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Intestinal parasitic infections of men in four regions of rural Kenya

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Summary

Faecal samples were obtained from 906 men living in four different regions of rural Kenya: the cool Highlands, the humid coastal lowlands, the equatorial Lake Victoria basin and the arid marginal highlands. The prevalence of intestinal parasitic infections is reported and compared, contrasted and discussed in terms of the typical environmental conditions in each region. Almost 70% of men appeared to be infected with intestinal helminths; hookworm was most common. The regional prevalence of hookworm infections appeared to be related to relative humidity.

Introduction

In 1974 the Government of Kenya began a national programme of labour-intensive road construction (Rural Access Roads Programme) designed to improve access to resources. As an extension of a pilot study (BROOKS *et al.*, 1979), the relationship between the health and productivity of roadworkers (LATHAM *et al.*, 1981; WOLGEMUTH *et al.*, 1982) was investigated between 1978 and 1980. As a part of these investigations a survey of the health, nutritional status and parasitic infections of labourers employed at roadsites in four different parts of Kenya was carried out (LATHAM *et al.*, 1982). The results of the examination of faecal samples for evidence of parasitic infections is reported in more detail here, with particular reference to environmental factors which might influence the local prevalence of infection in each region.

'Kenya possesses one of the most complicated and diversified physical environments ... found in any country' (OJANY & OGENDO, 1973). This is due mainly to the wide range in altitude of the land and the presence of large bodies of water, such as the Indian Ocean and Lake Victoria, which influence rainfall. Five main natural regions have been recognized (Fig. 1), these are the Highlands, coastal lowlands, Lake Victoria basin, marginal highlands and the arid plateaux and lowlands (OJANY & OGENDO, 1973). Although the boundaries between regions are not particularly distinct and this classifica-

Table I—Some information about the location of roadsites, the predominant tribes as well as details about the climate of a representative town[b] in each of 4 natural regions of Kenya[c]

Natural region	Highlands	Coastal lowlands	Lake Victoria basin	Marginal highlands
Provincial location of roads	Central	Coast	Nyanza	Rift Valley
District location of roads	Nyeri Murang'a Kirinyaga	Kwale	Kisumu	West Pokot
Population density of districts (people/km^2)[a]	212	35	206	31
Predominant tribe	Kikuyu	Wadigo	Luo	Pokot
Ethnic group	Bantu	Bantu	Nilote	Nilo-Hamite
Information about a representative town in each natural region	Nairobi	Mombasa	Kisumu	none
Altitude (m)	1798	16	1146	800-1200
Mean max temp. (°C)	23·6	30·1	29·4	30·0
Mean min. temp. (°C)	11·6	23·4	17·1	20·0
Relative humidity at 3 p.m. (%)	52	66	47	45
Average annual rainfall (mm)	900	1200	1280	700-800
Principal rainy season(s)	April & November	May	All year	Sporadic

[a]Calculated from the National Atlas of Kenya (1970) and the 1979 population census (Nation, 1979).
[b]Figures given for the representative towns taken from Ojany & Ogendo (1973) except for the marginal highlands for which there is no representative town, so estimates from the available information have been made.
[c]See Fig. 1.

