus, and Paracyclops fimbriatus.[8] There is no difference in the distribution of species or densities between guineaworm endemic states and those free from guineaworm disease.

Physical disabilities:

The disease is nonfatal, except when the rare complication of tetanus occurs. However, disability persists from the time blister formation takes place until the expulsion of the worm. The average duration of disability appears to be from four to six weeks. In some instances complete emergence of the worm takes as long as six months. Only less than 1 per cent of the cases end in permanent disability.

Economic loss:

Dracunculiasis affects most frequently the adult men belonging to the rural poor during summer when intensive agricultural activities could be seen, 12.2 million population are estimated to live in endemic villages in India. Basing on the available data, at least four per cent of the endemic population is estimated to suffer from active disease annually. Since only 34.5 per cent of the rural population is economically active[9] and wages for about 70 days are lost due to disability every year, it has been estimated that

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4,88,000 cases (4 per cent of 12.2 million) of which 1,68,360 are economically active (34.5 per cent economically active) lose about 11.7 million man days annualy in the country.

Seasonal variation:

Marked seasonality is characteristic of this disease in all the affected areas. However, areas with tanks/ponds as drinking water sources have more marked seasonality with peak in summer months namely April, May, June[2,5,6,7]. In areas with steps wells as the water sources, cases occur round the year though summer peak is clearly observed. The seasonality is associated to greater exposure about one year earlier by taking water from unsafe sources due to drying up of safe sources already present, consumption of larger quantity of water, greater density of cyclops per unit of water due to reduction in the water level in tanks and shollow water.

Reservoirs:

Man appears to be the only reservoir of this infection. Natural infections in cats and dogs in the affected villages are observed occasionally. Regretably no follow/of these animals has been made. It is unusual to see the affected animals in the endemic villages. Experimentally, dogs and cats have been infected with Dracunculus medinensis. Absence of reports about the occurrence of natural infection in animals from areas where the disease has disappeared during the last twenty years and absence of reappearance of this disease in the communities freed from this disease suggest that animals have no role in its spread to man.

Age and Sex:

Children below two years remain free and usually the incidence is very low in toddlers[5]. The incidence increases with advancemant of age and reaches a plateau beyond 35 years[5,6,7]. Exposure determines the incidence rate. The sex incidence also depends on the exposure. Higher rates among males are due to greater exposure with unsafe water source outside their homes[5].

Frequency of attacks:

Usually two to three worms emerge from an affected individual in a season. Emergence of seven to ten worms has been reported. The worms come out more often consecutively than concurrently. In one study only one out of ten patients had a single worm in a year[5]. Number of worms and their time of emergence are related to the intensity of infected cyclops and the duration of their presence in the waters.

Site of emergence:

Lower extremity particularly around and below the ankle is the commonest site of emergence in 95 per cent of instances.[5] However, all anatomical sites ~~sites~~ including some exotic ones have been described to be affected.

Family Size:

No association between the incidence and the size of the family has been observed[5].

