Diagnosis, transmission and immunology of human Oesophagostomum bifurcum and hookworm infections in Togo

Pit, D.S.S.

Chapter 2

Geographical distribution and epidemiology of *Oesophagostomum bifurcum* and hookworm infections in humans in Togo

Djemila S.S. Pit, Fleur E.M. Rijcken, Esther C. Raspoort, Sename M. Baeta and Anton M. Polderman

Reproduced with permission from:
the American Journal of Tropical Medicine & Hygiene
(1999), 61 (6), 951-955

SUMMARY

In contrast to the rest of the world, infections with *O. bifurcum* are commonly found in humans in northern Togo and Ghana. In addition, infections with hookworm are very endemic in this region. In the present paper, a detailed map of the geographic distribution of *O. bifurcum* and hookworm infections in northern Togo is made. There are a number of foci with high prevalence of infection with *O. bifurcum*. All the villages examined were infected with hookworm, and the distribution was quite patchy.

Women were more often infected with *O. bifurcum* than men, while infections with hookworm were more prevalent in men than in women. The prevalence and intensity of infection with both parasites were clearly age dependent.

We estimate that more than a 100 000 people are infected with *O. bifurcum* and more than 230 000 with hookworm.

INTRODUCTION

Oesophagostomum bifurcum is known as a common intestinal nematode of monkeys; until 1986, infections in humans were considered as rare zoonosis. In northern Togo and Ghana, however, *O. bifurcum* infections are known to be more than incidental infections among the population(Polderman et al., 1991). Pathology of *O. bifurcum* infections is caused by the encapsulation of the larvae in the intestinal wall; here the larvae develop in young adult worms before re-entering the intestinal lumen to start egg production. Outside the host, in a moist environment, these eggs develop in third stage larvae, which have to be ingested by a new host. It is not surprising that the highest prevalences of infection are measured during and shortly after the rainy season. Transmission is oral, but which behavior promotes transmission is little understood. Preliminary data, based on rather haphazard, non-random, surveys in northern Togo and Ghana, estimated that 30% of the population was infected with *O. bifurcum*, and in some villages prevalences over 50% were found (Krepel et al., 1992). The parasite's distribution seems very focal, being abundant in this region and almost absent elsewhere. Even in Togo itself, clinical cases, frequently seen in Dapaong, are never seen further to the south. In the same region, hookworm infections, for 99% caused by *Necator americanus* (Blotkamp, personal communication) are highly endemic. To achieve a better understanding of the distribution and possibly its underlying causes, the present paper aimed at creating a detailed map of the geographic distribution of *O. bifurcum* and hookworm infections in northern Togo (Figure 1). Furthermore, the gender and age-dependent prevalence and intensities of infections with *O. bifurcum* and hookworm are reported such that more insight in the way of transmission (i.e. oral versus percutaneous) and the reason for this confined distribution of the parasite might be obtained. The investigation constitutes a surveillance baseline for *O. bifurcum* and hookworm

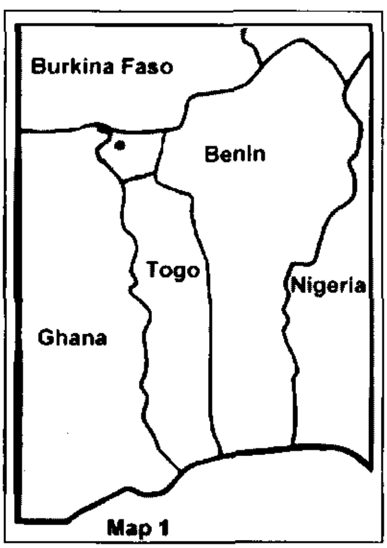

Fig 1.Sketch map of the research area in Togo (West Africa).

infections in the area, which is relevant to the design of control.

MATERIAL AND METHODS

Study area.

To avoid the influence of seasonal fluctuations of prevalence and intensity of infection, the survey was conducted in a short period, between August and November 1997 in northern Togo, an area of approximately 4220 km^2, with Dapaong as the main town. The area is subsahelian, consisting of open Savannah land, that is dry and rocky with a few trees. In the villages, the houses are scattered over the farmlands. The population of 336 000 inhabitants is mainly from the ethnical groups Moba and Gourma, and the Peuhl nomads (Addra, 1992). The research area was limited by the latitude 10°27' (N, S) to the south and by the country borders (Ghana to the west, Burkina Faso to the north, and Benin to the east). In order to achieve a geographically homogenous distribution of the villages over northern Togo, the area was divided in squares of 18x19 km. In each of these squares, 4 villages were selected. Per village, eighty individuals, from 20 different households, were invited to participate in the survey, after having been duly in-

formed. From each household a man and a woman between 20 and 60 years, and a boy and a girl between 5 and 19 years were asked to give their name, age and sex. A similar procedure was applied in a parallel study in Ghana, to enable comparison of the observations in countries (Dery & Yelifari, in preparation).
Per village, 10 infants (0-4 years) were also added to the survey.

