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Guineaworm infection in the Wa district of north-western Ghana

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The Ghana-5 schistosomiasis project is situated in an exclusively rural area of north-western Ghana. Since the inhabitants rely for the most part on natural sources of drinking water the transmission of both urinary schistosomiasis and guineaworm infection must often occur at the same sites, and the epidemiology and the problems of control of these diseases might be expected to have features in common. An epidemiological survey of 8 300 people in 1967–68 showed that guineaworm had a scattered distribution, 35 of 43 villages having an annual incidence of less than 10 %. Intensive study of 5 of the most seriously affected villages over a period of 3 years has shown that there is a delicate balance between the parasite and its human host in this area, largely as a result of the impermanent nature of the principal transmission sites, i.e., ponds and the smaller riverine pools. The timing, duration, and intensity of transmission have been shown to vary widely from one locality to another, as well as from year to year. These characteristics are determined by the type and extent of the local source of drinking water, the availability of alternative sources, and the monthly pattern of rainfall.

Guineaworm (*Dracunculus medinensis*) infection is generally believed to be a disease of public health importance in the interior savanna of West Africa, where the population, which is almost entirely rural, often has to obtain drinking water from natural sources that are shared by a large number of people. However, lack of information on the transmission of the disease and of the morbidity caused by it has hitherto prevented an adequate assessment being made of the magnitude of the problem in north-western Ghana; the investigations described in this report were intended to supply the information necessary for such an assessment.

The Ghana-5 project area in its present form occupies the area lying between coordinates 9°48′ and 10°7′ N and 2°26′ and 2°45′ W. It covers an area of approximately 1 166 km² with an estimated population in 1967 of 39 500 (34 per km²) living in 118 localities.

The area is crossed from east to west by two sizable rivers that empty into the Black Volta River, the latter forming the western boundary and being the only permanent river in the area; there are numerous small streams, some of which have been dammed to provide water throughout the year. The average annual precipitation (1917–57) is 110.5 cm. Almost all the rain falls between April and October, most of it in August and September. The rivers and streams normally cease to flow from October or November.

The findings that follow are derived from three sources. (1) An epidemiological survey of schistosomiasis was made in 1967 and 1968, in the course of which records were also kept of active cases of guineaworm infection and persons with a history of guineaworm infection during the previous year. (2) Observations were carried out in 5 selected villages known to have relatively high guineaworm infection rates; these villages were visited monthly—as far as the unit's schistosomiasis control activities permitted—from December 1968 to September 1971. (3) In 1969 and 1970 various procedures were carried out in the 5 villages selected for detailed study, with the aim of determining seasonal changes in the relative density and infectivity of the vectors. For clarity, the information obtained from each source is considered separately.

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DATA ON GUINEAWORM FROM THE SCHISTOSOMIASIS EPIDEMIOLOGICAL SURVEY OF 1967–68

It was intended that a random sample of 25% of the population should be examined. In fact, information was collected on 8 274 persons in 43 localities, representing 21% of the estimated population. The method of sampling and the age and sex composition of the population from which the sample was drawn will be described elsewhere but are not considered to be essential for the present account.

INCIDENCE OF GUINEAWORM

Although data collected by questioning are always suspect to some extent, the appearance of a guineaworm is probably a sufficiently memorable event to justify recording a history of infection, at least during the previous year. It was fortunate that this was done since, on account of the time of year at which the survey was carried out, only 87 (1.1%) of the 8 274 persons examined presented active guineaworm lesions. Combining active cases with those with a history of guineaworm infection during the year prior to the survey, a total of 470 cases was obtained, which represents an annual incidence of 5.7%. Of the 4 291 males, 222 (5.2%) were infected, while there were 248 (6.2%) cases among the 3 983 females; the higher rate in females was significant at the 95% level of probability ($\chi^2 = 4.3$, $P < 0.05$). Differences in infection rates in the various age groups were not marked; the rate was 1.6% in children aged 0–4 years, rose to a maximum of 9.7% at 20–24 years, and fell to 3.6% in persons aged 65 years or over.