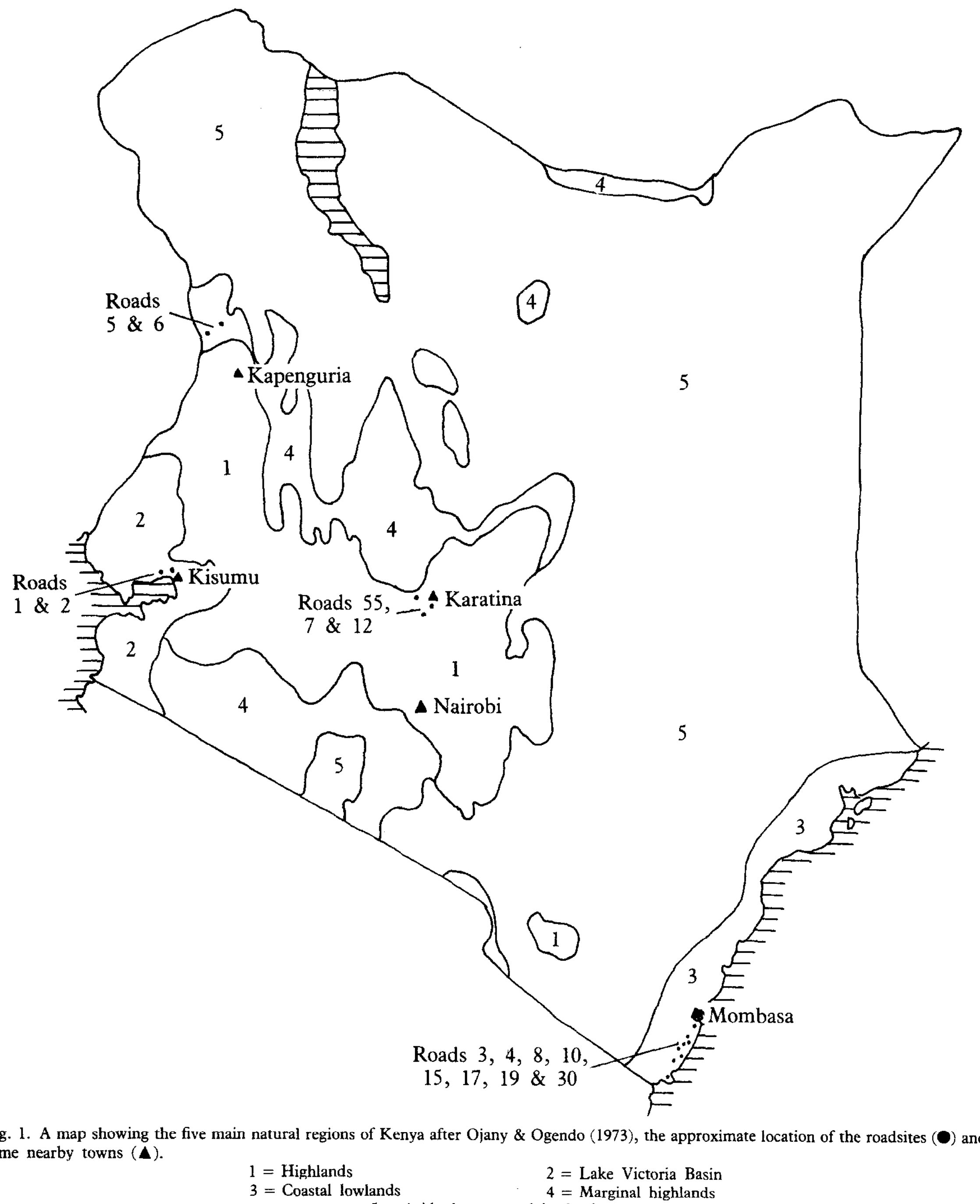

Fig. 1. A map showing the five main natural regions of Kenya after Ojany & Ogendo (1973), the approximate location of the roadsites (●) and some nearby towns (▲).

1 = Highlands 2 = Lake Victoria Basin
3 = Coastal lowlands 4 = Marginal highlands
5 = Arid plateaux and lowlands

tion is an oversimplification of a complex and diverse ecosystem, each region has certain characteristic geomorphological, climatic or demographic features (Table I).