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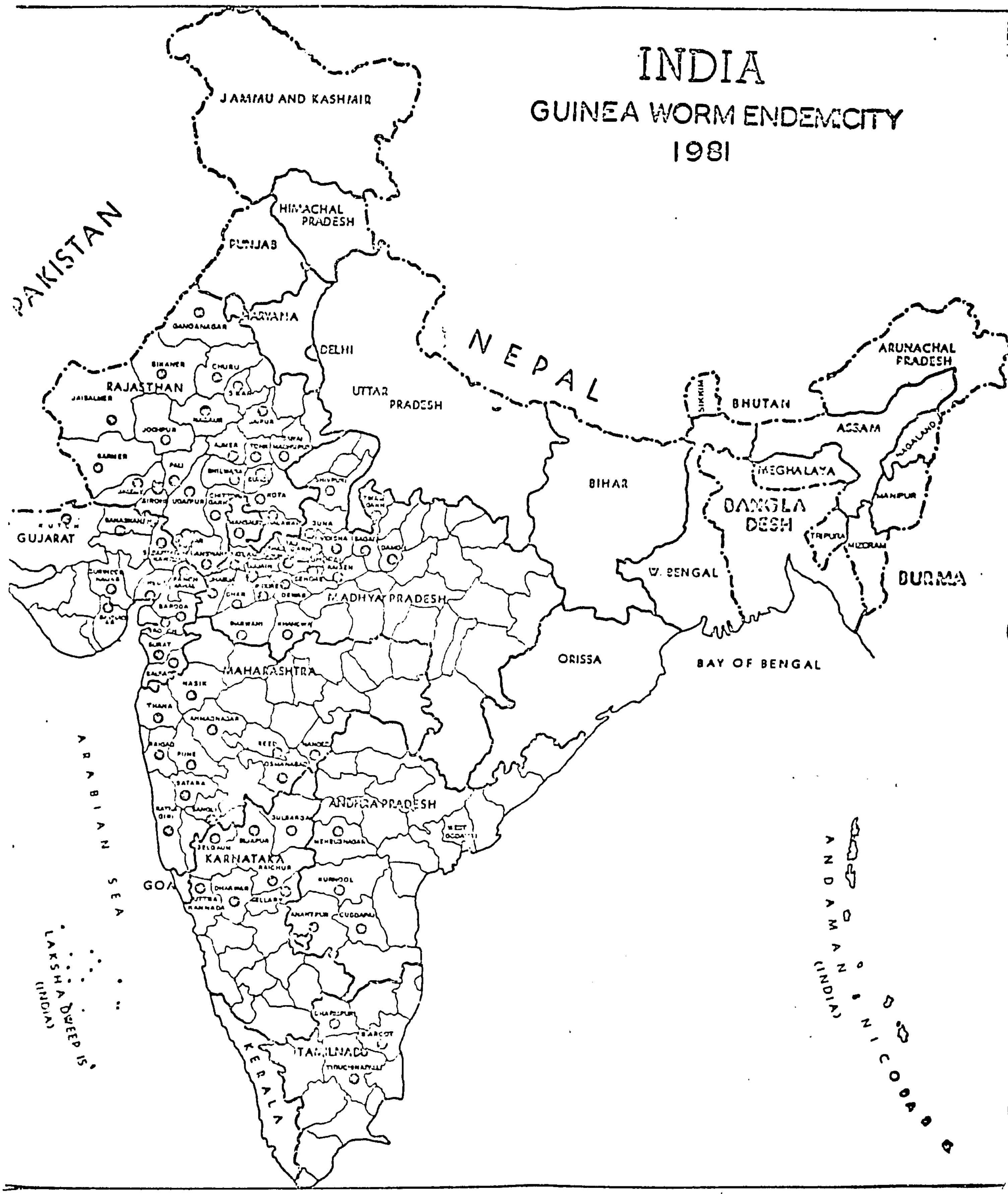
INDIA
GUINEA WORM ENDEMICITY
1981
JAMMU AND KASHMIR
HIMACHAL PRADESH
PUNJAB
PAKISTAN
HARYANA
DELHI
UTTAR PRADESH
NEPAL
SIKKIM
BHUTAN
ARUNACHAL PRADESH
ASSAM
NAGALAND
MEGHALAYA
MANIPUR
BANGLA DESH
TRIPURA
MIZORAM
BURMA
BIHAR
W. BENGAL
RAJASTHAN
GANGANAGAR
BIKANER
CHURU
JAISALMER
JODHPUR
BARMER
PALI
AJMER
TONK
BHILWARA
KOTA
UDAIPUR
SIROHI
GUJARAT
KUTCH
BANASKANTHA
MADHYA PRADESH
SHIVPURI
GUNA
VIDISHA
DAMOH
DHAR
DEWAS
BARWANI
KHANDWA
ORISSA
BAY OF BENGAL
BARODA
SURAT
BALSAR
MAHARASHTRA
NASIK
THANA
AHMADNAGAR
BEED
NANDED
RAIGAD
PUNE
OSMANABAD
SATARA
RATNAGIRI
SANGLI
ANDHRA PRADESH
GULBARGA
MEHBUBNAGAR
WEST GODAVARI
BIJAPUR
BELGAUM
KARNATAKA
RAICHUR
GOA
DHARWAR
UTTRA KANNADA
BELLARY
KURNOOL
ANANTPUR
CUDDAPAH
ARABIAN SEA
LAKSHADWEEP IS (INDIA)
ANDAMAN AND NICOBAR (INDIA)
DHARMAPURI
N. ARCOT
TAMILNADU
TIRUCHIRAPALLI
KERALA