Wide variations in overall prevalences were noted, the annual incidence being less than 1% in 13 of the 43 villages and less than 10% in 35, while 3 villages had rates of 20–39%. Within the range of villages studied, population size was not related to the incidence of guineaworm infection; there are, however, no large towns in the project area since Wa, the administrative headquarters of the project, lies just outside its limits.

INCIDENCE OF INFECTION RELATED TO THE SOURCE OF DRINKING WATER

The sources of water used for drinking and the infection rates recorded in persons using the various sources are shown in Table 1. It is characteristic of the area that the majority of people rely on different sources at different times of the year on account of the rapid drying up of the smaller bodies of water as the dry season progresses. As a result, no clear indication of the relative risk of infection associated with each source emerges from the table. Among the inhabitants of the 6 villages who obtain drinking water from the perennial Black Volta, at least in the dry season, the incidence amounted to only 0.7%.

Table 1. Incidence of guineaworm infection in relation to sources of drinking water

Source of drinking water	No. of persons examined	No. positive	Percentage
boreholes, deep wells	1 418	48	3.4
ponds, shallow wells, borrow-pits	3 798	235	6.2
rivers, streams, pools	6 090	308	5.1
dams	3 366	118	3.5

For the purposes of the schistosomiasis survey, information was collected on swimming habits. Unexpectedly, when data on guineaworm were analysed it was found that guineaworm infection rates were markedly higher in swimmers than in nonswimmers in both sexes and at most ages. No satisfactory explanation can be offered for such an association, which, to the writer's knowledge, has not previously been described.

INCIDENCE RELATED TO ETHNIC GROUP

In order of numerical importance, the 3 principal ethnic groups are Lobis, Dagartis, and Walas. As can be seen from Table 2, guineaworm infections in

Table 2. Incidence of guineaworm infection in relation to ethnic group

Ethnic group	No. examined	No. positive	Percentage
Lobi	4 182	146	3.5
Dagarti	2 062	235	11.4
Wala	1 871	86	4.6
others	159	3	1.9

Dagartis exceeded those in the other groups combined.

In contrast to the other two large groups, which are almost exclusively occupied in farming, Walas are also involved in trading. As traders, they are concentrated in the larger villages and towns where they generally occupy the central nucleus of houses. As a result, a far higher proportion of Walas (80%) have access to boreholes or wells than any of the other groups represented, although many of them do not take advantage of these facilities. The lower incidence of guineaworm in Lobis is partly explained by the fact that 27% of them live in the 6 villages that obtain water from the Black Volta.

MONTHLY HOUSE-TO-HOUSE VISITS IN FIVE SELECTED VILLAGES

INFORMATION COLLECTED IN THE FIELD

Monthly case-finding visits to the 5 villages were carried out from December to September in 1968–69 and 1969–70, and from November 1970 to September 1971, being suspended in the remaining months each year because of the staff's preoccupation with schistosomiasis control activities. It is convenient to refer to the data collected during each of these periods as the data for 1969, 1970, and 1971, respectively.

On the monthly visits to each household any cases of guineaworm infection that were found were recorded as ambulant or prostrated (i.e., unable to carry out normal social functions); the total number of emerging worms and their anatomical sites were noted for each case.

Early in 1970 a census was taken to determine the age and sex composition of the population at risk in the 5 villages. The technical officer responsible estimated the ages and questioned each individual about previous guineaworm infections and about his domicile during the year prior to the inquiry. Altogether, data were recorded for 1 100 persons living in 79 houses or compounds. It was found that a negligible number of people had been domiciled elsewhere 1 year prior to the census, and it is not considered necessary to exclude these.