The Highlands lie mostly above an altitude of 1500 m and have a subtropical climate which endows the region with some of the most fertile and densely populated land in Kenya. In contrast, the Coastal lowlands have a more characteristically tropical climate due to the equatorial heat and a high but seasonal rainfall. It is a relatively distinct natural region about 50 km wide along the coast, below an altitude of 250 m. The basin around Lake Victoria, which is situated in the west of Kenya about 1100 m above sea level, is of interest as the homeland of the Luo, the only Nilotic tribe in Kenya (SELIGMAN,

Table II—The estimated percentage prevalence of intestinal parasitic infections among roadworkers at 15 roadsites in 4 natural regions of Kenya, examined between February 1978 and February 1980

Natural Region		Highlands			Coastal lowlands								Lake Victoria basin		Marginal highlands	
Road number		55	7	12	3	8	10	4	15	17	19	30	1	2	5	6
Month/year men examined		2/78	5/78	5/78	6/78	6/78	6/78	2/79	3/79	2/79	2/79	2/79	6/79	6/79	2/80	2/80
Number of men		53	80	46	50	44	47	68	33	52	55	69	99	56	77	77
Hookworm	%	39·6	31·2	8·7	74·0	75·0	70·2	67·6	72·7	65·4	60·0	63·8	7·1	25·0	7·8	14·3
Trichuris trichiura	%	3·8	11·2	6·5	34·0	36·4	25·5	55·9	57·6	30·8	74·5	50·7	12·1	33·9	1·3	62·3
Ascaris lumbricoides	%	35·8	17·5	2·2	6·0	9·1	4·3	2·9	12·1	3·8	12·7	7·2	5·1	19·6	1·3	0
Schistosoma mansoni	%	3·8	1·2	8·7	0	0	0	2·9	0	7·7	0	0	62·6	32·1	0	0
Taenia spp.	%	5·7	0	2·2	0	0	0	0	0	0	0	0	13·1	21·4	15·6	6·5
Protozoan cysts	%	26·4	41·2	52·2	28·0	43·2	23·4	29·4	18·2	23·1	5·5	24·6	27·3	25·0	27·3	48·1
Strongyloides stercoralis	%	1·9	0	2·2	0	0	0	0	0	0	0	0	0	5·4	1·3	0
Fasciola spp.	%	0	0	0	0	0	0	0	0	0	0	0	1·0	3·6	0	0
Schistosoma spp.	%	0	0	0	0	4·5	2·1	0	3·0	0	0	0	0	0	0	0

1966). The marginal highlands region, which is divided by the Highlands into two main parts (Fig. 1), lie mostly below an altitude of 1200 m and has a low, irregular rainfall. It contains the semi-arid regions of Kenya which support much of the country's abundant wildlife in scattered-tree grasslands, and its inhabitants are mainly pastoral people such as the Masai and Pokot. The last natural region, the arid plateaux and lowlands, consists of a vast but largely uninhabited region of desert and semi-desert in the east and north of the country.

Rural Access roads are being constructed in many of the more densely populated parts of the first four natural regions described above. Daily paid roadworkers are recruited from the local population to build dirt roads into the countryside: these men were the subjects of this investigation.

Materials and Methods

Faecal samples were obtained between February 1978 and February 1980 from 906 roadworkers at 15 roadsites in the four natural regions of Kenya under study. The approximate locations of the roadsites is shown in Fig. 1. The subjects were not only inhabitants of four markedly different environments but were also, in each region, from a locally predominant tribe which represent three of the four principal ethnic groups of Kenyan Africans (Table 1).

Each man was provided with a sheet of thick paper and asked to provide a stool from which a sample weighing on average about 0·5 g was taken and fixed in a preweighed bottle containing PVA/Schaudinn's fluid (BROWN, 1975) for subsequent quantitative examination, except for 53 samples collected at Road 55 which were only examined qualitatively. Each bottle was reweighed and the sample was processed using an ether sedimentation technique described by HALL (1981a) to concentrate any stages of parasites. This method involves the crude filtration of faeces through gauze and concentration by centrifugation followed by further centrifugation with diethyl ether. This process serves to separate parasite eggs, larvae or cysts from some of the fine faecal detritus. The stages of parasites were identified and the results expressed as eggs per gram of faeces (epg). A broad spectrum anthelmintic was given to each man, usually at the time faeces were collected, while specific anthelmintics were also given when feasible.

Results

The estimated prevalence of intestinal parasitic infections, including *Schistosoma mansoni*, is given for each roadsite in Table II and by natural region in Table III. The mean faecal egg counts for four helminth infections of roadworkers are given in Table IV.