WHO/AFRO PROGRAMME PROPOSAL FOR CONTROL OF DRACUNCULIASIS IN THE AFRICAN REGION

Dr A. H. ABDOU
AFRO Regional Officer for
Parasitic Disease

BACKGROUND

Dracunculiasis, or Guinea worm disease, is a parasitic infection caused by ingestion of water which is contaminated with Cyclop containing larval stages of the worm Dracunculus medinensis, It occurs sporadically in some rural communities without adequate supplies of safe drinking water. In affected areas, in Africa, the socio-economic impact of this disease is appreciable, though inadequately documented. In one West African country where the problem was studied, investigators found that over half the adult male farmers in affected communities were incapacitated for periods averaging five weeks during the season of peak agricultural activities, because of the pain and crippling associated either directly or indirectly with the emergence of the large female worm. Thus the decline of dracunculiasis would have a positive impact not only on the health, but also on the economy of the affected African population.

At the thirty-fourth World Health Assembly in May 1981, the resolution on the International Drinking Water Supply and Sanitation Decade (WHA34.25) noted the special opportunity which the Decade could contribute towards the control or elimination of dracunculiasis in endemic areas. The same idea was endorsed at the April 1981 meeting of the Steering Committee for the Decade, and was highlighted in the September-October 1980 issue of "Bulletin de l'Organisation de Coordination et de Coopération pour la Lutte contre les Grandes Endémies", which was entirely devoted to dracunculiasis. As improvements are made to water supply systems, the incidence of this disease no doubt will continue to decline in areas where it still persists, but additional control measures are likely to be required. For example, India has recently embarked on a national effort which combines intensified surveillance, provision of safe drinking water, provisional chemical treatment of unsafe water sources, and health education, and which is intended to eradicate dracunculiasis from India by December 1985.

Dracunculiasis is the only parasitic disease known to be transmitted solely through drinking water. Thus, the Decade presents a unique opportunity to control/eliminate it in affected African population.

Although the control and eventual elimination of dracunculiasis is feasable, the disease has not received enough attention in national health programmes in the African Region. The present workshop on opportunities for control of dracunculiasis and its various working groups offers an excellent opportunity to exchange professional expertise and experience and to discuss ways and means of initiating/supporting national efforts to bring this infection under control and possibly eliminating it.

PROGRAMME PROPOSAL

OBJECTIVES

Specific Objectives

- To create awareness of this disease and its socio-economic impact and the benefits of eliminating it;
- To strengthen international recognition of the problem and attract bilateral and multilateral resources;
- To demonstrate the role of safe drinking water in eliminating dracunculiasis.

Principal Objective

The main objective of the programme proposals is to give priority in providing safe drinking water to all identified villages/areas affected by dracunculiasis and currently having cases of the disease during the International Drinking Water Supply and Sanitation Decade (IDWSSD). Areas with past history of cases should have the second priority.

International awareness and recognition of dracunculiasis has been essentially accomplished by, the resolution of the WHA34.25, the advent of the IDWSSD whose steering committee endorsed the idea of using dracunculiasis control as an indicator of the Decade's impact on health and the embarkment on a national programme for the eradication of dracunculiasis in India.

PLANNED ACTIVITIES

Although the planned activities deal with dracunculiasis in the whole Region, yet the near future efforts will be focused on West Africa. AFRO is cooperating with affected Member States in this subregion to initiate/implement their national programmes for dracunculiasis eradication in conjunction with their primary health care services and the water and sanitation projects.

The plan of operation includes three principal phases

Phase I : Review current knowledge regarding dracunculiasis and the establishment of accurate baseline data.

Phase II : Development of suitable control measures.

Phase III : Evaluation and monitoring.

PHASE I

This phase should start by thoroughly reviewing current knowledge regarding dracunculiasis, its epidemiology, surveillance, control and socio-economic impact in West Africa.

The current distribution of dracunculiasis in the African Region includes much of the savanna belt of West Africa and some parts of eastern Africa. Among the African countries the disease apparently exists in Benin, Cameroon, Chad, Ethiopia, Ghana, Guinea, Ivory Coast, Liberia, Sudan, Togo, Uganda and Upper Volta. The number of cases given in table I were obtained from officially reported data and from published reports related to the areas of operation.