RESULTS

Incidence related to age and sex

The total proportion of persons infected increased from 22.8% in 1969 to 26.1% in 1970, falling again to 22.8% in 1971. The age and sex distribution was similar in all 3 years. From the data for 1970, which are summarized in Table 3, it can be seen

Table 3. Age and sex distribution of persons (1) infected with guineaworm during 1970, and (2) ever infected up to the end of September 1970

Age (years)	Males					Females					Total				
	No. in age group	Infected in 1970		Ever infected		No. in age group	Infected in 1970		Ever infected		No. in age group	Infected in 1970		Ever infected	
		No.	%	No.	%		No.	%	No.	%		No.	%	No.	%
0–4	99	6	6.1	11	11.1	93	5	5.4	12	12.9	192	11	5.7	23	12.0
5–9	81	26	32.1	38	46.9	75	24	32.0	36	48.0	156	50	32.1	74	47.4
10–14	88	32	36.4	59	67.0	77	30	39.0	58	75.3	165	62	37.6	117	70.9
15–19	52	19	36.5	40	76.9	30	14	46.7	25	83.3	82	33	40.2	65	79.3
20–29	38	9	23.7	30	78.9	73	30	41.1	58	79.5	111	39	35.1	88	79.3
30–39	57	16	28.1	51	89.5	91	29	31.9	76	83.5	148	45	30.4	127	85.8
40–49	65	12	18.5	59	90.8	71	18	25.4	59	83.1	136	30	22.1	118	86.8
⩾50	59	5	8.5	43	72.9	51	12	23.5	43	84.3	110	17	15.5	86	78.2
total	539	125	23.2	331	61.4	561	162	28.9	367	65.4	1 100	287	26.1	698	63.5

that the incidence rose sharply between the ages of 5 and 9 years, reaching its maximum in both sexes in the 15–19-year age group and declining thereafter. At all ages above 9 years females were affected more than males, the total incidence being once again significantly greater at the 95% level in females than in males ($\chi^2=4.6$, $P<0.05$). No case was recorded in any person under 1 year of age.

The age and sex distribution of persons who had ever been infected up to September 1970, also shown in Table 3, confirms that in both sexes the sharpest increase in the incidence of new cases occurred between the ages of 5 and 14 years, almost half the population having been infected by the age of 9 years. By 14 years of age 67% of males and 75% of females in these villages had suffered from guineaworm infection. It also appears that in the oldest age group some 27% of males and 16% of females escaped infection altogether. The sudden drop in incidence in males in the over 50-year age group appears to be inconsistent with the rest of the table and possibly represents a failure on the part of some of the older men to remember suffering from guineaworm infections in earlier life. In general, however, these observations are in close accord with those of Scott (1960) in the North-West Ashanti (now Brong-Ahafo) region of Ghana.

In considering the data on incidence it should be borne in mind that figures based only on patent guineaworm infections probably underestimate the true incidence to some extent since in a certain proportion of cases the infection may only be discovered when calcified worms are revealed by X-ray examination (Reddy et al., 1968, 1969). There has been no opportunity to investigate this aspect.

Monthly incidence of guineaworm

To determine the seasonal pattern of infection the monthly incidence may be based on either the total number of cases recorded during the month or the total number of new cases, i.e., reported for the first time that year and in a particular month. Neither method is entirely satisfactory since the former takes no account of infections of long duration that may already have been recorded on a previous visit, while by recording each case only once the effect of superinfection in a prolonged transmission season may be obscured. For the monthly incidence of infection in the 5 selected villages in 1969, 1970, and 1971 both sets of data are given in Table 4.

The 3 years during which this information was collected followed years of exceptionally heavy (152 cm), average (119 cm), and exceptionally light

Table 4. Monthly incidence of guineaworm infection in 5 selected villages for 1968/69–1970/71 [a]

Month of observation	1968–69		1969–70		1970–71	
	New cases [b] (%)	Total cases (%)	New cases [b] (%)	Total cases (%)	New cases [b] (%)	Total cases (%)
Nov.	no survey		no survey		0.8	0.8
Dec.	1.3	1.3	3.8	3.8	1.1	1.2
Jan.	1.9	2.3	6.1	7.0	2.5	2.6
Feb.	4.0	4.8	5.9	8.3	3.7	4.7
March	2.5	3.0	3.9	5.6	2.6	4.4
April	5.6	6.9	2.0	4.1	3.0	4.8
May	3.0	7.6	2.4	4.8	3.3	6.8
June	1.4	3.5	no survey		1.5	6.1
July	1.7	2.4	1.3	3.4	2.6	6.8
Aug.	1.2	2.1	0.5	1.1	1.0	4.1
Sept.	0.6 [c]	2.1 [c]	0.3	2.4	0.6	2.3

[a] Total population at risk: 1 100 (1970 census).
[b] Reported as infected for the first time during the year in question in the month indicated.
[c] Two villages not visited; incidence rates adjusted accordingly.