Stool collection and parasitological diagnosis.

Individually labeled plastic containers for stool collection were distributed and collected the next day. The eggs of *O. bifurcum* are identical to those of hookworm. Only the third stage larvae of both parasites, obtained by coproculture, have distinguishable morphological features (Blotkamp et al., 1993). Therefore, a modified coproculture was made of 2 grams of stool per individual, as described elsewhere(Polderman et al, 1991). Larvae were identified by species and individually counted to a maximum of 100 per coproculture. The intensity of infection was quantified by classification of the larval counts as proposed earlier (Krepel et al., 1995).

Statistical methods.

Dapaong, as the main town of the area, was considered separately from the rest of the data obtained from individuals living in the rural area. The data collected from the infants were also considered separately. Prevalences of infection are given as the percentage parasitologically positive individuals in the population examined. Individuals were grouped into 7 age-categories of 5 years interval in the children, and 10 years interval in the adults. Differences in prevalences between gender and age-classes were analyzed by Chi-square tests. Differences in intensity of infection between gender and age-classes were analyzed by Mann-Whitney and Kruskal-Wallis non-parametric methods. Association between *O. bifurcum* and hookworm on a village - and individual level were measured by Pearson's correlation coefficient (r) and Kendall's rank correlation (τ), respectively.

RESULTS

In total 65 villages were examined in this survey, readable cultures were available from 75% of the distributed tubes, and stools were obtained from 3659 individuals. The research was done towards the end of the rainy season and people were working in the field, therefore some failed to return their tubes.

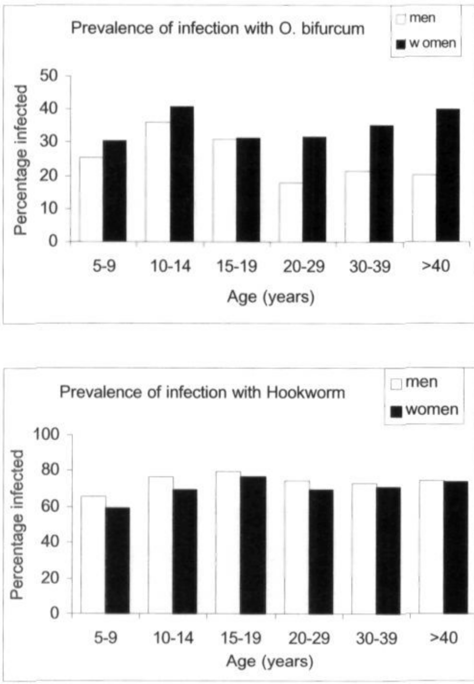

Fig. 2: Age-dependent prevalence of infection with O. bifurcum (a) and hookworm (b) in men (n= 1896) and women (n= 1763).

Over the whole region 29.5% of the population was infected with *O. bifurcum* and 70.3% with hookworm. This is likely to be an underestimation of the true prevalence, since very light infections are easily missed with a single coproculture (Pit and others, unpublished data). In Dapaong, the main town of the northern region, 266 individuals from different areas of the town participated in the survey, 12% was infected with *O. bifurcum* and 49% with hookworm.

Gender and age related prevalences and intensities of infection.

Overall, significantly more women were infected with *O. bifurcum* than men (34% vs. 25%; χ^2= 40.4, $p<0.0001$) (Figure 2a), but the difference was only significant in adults (older than 20 years; χ^2= 12.5, $p<0.0001$). Infection with hookworm, on the other hand, was significantly more prevalent among males than females (73% vs. 68%; χ^2= 35.4, $p<0.0001$) when the total population was considered. But when the population was grouped by age such difference was only significant in children from 5 to 9 years (χ^2= 4.5, $p<0.05$) (figure 2b).