The surveillance data reported are useful only as a broad indication on the general geographical areas known or reported to be recently affected. They reflect only vaguely the numerical extent of the problem, since this disease occurs in areas where reporting and surveillance systems tend to be rudimentary or non-existent. The disease has, in general, been neglected, and affected communities realize that hospital attendance does little, apart from controlling secondary infection, to modify the course of the disease; they tend, therefore, to accept this health problem with resignation. In one study in Togo, in 1977, less than 4% of cases of dracunculiasis observed had been reported to public health authorities. A recent study in Benin, in 1981, showed dracunculiasis to be present in almost all the regions of the country. It is estimated that 600 000 persons are affected. Out of 513 villages surveyed the infection exists in 192 villages. Another survey to study the socio-economic impact on these affected areas is in progress and the final results are expected to be available by May 1983.

When public health workers conducted a special village-by-village search for dracunculiasis in India in January and February 1981, they found an estimated 5.9 million persons to be at risk in 7 533 affected villages of seven States, whereas the same areas had reported 1.8 million persons to be at risk of this disease in 728 villages in response to a written inquiry 15 months earlier. Therefore, there is a need to further investigate the present incidence and prevalence of dracunculiasis more especially as it is estimated that only a third of the cases are seen in health centres and hospitals in West Africa. It is hoped that as more attention is paid to this disease, surveillance will improve.

In West Africa, the major specific activity carried out presently is a survey of dracunculiasis in Upper Volta by the "Organisation de Coordination et de Coopération pour la Lutte contre les Grandes Endémies" (OCCGE) with headquarters in Bobo-Dioulasso with participation of the CDC staff member. Discussions are new taking place with the aim to initiate similar studies in other countries namely Mali, Benin, Togo and Ivory Coast. There is an understanding that the CDC staff member on EPI projects under AID auspices would be available if such additional studies were to be carried out.

As a further step to accelerate dracunculiasis survey the project of Strengthening Health Delivery System (SHED) based in West Africa under AID auspices has agreed to provide a consultant epidemiologist for 3 years to cooperate with interested governments in carrying out surveys to clarify the extent of the disease and its impact on the affected areas. During his mission the consultant will further study the best suitable methods of case-finding to determine the prevalence of infection in selected areas and determine the peak season.

During this phase heavily infected villages and areas at risk will be identified. As a first step AFRO sent a memorandum to all concerned Member States requesting them to intensify their epidemiological surveillance of dracunculiasis, to identify areas of high prevalence, to select sample village/area for frequency observation, to measure the extent of infection with selected communities and to measure the economic impact. All these activities will pave the way for the conduction of follow-up studies to monitor progress in the reduction of this disease and its final elimination.

PHASE II

Recently AFRO has been initiating and supporting national efforts in West Africa to intensify surveillance, provision of safe drinking water, provisional chemical treatment of unsafe water resources and health education with the intention to eradicate dracunculiasis. To support such programmes a feasibility study will be carried out to determine the most suitable and alternative methods and strategies to control dracunculiasis with emphasis on cost-effectiveness under the African environment.

The success of the proposed programme depends on:

- Intensive and prompt case-finding operations.
- Identifying infective water resources and rendering them safe.
- Providing alternative safe water supply.
- Personal prophylaxis, health education and community involvement.

Unlike most parasitic disease, individuals infected with dracunculiasis are easily recognized, and thus could be prevented from contaminating water sources. Although drug treatment alleviates the infection yet unfortunately no known drug is suitable for effective mass treatment. Therefore, it is of utmost importance to identify infective water resources so that adequate measures can be applied to make them safe. Dracunculiasis can be prevented by chemical treatment of infected water, however, since repeated applications are required, such a treatment is quite impractical in the Region.

Dracunculiasis can be rapidly eliminated from affected communities by applying the well-known, but expensive measure i.e clean and safe drinking water supply. Personal prophylactic measures such as boiling and straining drinking water are difficult to perform continously hence the importance of providing alternative safe water supplies. Because, safe drinking water is expensive, it is quite difficult to gain support for such intervention solely to eliminate this disease, hence the significance of linking the programme with the water and sanitation Decade. The disease offers a uniquely visible, significant and rapidly achievable indicator of the health benefits of this programme thus increasing the support for Decade activities at rural and village levels. For all these reasons, AFRO is trying to help improve communications and coordination between ministries of health and relevant national water supply/sanitation agencies on the problem of drácunculiasis.