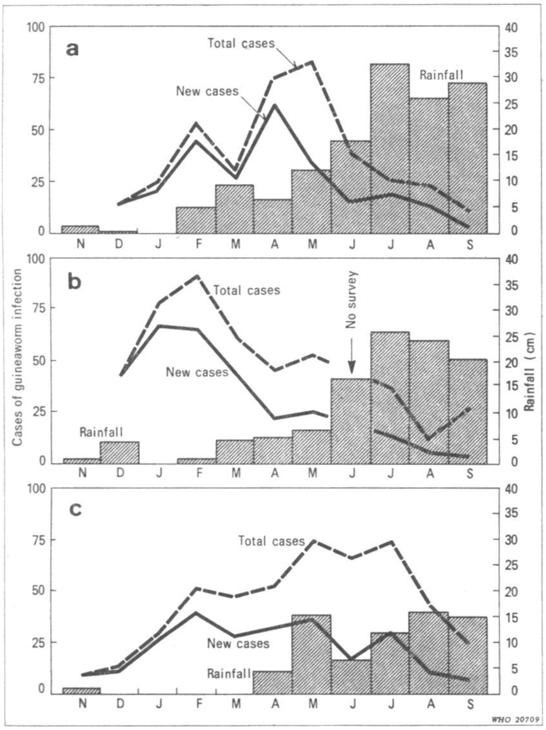

Fig. 1. Monthly variation in the total number of cases and the number of new cases of guineaworm infection in 5 localities of the Ghana-5 project area plotted against the rainfall in the previous year. *a,* Rainfall of 1967–68, cases of 1968–69; *b,* rainfall of 1968–69, cases of 1969–70; *c,* rainfall of 1969–70, cases of 1970–71.

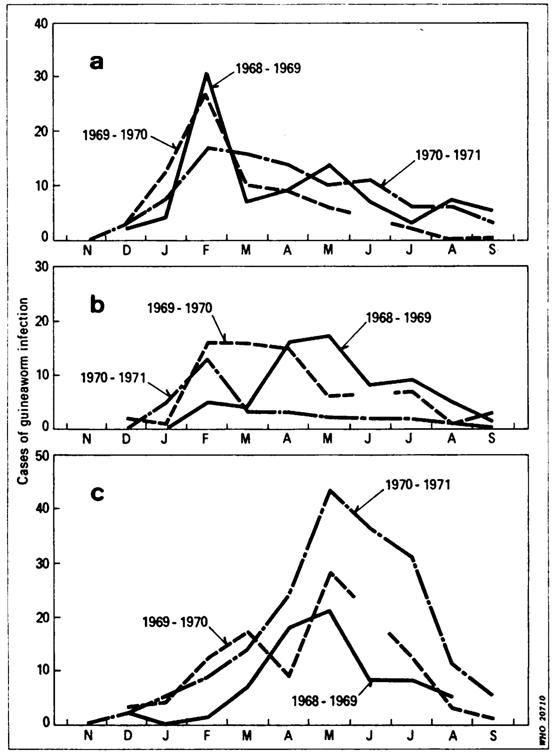

Fig. 2. Total numbers of cases of guineaworm infection in Gbegru (*a*), Tambale (*b*), and Gonggo (*c*) in 1968–69, 1969–70, and 1970–71, by month of survey. Note: no survey was made in June 1970.