Prevalence and intensity of infection with *O. bifurcum* and hookworm were clearly age-dependent. Prevalence of infection with *O. bifurcum* rose steeply until the age of 14 reaching a maximum of 43%, then prevalence and intensity of infection decreased slightly and maintained a plateau throughout adulthood (figure 3a). Prevalence of infection with hookworm reached its maximum of 80% infected in the 15 to 19 years old, and stabilized around 71% in adults (figure 3b). Heavy infections (more than 30 larvae per coprocul-

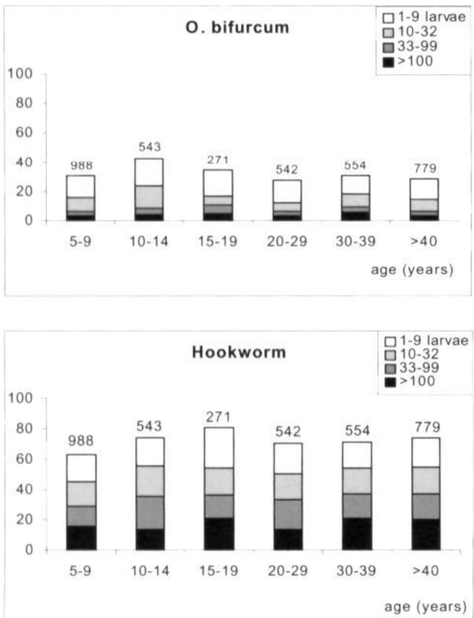

Fig. 3: Prevalence and intensity of infection with O. bifurcum (a) and hookworm (b), in different age classes, measured by coproculture larval count. Figures indicate the number of people examined.

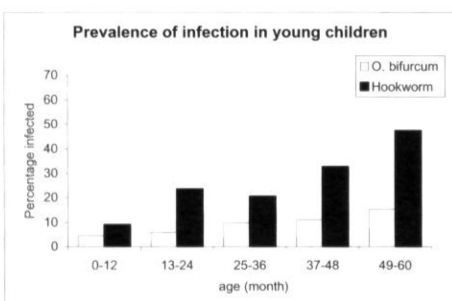

Fig. 4: Age dependent prevalence of infection with O. bifurcum and hookworm in children younger than 4 years old (n= 434)

ture), were also most frequently seen in this age group.

Thirty percent of the young children (0-4 years) was already infected with hookworm. Figure 4 shows the rapid increase of the prevalence of infection with hookworm in these children; almost 10% of the infants younger than 1 year were already infected, and half of the 5 years old were infected with hookworm. Prevalence of infection with *O. bifurcum* increased less dramatically in infants, but nonetheless infection was prevalent in more than 10% of 5 years old children.

Geographical distribution of O. bifurcum and hookworm.

Figure 5 represents the geographical distribution of the villages where *O. bifurcum* is prevalent. There are a number of foci with high prevalence of infection with *O. bifurcum*. The highest prevalence of infection of 78% was measured in Dassoute, close to the Ghanaian border. In northern Ghana, a highly endemic area is found next to the highly endemic area in Togo (Dery & Yelifari, personal communication).