Faecal samples were collected during two separate visits to different roadsites in the Coastal lowlands, in June 1978 (Roads 3, 8 and 10) and between February and March 1979 (Roads 4, 15, 17, 19 and 30). Although there is no striking difference in the prevalence of infection between the two visits there was a difference in the apparent intensity of infection; the mean hookworm egg count in 1978 was 460 ± 1160 epg while in the men examined in 1979 it was significantly lower at 198 ± 417 epg ($p<0·05$).

Table III—The percentage of Kenyan roadworkers showing evidence of parasitic infections by finding eggs, larvae or cysts in faeces, given for each of 4 natural regions and in total

	Highlands n = 179	Coastal lowlands n = 418	Lake Victoria basin n = 155	Marginal highlands n = 154	Total n = 906
Hookworm	27·9%	67·9%	13·5%	11·0%	41·1%
Trichuris trichiura	7·8%	46·4%	20·0%	31·8%	31·8%
Ascaris lumbricoides	19·0%	6·9%	10·3%	0·6%	8·8%
Schistosoma mansoni	3·9%	1·4%	51·6%	0	10·3%
Taenia spp.	2·2%	0	16·1%	11·0%[a]	5·1%
Protozoan cysts	39·7%	24·4%	26·5%	37·7%	30·0%
Strongyloides stercoralis	1·1%	0	1·9%	0·6%	0·7%
Fasciola spp.	0	0	1·9%	0	0·3%
Schistosoma spp[b]	0	1·0%	0	0	0·4%

[a]Using other diagnostic methods a total of 25 men were in fact found to be infected (see HALL *et al.*, 1981).
[b]Schistosome eggs with a terminal spine.

Table IV—The average and standard deviation ($\bar{x} \pm$ S.D.) of egg counts for 4 species of helminth detected in the faeces of roadworkers in 4 natural regions of Kenya

		Highlands	Coastal lowlands	Lake Victoria basin	Marginal highlands
Hookworm	$\bar{x} \pm$ S.D.	88 ± 125	292 ± 750	53 ± 79	25 ± 24
	n	29	276	21	17
Trichuris	$\bar{x} \pm$ S.D.	38 ± 28	202 ± 290	64 ± 71	99 ± 90
trichiura	n	11	188	31	49
Ascaris	$\bar{x} \pm$ S.D.	225 ± 497	361 ± 676	34 ± 39	—
lumbricoides	n	15	29	16	1
Schistosoma	$\bar{x} \pm$ S.D.	73 ± 63	20 ± 9	72 ± 115	—
mansoni	n	5	6	78	0

Table V—The percentage of Kenya roadworkers showing evidence in faeces of intestinal helminth infections (including *Schistosoma mansoni*) given for each of 4 natural regions and in total. Also shown are the number of infections/person

	Highlands n = 179	Coastal lowlands n = 418	Lake Victoria basin n = 155	Marginal highlands n = 154	Total n = 906
No infections	52·0%	16·5%	21·9%	52·6%	30·6%
1 infection	36·3%	47·1%	48·4%	38·3%	43·7%
2 infections	9·5%	33·0%	23·2%	9·1%	22·6%
3 infections	2·2%	3·3%	5·8%	0·0%	3·0%
4 infections	0	0	0·6%	0	0·1%
Infections/person	0·62	1·23	1·15	0·56	0·98

Of the 906 male roadworkers examined during this investigation in Kenya almost 70% were found to show evidence of infection with one or more intestinal helminths (Table V). However the number of men examined in the coastal lowlands, where infections were generally prevalent, comprised almost half the total sample size.

Discussion

All faecal samples were collected, preserved, processed and examined using the same technique by one person. This helps to provide a sound basis for comparing the intestinal parasites of men in each region of Kenya, as different methods of faecal processing may vary in the sensitivity and reliability with which they detect infections (RIJPSTRA, 1975). The ether sedimentation technique of faecal processing and examination has been shown, in a previously reported investigation conducted among roadworkers near the Kenyan coast, to be about 95% reliable in detecting infections, except at low egg concentrations (HALL, 1981a, b).