(76 cm) rainfall. In Fig. 1 the monthly variations in the total number of cases and in the number of new cases have been plotted against rainfall in the previous year, and it can be seen that there was a marked difference in the shape of the curve from one year to another. Some of the factors involved in producing these differences can be appreciated by considering three of the villages individually (total number of cases only).

Gbegru (Fig. 2a). The confirmed source of infection is a deep pond that is dug out at the end of each dry season to increase its capacity during the following rainy season. It is the classical guineaworm transmission site. This pond is small in extent but deep enough to contain water for several months during the dry season; access is restricted since one side is steeply banked, and the bottom shelves gradually so it is necessary to wade into the water in order to fill water pots. The pond is the source of water for the entire village until it dries up; the women then use dug wells that fill by seepage and are free from cyclops. The cases of guineaworm in Gbegru contribute annually to the February peak of incidence.

Tambale (Fig. 2b). The dry season source of drinking water is a chain of small pools. High infection rates do not occur—partly, no doubt, because there is no great concentration of population at any one of the pools, but mainly because the pools normally begin to dry out in February or March, and water is then drawn from holes dug in the stream bed. Transmission was interrupted unusually early, therefore, in the dry season of 1969–70.

Gonggo (Fig. 2c). In the dry season water is taken from four pools in one of the larger seasonal rivers. Two pools are permanent and reduce in size only gradually. The long dry season of 1969–70 particularly favoured the increase of transmission in these habitats, and the high total incidence of cases in May 1971 (Fig. 1c), as well as the divergence of the curves for the total number of cases and the number of new cases, was due to the large number of reinfections in Gonggo at that time. At this point a sharp increase in the number of multiple infections was also apparent, an average of 2.3 worms per case being found. To a lesser extent Gonggo was responsible for the April–May peaks in the two previous years (an infected cyclops was found in one of the pools in May 1969).

Monthly variation in the number of guineaworm lesions per case

Based on the total cases seen each month (December 1969 to September 1970), the mean number of lesions per case varied from a maximum of 1.69 in December to a minimum of 1.17 in the following August. A " lesion ", for this purpose, was taken to be a guineaworm ulcer, whether or not the remains of the worm were still visible. There was no clear association between the incidence of infection and the number of lesions until the onset of the rains; then, a diminishing number of lesions per case tended to go in step with a diminishing incidence of new cases.

Monthly variation in " prostration "

Table 5 shows the number and percentage of prostrated cases seen in each month of 1970, together with the mean number of lesions per prostrated case. It can be seen that the maximum degree of incapacitation was registered late in the dry season and early in the following rainy season. A comparison of prostrated and ambulant cases showed that the former had a slightly higher average number of lesions in most months, a maximum of 3.1 lesions per prostrated case being recorded in December. It was clear, however, that it was the site at which the worms emerged, rather than their numbers, that determined the degree of disability.

Disabled persons in every case presented with at least 1 worm on some part of the legs; other patients with multiple lesions were often not seriously inconvenienced by them. The explanation for the marked increase in prostrated cases at the end of the dry season of 1970 lies in the definition of a prostrated case. The " normal social functions " at that time of the year include spending a considerable part of the day sowing and preparing the ground for the new crops. Patients with guineaworm infections who were able to carry on with their usual domestic duties but were unfitted for work in the fields were classed as " prostrated ". The highest number of worms encountered in a patient at any one time was 7; 2 patients (one of them ambulant) presented with 6.

Table 5. Monthly variation in number of prostrated cases and in the mean number of lesions per prostrated case, 1970

Month of observation (1969–70)	Total no. of cases	Total no. of prostrated cases (percentage in parentheses)	Mean no. of lesions per prostrated case
Dec.	42	8 (19.0)	3.1
Jan.	77	11 (14.3)	1.6
Feb.	91	15 (16.5)	2.1
March	62	23 (37.1)	1.7
April	45	19 (42.2)	1.4
May	53	24 (45.3)	1.6
June		no survey	
July	37	15 (40.5)	1.3
Aug.	12	2 (16.7)	1.0
Sept.	26	0	—

Although all the villages were within 32 km of a hospital none of the patients had sought, or been taken for, medical treatment. The ulcers invariably healed and in no case were crippling sequelae noted.