The use of all kinds of available media and the various approaches for health education to convey the necessary knowledge about the disease is the back bone for the success of the eradication programme. Special training and hygiene teaching will be particularly directed to para-medicals, primary health care workers, village elders, religious leaders, teachers and all voluntary agencies. In the absence of a safe drinking water source the salient methods of prevention are: boiling of water before drinking, sieving it through double folded cloth or treating it with chemicals. Wide publicity will be given so that the community only use safe drinking water and more important to prevent infected persons from contact with water in ponds, wells, tanks etc. Full participation by members of the community in planning and operating the campaign will encourage proprietary pride and ensure the success of the eradication programme through their own efforts.

PHASE III

There is a need to identify and develop indices of economic and social activities to measure the impact of dracunculiasis control. The parameters will be derived from the local social and economic situation e.g. industrial or agricultural enterprises, school attendance and absenteeism etc.

Guidelines for evaluation control achievements and suitable basis for assuring that elimination has been achieved will be established. The prevalence of dracunculiasis before and after intervention to interrupt transmission will be measured. A two years follow-up after safe water is provided and used will be needed.

WHO/AFRO INVOLVEMENT

Resolution WHA33.25 and AFR/RC31/R14 laid special emphasis on the importance of the Decade in health for all by the year 2000, on efforts expected from Member States and on the support to be given by WHO, UNDP, other organizations and donner agencies. Following the resolution WHA34.25 of the 34th World Health Assembly, May 1981, AFRO strengthened further communication and technical cooperation with Member States so as to start/consolidate their national campaigns for eradication of dracunculiasis based on primary health care system.

The activities of the programme, so far, have consisted chiefly of joint multidisciplinary consultant missions involving health engineers, epidemiologists, health educators, financial analyst etc. Also, interested international, intergovernmental, nongovernmental and bilateral agencies were contacted for technical/financial cooperation. As a part of its Regional programme for the Decade WHO is collaborating with Member States in formulating national DWSS programmes, including dracunculiasis eradication, and identifying external funds. In this connection, operational linkages are being developed with CDC, SHED and OCCGE.

EHE/HQ proposed that a WHO sanitary engineer be attached to the mission which is carrying out the present dracunculiasis survey in Upper Volta with a view of relating the mission more effectively to actual government programmes for the improvement of water supply and sanitation. Funds had been ear-marked for this offer.

A variety of international agencies as well as bilateral/multilateral agencies are currently cooperating with WHO providing technical and/or financial support for the Region:

- The interregional WHO/SIDA cooperative project provided two permanent professional staff members, a health engineer and a financial analyst.
- The interregional WHO/GTZ cooperative project provided a health engineer to be based permanently at Ouagadougou, Upper Volta. It is also planned and a decision has already been made, to assign a second full-time health engineer to be based at Lome, Togo. The project has been particularly active in organizing and running national workshops which provided excellent media for gaining national support to the ongoing activities.
- The joint WHO/World Bank programme is under way in very many countries in the Region.
- On the other hand, at country level and frequently on a bilateral basis several multilateral, bilateral and nongovernmental agencies are currently cooperating or willing to do so including the EDF, WAEC, USAID, FAC, NORAD, SIDA, DANIDA, the Saudi Fund, CARE etc. For all these activities coordination and follow-up are provided at the Regional Office, Brazzaville, Congo.

WHO intends to align planned or yet unplanned water sanitation programmes in areas with dracunculiasis prevalence which are supported by UNICEF; the ILO Special Public Works Programme; World Bank/TAG; World Bank/PNH; FED; GTZ, and of course, WHO's technical cooperation in respect to the Water/Sanitation Decade.

It is also our intention to develop an operational comprehensive manual for the eradication of dracunculiasis in Africa, persons working in the field would find such guidlines and methods of national surveillance useful to carry out their day to day work.

Training of nationals at all levels will have top priority to improve managerial skills, manpower training, setting up information systems and operating and maintaining existing facilities. Such task forces are needed to carry out a well planned strategy for the eradication of dracunculiasis in West Africa.