The intensity of an intestinal helminth infection may sometimes be indicated by the concentration of its eggs in faeces. In the present study there are strong associations between this estimate of intensity (Table

IV) and the local prevalence (Table III) of infections with *Trichuris trichiura* ($r = +0.96$, $p<0.05$) and hookworm ($r = +0.994$, $p<0.01$). However when individuals are considered there may be significant short term variations in egg counts. A study of the concentration of nematode eggs in faeces collected from 10 infected roadworkers in the coastal lowlands showed a wide range in egg counts between samples collected from the same stool and over a five-day period (HALL, 1981a).

The existence of a parasitic infection in a community depends on the sequential transmission of the organism through an ecosystem from host to host. Thus natural conditions in the environment outside the host must be favourable not only for the survival of all stages of the parasite but also for the intermediate hosts on which their development and transmission may depend (PAVLOVSKY, 1966). The regional prevalence of a parasitic infection may therefore be evidence of favourable or unfavourable conditions and factors which influence survival or transmission. For example *Schistosoma mansoni* was not found among the Pokot tribesmen in the Marginal highlands or among the indigenous roadworkers of the coastal lowlands; the infections in the coastal lowlands were detected in some immigrants from known foci of infection in the Highlands and Lake Victoria basin. The lack of infections probably reflects the absence of snails of the genus *Biomphalaria* at the coast (TEESDALE, 1962) and the lack of aquatic breeding sites in the semi-arid parts of the marginal highlands. Yet even within one natural region there may be differences in the prevalence of infections at roadsites relatively close together (Table II). For example the prevalence of *Trichuris trichiura* at Road 5 (1·3%) in the Marginal highlands is very different from that at Road 6 (62·3%) approximately 30 km away, where local conditions must provide a suitable microenvironment for transmission. Yet given that there may be differences in the point prevalence of an infection between roadsites, the parasite burdens of roadworkers in each natural region are significantly different in terms of species prevalence, mean egg counts and number of infections/person (Table III, IV & V). For some species of infection such differences may be associated with certain regional characteristics.

The hot and humid coastal lowlands appear to provide a highly suitable environment for the transmission of hookworm infections. There is a strong and significant correlation ($r = +0.999$, $p<0.01$) between the figures quoted in Table I for the daytime relative humidity of the representative town in each natural region and the local prevalence of hookworm infections (Table III). The regression line for these points would suggest that the survival of hookworm larvae depends on a relative humidity of greater than 40%. DIESFELD & HECKLAU (1978) have also reported a significant positive association between the local prevalence of hookworm infections reported by hospitals throughout Kenya and 'dampfdruck' (water vapour pressure). Temperature and rainfall are both significant determinants of relative humidity. Thus the apparently greater intensity of infection observed in June 1978 just after the principal rains in the coastal lowlands (Table 1), compared with the average egg count in samples collected in February and March 1979 before the rains, may be due to a rise in the rate of transmission and infection just before samples were collected. This indicates that hookworm burdens may show relatively short term fluctuations in size; no significant difference was observed for *Trichuris* egg counts. It also illustrates the limitations of the information generated by point prevalence surveys which reveal the situation at one particular time but provide little information about the dynamics of infections in individuals or communities.

Although the intestinal nematodes *Ascaris lumbricoides* and *T. trichiura* are both transmitted by the faeco-oral route there is no similarity between the prevalence of both infections in each region of Kenya. This may be due to some degree of acquired immunity to reinfection with *Ascaris* (THORSON, 1970) or it may be a result of differences in the relative ability of their eggs to survive in the environment. *Ascaris* infections were most prevalent in the cool Highlands whereas *Trichuris* was more common in roadworkers in the more tropical coastal lowlands, thus *Ascaris* eggs may not perhaps be so resistant as commonly thought. In an analysis of the results of faecal examinations conducted in hospitals throughout Kenya, DIESFELD & HECKLAU (1978) associated the local prevalence of *Ascaris* infections with high population densities; a similar strong, but not significant positive correlation ($r = +0.84$), is indicated by the present study (Tables I and III). The differences in the prevalence of *Ascaris* and *Trichuris* infections between regions could also be due to different standards of local sanitation and personal hygiene.