Duration of the individual guineaworm lesions

The duration of the 591 lesions recorded in 1970 was assessed by the number of consecutive monthly visits at which the same lesion was observed. A small error is probably involved in these figures since newly emerging worms may occasionally have been confused with lesions previously present at the same site; however, they are probably accurate enough to indicate the usual situation, which may be summarized as follows: 550 (93.1 %) lesions were present at the time of a single visit; 33 (5.6%) were still present 1 month later; 7 (1.2%) were recorded in 3, and 1 (0.2%) in 4, consecutive months.

Disability of the cases in terms of the number of monthly visits on which they were recorded as (1) infected and (2) prostrated during 1970

Although only 7% of lesions were observed at more than 1 visit, superinfection and the emergence of worms in sequence sometimes resulted in prolonged periods of disability. Altogether, 62% of all patients were regarded as healed when they were seen 1 month later and did not again produce guineaworm lesions that year; 26% of patients were found to be infected on 2, and 10% on 3 occasions; a few patients were classed as being infected 4 or 5 times during the year.

Among the prostrated cases, 86% were classed as such on only 1 occasion, being regarded as either ambulant or healed thereafter; 13% were recorded as prostrated on 2 occasions, and a single case was prostrated on 3 of the monthly visits.

Anatomical distribution of the worms

The sites of emergence of the worms corresponded to those recorded in other surveys made elsewhere; 92% were on the lower limbs.

Reinfection

It is generally acknowledged that some persons are more liable to recurrent attacks of guineaworm infection than others. This was confirmed in the present study; only 24 (5.5%) of the 433 persons who had no previous history of guineaworm infection became infected during 1970, while 263 (39.4%) of the 667 who had previously been infected developed reinfections in that year. Since 41% of those with no previous history belonged to the youngest age group, and were therefore less likely to have been infected in any case, the figures were recalculated to exclude children aged 0–4 years. This adjustment made no appreciable difference, the rate for 1970 among those with no previous history of infection becoming 6.6% and the rate for those reinfected in 1970 becoming 39.7%. These figures did not appear to be the result of variable exposure to infection since they held true even where all the inhabitants obtain water from a known transmission site during the dry season.

PRACTICAL PROCEDURES

In 1969 and 1970 all known sources of drinking water were sampled on each monthly visit to the villages selected for detailed study, the object being to identify sources involved in the transmission of guineaworm. An approximate estimate of the density of cyclops was obtained and an attempt was also made to determine the monthly variation in the rates of infection of cyclops with guineaworm larvae.

The density of cyclops was estimated by filtering 20 litres of water through cotton of approximately 350 μm mesh. The water was obtained by immersing a calibrated bucket in water at places then being used by the local women. Onabamiro (1951) has pointed out the sources of error involved in this method when absolute values for density are required, but it was regarded as sufficiently accurate for our purposes; this method also has the advantage of being the same as that by which water pots are usually filled in this area.

To determine infectivity rates 100 litres of water were strained through cotton. In 1969, the copepods were then sedimented with a few ml of formol-saline, transferred to a glass slide, and examined. In 1970, at the suggestion of Muller (personal communication), the stimulating effect of hydrochloric acid on the infective larvae, originally observed by Leiper (1906), was utilized. The cyclops were killed by exposure to 0.05% hydrochloric acid; any guineaworm larvae in the cyclops became more active and hence easier to see. When the cyclops were sufficiently numerous a minimum of 200 were examined from each habitat every month. Infection rates were based on mature cyclops (all species); unfortunately the species to which infected specimens belonged could not be determined.

IDENTIFICATION OF TRANSMISSION SITES

Of the 21 sources of drinking water that were in use at various times in the 5 villages, 17 were pools or streams, two were shallow wells, and 2 were man-made ponds. Infected cyclops were obtained at some time from 4 of the pools and both of the ponds; neither of the shallow wells was found to be infected at any time. In 2 of the villages no transmission site could be identified.