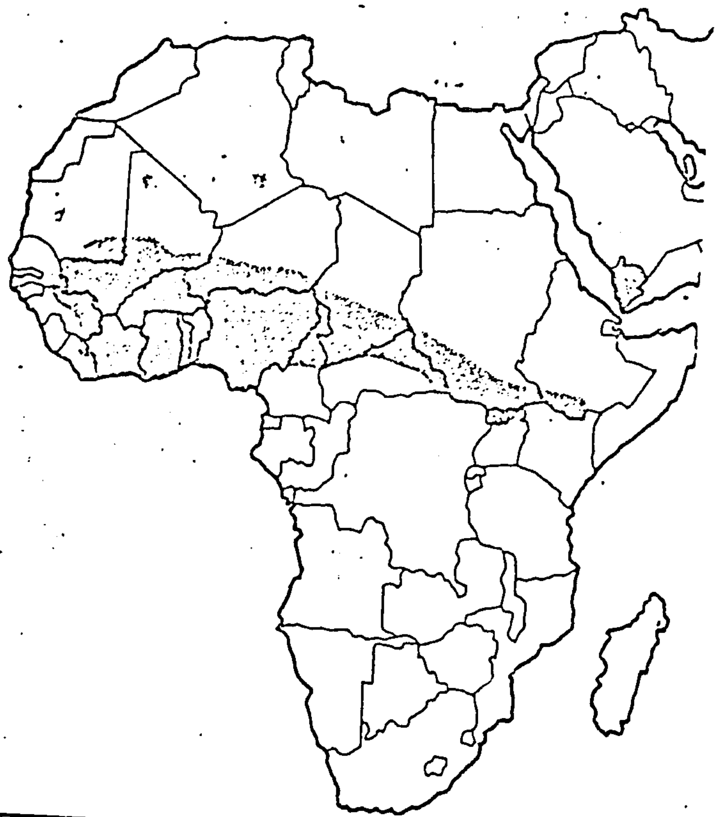

Fig. 1
Areas in which Dracunculiasis Is Reported or Probably Exists
Régions où la Dracunculose est signalée ou existe probablement

Continent	Country Pays	Regions Régions	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AFRICA -	Benin - Bénin	Queme	90	-	50	-	-	-	-	-	-	-
		Atlantic - Atlantique ..	100	-	90	-	-	-	-	-	-	-
		Mono	70	-	30	-	-	-	-	-	-	-
		Zou	1 000	-	510	-	-	-	-	-	-	-
		Borgou	130	-	50	-	-	-	-	-	-	-
		Atakora	90	-	90	-	-	-	-	-	-	-
		TOTAL	1 480	-	820	-	-	-	-	-	-	-
	Cameroon - Cameroun		-	-	-	251	-	-	-	-	-	-
	Chad - Tchad		-	-	-	-	-	-	172	-	-	-
	Ghana	Accra	6	30	15	49	3	65	[illegible]	-	-	-
		Ashanti	35	-	-	1 536	229	19	83	-	-	-
		Brong.Ahafo..	290	453	90	194	225	362	619	-	-	-
		Central	18	95	-	267	62	143	146	-	-	-
		Eastern	624	48	261	600	335	319	89	-	-	-
		Northern	127	910	748	1 031	454	231	432	-	-	-
		Upper	348	9	56	185	86	347	75	-	-	-
		Volta	45	27	39	127	62	71	148	-	-	-
		Western	200	34	15	63	15	60	57	-	-	-
		TOTAL	693	1 606	1 226	4 052	1 421	1 617	1 676	-	-	-
	Ivory Coast-Côte d'Iv.		4 891	4 654	6 283	4 971	4 656	5 207	6 993	-	-	-
	Mali		668	786	737	542	760	1 084	-	-	-	-
	Mauritania-Mauritanie		..	-	-	-	-	127	-	-	-	-
	Niger		-	-	-	-	2 600	3 000	5 560	-	-	-
	Nigeria Nigéria		98	-	-	1 007	-	-	-	-	-	1 693
	Senegal Sénégal		-	334	208	65	137	-	-	-	-	-
	Togo		-	-	-	3 261	1 648	-	2 617	2 673	-	-
	Upper Volta Haute-Volta		5 822	4 404	4 00[illegible]	6 277	1 557	-	2 885	2 694	2 565	-

EDF	-	European Development Fund
WAEC	-	West African Economic Community
USAID	-	US Agency for International Development
FAC	-	Fonds d'Aide et de Coopération
NORAD	-	Norvegian Agency for International Development
SIDA	-	Swedish International Development Agency
DANIDA	-	Danish International Development Agency
CARE	-	Cooperative for American Relief to Every where
GTZ	-	Agency for Technical Cooperation of the Federal Republic of Germany (Gesellshaft Techniche Zussamen)
IDWSSD	-	International Drinking Water Supply and Sanitation Decade
DWSS	-	Drinking Water Supply and Sanitation
UNICEF	-	United Nations Children's Fund
NGO	-	Nongovernmental Organization
FED	-	Fonds European Development
TAG	-	Technical Advisory Group
PNH	-	Population, Nutrition and Health