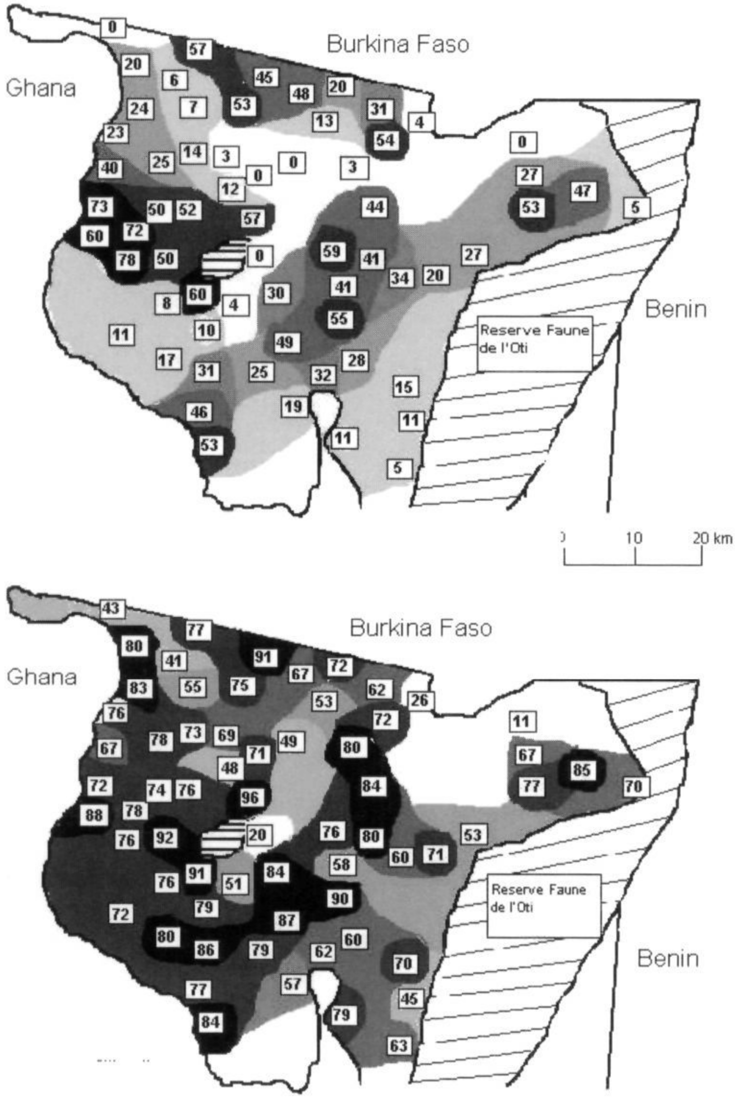

Fig 5 &6: Geographical distribution of O. bifurcum and hookworm in northern Togo. Each square represents a village indicating the prevalence of infection. The darkness of the color corresponds to the prevalence of infection.

There is clearly a band of lowly endemic villages from the northeast toward the northwest. Three additional villages (Kougniéré, Magnan and Payouka) just south of the research region (70 km south of Dapaong) have been examined as well. *O. bifurcum* larvae were not found in the coprocultures, but 57% of the population examined (n= 190) was infected with hookworm.

Figure 6 represents the distribution of the villages where hookworm is prevalent. Every village examined in northern Togo was infected with hookworm: the lowest prevalence of infection (11%) was found in Koundjouaré close to the border with Benin, while the highest prevalence (96%) was measured in Batamboré, south of Dapaong. The distribution was quite patchy.

At the village level there was a significant correlation between the prevalence of infection with *O. bifurcum* and hookworm (Pearson Correlation coefficient: 0.569; $p<0.001$). Also within an infected village, there was a significant rank correlation between the larval counts of *O. bifurcum* and hookworm at the individual level (Kendall's rank correlation=0.324; $p< 0.001$)

DISCUSSION

Over the region as a whole, 29.5% of the population was infected with *O. bifurcum* and 70.3% with hookworm. Yet, these high prevalences of infection with *O. bifurcum* are not suggestive for recent transmission and a newly emerging parasitic infection. The prevalences appear remarkably stable when compared with the prevalences found in those villages where *O. bifurcum* infections were first recognized some 9 years ago (Table 1) (Krepel et al., 1992). Although plant anthelmintics and modern drugs are used, community based parasite control has never been attempted in the region and inadequate sanitation, poor hygiene and shoelessness are the factors responsible for the persistence of transmission of *O. bifurcum* and hookworm in the region.

The prevalence and intensity of infection with *O. bifurcum* and hookworm increased rapidly with age and remained at a plateau in teenage and adulthood. This pattern of prevalence is typical for intestinal nematode helminth parasites in communities with stable endemic infection (Elkins et al., 1986), and resembles those reported elsewhere for hookworm infections (Bradley et al., 1992; Palmer

& Bundy, 1995; Haswell-Elkins et al., 1987). Differences in prevalence and intensity of infection could be due to age-dependent transmission, acquired resistance or a combination of the two processes (Elkins et al., 1986). Unlike other helminth infections, there does not seem to be a correlation between worm load and pathology with *O. bifurcum*, but intensity of infection is a more precise parameter to quantify infection and transmission than prevalence of infection alone.

Table 1: Prevalence of infection found in 1988 (Krepel et al., 1991) and in 1997, in the same villages.