MONTHLY VARIATION IN DENSITY OF CYCLOPS

It is not possible to express the fluctuations in the relative density of cyclops in terms of the combined habitats since several that were sampled in some months were dry or not in use, and therefore not sampled, in other months. The response of the different habitats to the advance of the dry season varied greatly; some were already dry by December in 1969 and remained so for up to 5 months. Other

Table 6. Infection rates and relative density of cyclops (all species) in 6 confirmed guineaworm transmission sites on the date on which transmission was confirmed, and estimated number of potentially infective cyclops per litre of water

Date	Infection rates in cyclops (all species)			Relative density of cyclops (all species) per litre of water	Infective cyclops per litre of water
	No. examined	No. infected	%		
17 June 1969	213	1 [a]	0.5	15.0	—
18 Aug. 1970	73	1	1.4	1.2	0.02
10 May 1969	213	4	1.9	104.6	2.0
9 April 1969	419	4	1.0	18.5	0.2
5 Sept. 1969	3	1	(33.3)	0.9	0.3
16 May 1969	80	1	1.3	0.3	<0.01

[a] Non-infective larva.

habitats contained some water throughout the period of study and showed a steady rise in the population density of cyclops as the dry season progressed and the volume of water diminished. In some large pools, however, despite the fact that some water was present during several months in the dry season, no demonstrable increase in the density of cyclops occurred. A sharp reduction in the density was usually recorded after the heavy rains in August and September.

INFECTION RATES IN CYCLOPS

Of the many thousands of cyclops that were examined only 12 were found to contain guineaworm larvae, and the larva in one case was non-infective; camallanid larvae were recorded twice. Only 1 guineaworm larva was present in each infected cyclops. Table 6 shows the date on which each of the 6 infected habitats was found to be infected, the infection rate among the cyclops examined, the relative density of cyclops at the time, and the number of potentially infective cyclops per litre of water.

In view of the low infection rates recorded (except in September 1969) it is highly probable that other infected habitats escaped detection and that those that could be incriminated must have been infected over a longer period than is suggested by Table 6. Consequently, it was not possible, as had been hoped, to establish any relationship between the curve for infection in the vector and the subsequent appearance of new cases in man.

The infection rates obtained for the 6 confirmed transmission sites may be compared with the figure given by Onabamiro (1951) for part of a pond in south-western Nigeria at the height of the dry season; Onabamiro estimated that there was an average of 9.5 guineaworm larvae in every 5 litres of water. In the present study this figure was approximated only in one habitat in May 1969. At the time of year when the Nigerian results were obtained, i.e., April, over 80% of the 900 or so villagers showed clinical evidence of guineaworm infection. Infection rates of this magnitude are unknown in the Ghana-5 project area, the highest recorded in any one of the 5 selected villages being 19.4% of 134 inhabitants, in December 1969.

DISCUSSION

The 43 villages included in the survey of 1967–68 were considered to be representative of rural north-western Ghana as a whole. In 35 villages the annual incidence of guineaworm was less than 10% and in 13 villages was less than 1%. Considering that these incidence rates are based on cases with a history of guineaworm during the year prior to the survey, in addition to active infections, guineaworm can hardly be ranked as a major public health problem in the area.

Even in the 5 villages that were chosen for special study because of their relatively high incidence of guineaworm infection, and in which 71% of the inhabitants have suffered from an infection by the age of 14 years, transmission was shown to be unstable and greatly influenced by the annual variations in rainfall. The usual picture is of an outbreak of short duration with few multiple infections. However, in a village relying entirely on large riverine pools for its water supply, a long, uninterrupted dry season permits superinfection to occur, with a late increase in both the total number of cases and the number of multiple infections.

Small pools and ponds are the sites most likely to be implicated in transmission but they generally do not persist far into the dry season. The alternative water sources that are then commonly used are dug wells, which fill by seepage, and permanent pools, which are often a considerable distance from the village. Cyclops have not been found in the wells and although transmission is possible in the permanent pools it requires time to develop and the nature of the habitat would in any case not favour intense infection; these pools usually remain in use only a short time before the first rains of the season allow the villagers to return to their main sources of water. In short, the scarcity of water in this area, which to some extent exposes the inhabitants to infection with guineaworm, also affords them some protection since their contact with the sources of infection is necessarily brief.