DEFINITION OF TASKS, DRACUNCULIASIS WORKSHOP

Working Group 1 - Problem Assessment

a. case definition

b. obtaining relevant epidemiologic information - survey methods

c. identifying target populations

d. training local authorities to provide information

e. needed research

Members: Donald Belcher (Chair)
Alfred A. Buck (rapporteur)
Ralph Muller
O. O. Kale
M.I.D. Sharma
J. Prod'hon
E. F. Quashie
Bruce Weniger
Ronald Waldman

Working Group II - Selection and Implementation of Control Measures

a. establishing range of options

b. consulting with local authorities/data sources

c. developing control strategies for specified geographic areas

d. recruiting needed personnel

e. establishing operational linkages with relevant agencies at local, regional, and national levels

f. needed research

Members: Herbert Gilles (Chair)
Fred Golladay (rapporteur)
Douglas Hudgins
C. K. Rao
Ray Iseley
Gerard Rohlich
Joshua Adeniyi
Matthew Shulman
Ernesto Ruiz

Working Group III - Evaluation

a. establish surveillance system

b. methods for determining water use patterns

c. monitoring implementation of control efforts

d. Guidelines for evaluating achievements in control efforts

- operations
- epidemiologic outcome
- socioeconomic benefits

e. establishing basis for deciding that elimination has been achieved

Members: Donald Hopkins (Chair)
William Ward (rapporteur)
Brian O.L. Duke
F. K. Kloutse
Fergus McCullough
A. Abdou
Steven Jones
Kenneth W. Bernard

APPENDIX C

GROUND WATER SUPPLY (SPRINGS, DUG, BORED, DRILLED WELLS)

	Treatment Level	Type of Treatment	Water-Based Transmission (Guinea Worm)	Cost	Administration	Infrastructure Support Needed	Reliability	Individual Identification	Evaluation Indicators	Advantages	Disadvantages
UNPROTECTED	"STEP-WELL" *	NONE	HIGH RISK	LOW	N/A	LOW	LOW	HIGH	MOD- ~~COMPLEX~~	D	1,7
	UNLINED DUG	NONE	LOW RISK	LOW	N/A	LOW	HIGH	HIGH	MOD	E	7
	LINED DUG	NONE	LOW RISK	MOD	COMPLEX	LOW	HIGH	HIGH	MOD	E	7
PROTECTED	** COVERED LINED DUG	INITIAL DISINFECTION AFTER CONSTRUCTION	~~NO~~ RISK	MOD/HIGH	COMPLEX	MOD.	HIGH	HIGH	MOD	C,E	4
	** COVERED LINED DUG w/ ~~HAND~~ PUMP	↓ and maintenance	NO RISK	HIGH	COMPLEX	HIGH	LOW	MOD/LOW	MOD	C,E	4
	TUBE WELLS w/PUMPS	↓	NO RISK	HIGH	COMPLEX	HIGH RECURRING CAPITAL COSTS	O&M DEPENDENT	LOW	SIMPLE	C,E	4,
	TUBE WELLS & SPRINGS w/PIPED DIST	DISINFECTION	NO RISK	VERY HIGH	MOD	HIGH RECURRING CAPITAL COSTS	O&M DEPENDENT	LOW	SIMPLE	C,E,F	4,6

*ACTUALLY [illegible] CHARACTERISTIC OF SURFACE SUPPLIES - "STEP WELL" CHARACTERISTIC USE GROUNDWATER (COULD ALSO USE FREE FLOWING SPRINGS) — individual protective measures required (see Surf[illegible] measures)