Village	O. bifurcum		Hookworm	
	1988	1997	1998	1997
Barkoissi	20	19	57	57
Borgou	36	27	73	53
Boumbouaka	9	4	69	51
Cinkassé	8	0	48	43
Dapaong	13	12	47	48
Dassoute	58	78	64	76
Nagbeni	50	28	83	60
Naki-Est	60	41	65	58
Naki-Ouest	15	25	77	78
Namoudjoga	12	3	65	80
Nanergou	3	14	44	73
Nano	17	8	67	76
Timbou	11	6	39	41
Yembour	17	46	57	77

The geographical distribution of *O. bifurcum* and hookworm infections in northern Togo is not entirely random but seems confined to a number of high transmission foci. Since *O. bifurcum* infections were not found in the villages south of 10°27' (N,S), *O. bifurcum* seems to be really confined to the northern region of Togo and neighboring Ghana. Southern Burkina Faso and northern Benin have not been examined yet. Undoubtedly, factors such as soil characteristics, altitude dependent microecology, and subtle variations in host behavior contribute to the geographical distribution of both parasites, but clear associations between these variables and infection are not recognized as yet. Despite different transmission modes of *O. bifurcum* and hookworm, (oral versus percutaneous), there is a correlation between the prevalences and intensities of infection with both species, not only at the individual but also at the village level. The latter association would suggest that environmental factors that determine survival of the free living larval stages of both species may play a role in addition to behavioral and hygienic factors. Preliminary attempts to correlate the patchy distribution of both nematodes with differences in geological, vegetational and climatological characteristics of the area (based on detailed maps (Addra, 1992)) were unsuccessful. Further and more refined studies are required to understand the focality of the distribution.

The rural population of northern Togo is estimated at 336 000 inhabitants (Addra, 1992). Taking the age distribution and the age-specific differences in prevalence into account, it can be estimated that 101 000 people are infected with *O. bifurcum* and 237 000 are infected with hookworm. Although prevalence data should not readily be used to assess the dimensions of a public health problem, the abundance of this little known parasitic nematode in combination with its occasional severe pathology it causes indicates that *O. bifurcum* is a locally common and important parasite in northern Togo. There is an urgent need to extend the distribution studies to the neighboring regions and more clinical and epidemiological information is needed to assess its public health importance and the priority for prevention and control.

Acknowledgment:

We wish to thank Mrs. Assibi Kankpé, Mr. Etienne Yark, Mrs. Corine Visser and Mrs. Anika Dam for their valuable assistance in the organization of the fieldwork and collection of some of the data. The statistical advises of Dr Saskia le Cessie are gratefully acknowledged. The survey Togo was supported by the Ministry of Health in Lomé and Dapaong. Financial support: This research is funded by the Netherlands Organization for Scientific Research in the Tropics (NWO/WOTRO).

REFERENCES

Addra TC, 1992. Atlas de Developpement Regional du Togo. Direction Générale du plan et du développement. *Direction de la Car-*

tographie National et du Cadastre.

Blotkamp J, Krepel HP, Kumar V, Baeta S, van't Noordende JM, Polderman AM, 1993. Observations on the morphology of adults and larval stages of *Oesophagostomum sp.* isolated from man in northern Togo and Ghana. *J Helminthology 67: 49-61.*

Bradley M, Chandiwana SK, Bundy DAP, Medley GF 1992. The epidemiology and population biology of *Necator americanus* infection in a rural community in Zimbabwe. *Trans R Soc Trop Med Hyg 86, 73-76.*

Elkins DB, Haswell-Elkins M, Anderson RM, 1986. The epidemiology and control of intestinal helminths in the Pulicat Lake region of Southern India. I. Study design and pre- and post- treatment observations on *Ascaris lumbricoides* infection. *Trans R Soc Trop Med Hyg 80, 774-792.*

Haswell-Elkins MR, Elkins DB, Anderson RM 1987. Evidence for predisposition in humans to infection with Ascaris, hookworm, Enterobius and Trichuris in a South Indian fishing community. *Parasitology, 95, 323-337.*

Krepel HP, Baeta SM, Polderman AM, 1992. Human Oesophagostomum infection in northern Togo and Ghana: epidemiological aspects. *Ann Trop Med Para 86:289-300.*

Krepel HP, van der Velde EA, Baeta SM, Polderman AM, 1995. Quantitative interpretation of coprocultures in a population infected with *Oesophagostomum bifurcum.* Trop & Geo Med 47, 4, 157-159.

Palmer DR, Bundy DAP, 1995. Epidemiology of human hookworm and *Ascaris lumbricoides* infestations in rural gambia. *East African Med J 72, 8, 527-530.*

Polderman AM, Krepel HP, Baeta SM, Blotkamp J, Gigase P, 1991. Oesophagostomiasis, a common infection of man in Northern Togo and Ghana. *Am J Trop Med Hyg 44: 336-344.*