In some cases distant dams and boreholes are the alternative sources of water late in the dry season. When used exclusively, the former reduce, and the latter remove, the possibility of guineaworm infection occurring, but since they are often used only when other sources have failed the users may already have been exposed to infection. This is considered to be the reason why 3.4% of those who were recorded as obtaining water from boreholes and/or deep wells were found to be infected. In the neighbouring territory of Upper Volta, Lamontellerie (1968) attributed the continuing incidence of guineaworm infection in people using wells to (1) faulty construction of the wells, specifically to the absence, or insufficient height, of the surrounding parapets, which allowed the wells to become flooded by surface water during the rains, and (2) inadequate protection of the area surrounding wells, with the result that the water containers became contaminated with first-stage larvae when they were placed on the ground, the larvae then being transferred to the well when the containers were immersed in the water. As far as the Ghana-5 project area is concerned these factors did not seem to operate, since the construction of the wells was generally adequate.

The multiplicity of water sources and the discontinuous nature of guineaworm transmission in the area surveyed account for several of the findings, including the difficulty of finding infected cyclops and the low infective density of cyclops per litre of water, the generally small number of worms per case, and, above all, the markedly lower rates of incidence than are encountered in areas where transmission is more prolonged or intense.

Although the scope of the practical procedures used in this study was limited by the scarcity of infected cyclops they nevertheless served a useful purpose in identifying some of the sites of guineaworm transmission and at the same time provided detailed information about local habits of water use and the cyclops habitats in use at any given time. With this information and the data from the monthly case-finding visits, it was usually possible to reconstruct the circumstances under which infections had occurred, the only assumption necessary being that the incubation period of the disease is approximately 1 year; in general, the observations in the individual localities have been consistent with this assumption.

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RÉSUMÉ

INFECTION PAR LE VER DE GUINÉE DANS LE DISTRICT DE WA (NORD-OUEST DU GHANA)

Dans le cadre d'un projet pilote de lutte contre la schistosomiase, on a recueilli en 1967-68 des données sur l'infection par le ver de Guinée dans une région rurale du nord-ouest du Ghana. L'enquête, portant sur 8300 personnes, a révélé une incidence globale annuelle de 5,7%; cependant, dans quelques foyers isolés, la fréquence de la maladie était très élevée.

Des investigations intensives menées en 1968-71 dans cinq villages particulièrement touchés ont montré que près de la moitié de la population avait contracté l'infection dès l'âge de 9 ans et que certains sujets étaient particulièrement exposés au risque de réinfection. D'après les chiffres de 1970, le nombre moyen de vers en voie d'expulsion variait de 1,69 à 1,17 par cas; 93% des lésions n'étaient présentes qu'au cours d'une des visites mensuelles; 62% des 287 cas découverts n'étaient atteints d'une ou plusieurs lésions que pendant un mois seulement de l'année. Aucune des 591 lésions recensées n'avait entraîné d'invalidité permanente. Par contre, les incapacités temporaires étaient fréquentes, 40-45% des cas étant classés comme inaptes au travail vers la fin de la saison sèche; le degré d'incapacité était plutôt fonction du siège des lésions que de leur nombre.

L'incidence de la dracunculose était maximale durant la saison sèche. L'époque, la durée et l'intensité de la transmission différaient fortement selon les villages et selon les années, et dépendaient de la nature des sources locales d'approvisionnement en eau de boisson, de leur diversité éventuelle et des fluctuations de la pluviosité. La répartition très inégale de la maladie, la variabilité des taux d'infection dans les foyers d'endémie et la rareté des infections secondaires (dont témoigne, dans quelques localités, l'incidence relativement élevée des infections bénignes de courte durée) plaident en faveur d'une transmission discontinue résultant du caractère non permanent de la plupart des sources d'approvisionnement en eau.

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