TABLE I

		Treatment Level	Type of Treatment	Water Based Transmission (Guinea Worm)	Cost	Admins. Feasibility (Planning Coordination Implementation)	Infrastructure Support Needed	Reliability of Fail Safe Systems	Individual Identification with System	Evaluation Indicators [illegible]	Advantages	Disadvantages
Surface Sources	Unprotected	Unprotected Source	N/A	High Risk	N/A	N/A	None	N/A	High	Complex	None	~~No control~~ 1, 7
		Unprotected Source - Personal Treatment	Filtration	Low Risk	Low	Complex	Low	Low	High	Complex	A, B, D	2
			Clarification	Unknown	Mod-		Low	Low	"	"	B	3
			Disinfect/Boiling	Unknown	Mod/High		Low	Low	"	"	A, B, C	4
		Community Action	Excluding of infected person from water source	Low Risk	None ~~N/A~~	Moder-	None	Low	High	Complex	A, D	2, 5, 7
			Chemical Treatment									
	Protected	Passive Structure ~~to reduce~~ surface withdrawal	Elimination of surface contamination & reducing user/water contact	Mod. Risk	Mod	Mod-	Low	Low	Low	Complex	E	3, 4, 7
		Passive structure subsurface withdrawal	Infiltration Gallery	Low Risk	Mod High	Mod	Low	High	Low	Complex	E, C	4
		Conventional Treatment	Clarification Filtration Disinfection	No ~~Low~~ Risk	High	Mod.	High	Operation & maintenance dependent	Very Low	Simple	E, F, C	4, 6

Rohlich

Water Supplies

A basic requirement for the control of Guineaworm disease is the provision of a water supply that is free of infected cyclops.

Several options are available to fulfill this requirement, each of which is dependent, in large measure, on the unique local situation with regard to availability of sources of supply, adequate in quantity to meet demands; socio-economic factors and political, legal, and institutional constraints. Options range from relatively simple, low cost procedures carried out by individuals for personal or family water supply to sophisticated engineered systems for development, collection, treatment, and distribution and water in a piped system. The latter requires a commitment of capital for construction and adequate resources for maintenance and operation to insure reliability of performance of the system on a continuing basis.

The matrix in 'Table I outlines' the various options and compares them on a qualitative basis.

Assuming that the traditional supply will continue to be used individual treatment by one or a combination of the following can be used for unprotected sources:

filtration - through cloth, sand or other filtration media locally available.

clarification - use of a coagulating agent such as aluminum sulfate

boiling/disinfection

Community action where unprotected sources are used could be chemical treatment for vector control (discussed in section____), or excluding infected persons from water sources.

Surface supplies can be protected by structures to reduce access and surface contamination and by use of infiltration alleries or installation of conventional treatment.

Ground water supplies are obtained from dug wells or springs which may be unprotected or from protected wells. The latter may be dug wells which are lined and covered, with or without pumping equipment or tube wells.

Footnotes to Table I.

Advantages

A. Immediate short term control measure

B. User controlled

C. Protection against other water related disease transmission.

D. No resource allocation required.

E. Long Term control measure.

F. Agency level quality control.

Disadvantages

1. No control over guinea worm transmission.

2. Non-permanent solution

3. Questionable Effectiveness

4. Resource intensive (includes O & M)

5. Social and cultural acceptance

6. Infrastructure dependent

7. No protection against other water related diseases.

Suggested Research Projects

1. Chemical characteristics of water as related to propogation of cyclops and guinea worm larvae.

2. Continued studies on use of locally available materials for filtration with renewed emphasis on developing portable units for use by individuals.

3. Transfer of successful local technologies and materials use to other regions.

Training Needs

1. Training of water systems operators at village level. Emphasis on use of existing personnel such as school teachers, village health care workers (para-medics).

2. Educational program directed at technicians, engineers, sanitarians and others in agencies, at all levels, concerned with allocation and use of water. A principal objective of the program would be to develop an awareness of the guinea worm problem as related to water supply.

Water Supply Strategy

GOALS

Priority 1) Provision of alternate safe water supply

a) Level of technology within possibility of _____ to operate and maintain; consistent with ability of infrastructure to support and finally, consistent with allocation of national/regional/local resources to obtain maximum coverage. Use of local surveys to supplement and modify national plans/approach.

Use of surface resources only if ground water is inadequate or not suitable for drinking water.

Provision of exclusive water sources for human consumption and domestic use.

Priority 2) In absence of resources for provision of safe water, adequate in quantity than implementation of measures to reduce opportunities for Guinea worm infection:

- elimination of contact between guinea worm patient and water sources during transmission period
- introduction of personal protection measures.
- health education

Approaches

1) National Planning Function

- Lead agency must have authority to assure inter-agency cooperation.
- Inclusion of all agencies interested in water resources.
- Allocation of resources to take maximum advantage of opportunities for control.
- Non-rigid criteria and guidlines for water system control.

2) Local Planning Function

- Establishing regional and local survey techniques to water, populations and consumption, etc.

- Consultation with local users.