The regional prevalence of infection with *S. mansoni* in Kenya reflects the national distribution of the snail intermediate hosts, which may also be locally uneven. Infections were most common in the Lake Victoria basin at two roadsites situated relatively close to the lake shore. In addition, 13% of urine specimens collected from 154 of the same roadworkers were found to contain eggs of *S. haematobium* (HALL, 1981b). Although both infections are known to occur in this region, called by NELSON *et al.* (1962) the 'cradle' of African schistosome evolution, their distribution is patchy. *S. mansoni* occurs principally on the lake shore and islands, whereas *S. haematobium* is more commonly found on higher, better drained ground more inland (KINOTI, 1971b; MCCULLOUGH, 1972). The infections of *S. mansoni* detected among roadworkers in the Highlands occurred mainly among men at one roadsite who reported to have visited the nearby Mwea-Tebere irrigation scheme situated at a lower altitude, where *S. mansoni* is a common infection (HIGHTON, 1974).

The microscopical examination of faecal samples for the eggs of *Taenia* is not always a reliable means of diagnosis. Another investigation, which reports the results of the mass anthelmintic treatment of some of the same Pokot roadworkers (HALL *et al.*, 1981), indicated in fact that 25 men were infected with tapeworms, which was still lower than the expected number of infections. It is likely that most tapeworm infections were *T. saginata*. The relatively high prevalence of *Taenia* infections in the Lake Victoria basin may be explained by the fact that this region has the highest density of cattle in Kenya (National Atlas of Kenya, 1970). Dietary surveys in the other two natural regions of Kenya indicate that the roadworkers consume very little meat (ELLIOTT, 1980; WOLGEMUTH, 1981).

Only six men were found to pass eggs or larvae of *Strongyloides stercoralis* in their faeces. Other studies in Kenya have also reported low rates of infection ranging from 0·3% to 2·8% (DIESFELD, 1969; KINOTI, 1971a; RIJPSTRA, 1975; WIJERS *et al.*, 1972; KWAMINA DUNCAN, 1978). However REES *et al.* (1974) state that *S. stercoralis* is frequently found in Kenya in association with hookworm, especially in Nyanza (Lake Victoria basin) and near the coast.

The observation of the eggs of *Fasciola* spp. in three faecal samples collected in the Lake Victoria basin is thought to be the first report of this infection in man in Kenya, although the possibility that these were spurious and the presence of eggs was due to the men having eaten infected liver should not be overlooked. Three of the four men in the coastal lowlands in whose faeces a terminal spined schistosome egg was observed were found to be concurrently infected with *S. haematobium* (HALL, 1981b). The eggs lacked the typical central bulge of *S. bovis*.

It is not known whether the prevalence of parasitic infections changes significantly with time in one region; the results of an earlier study of roadworkers in the Coastal lowlands in 1976 suggest that there has been little change (ARNOLD *et al.*, 1978). Nor is it known if the infections of this small sample of men, a fraction of the total population of each region, provides a true picture of typical parasite burdens. Yet presented here is strong evidence that parasitic infections are common among male roadworkers in Kenya, among poor rural people and, therefore, perhaps among much of Kenya's population.

References

Arnold, S., Brooks, M., Crompton, D. W. T. & Latham, M. C. (1978). Intestinal parasites in Kenyan roadworkers. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **72**, 210-211.

Brooks, R. M., Latham, M. C. & Crompton, D. W. T. (1979). The relationship of nutrition and health to worker productivity in Kenya. *East African Medical Journal*, **56**, 413-421.

Brown, H. W. (1975). *Basic Clinical Parasitology*. (4th edit.) New York: Appleton-Century-Crofts.

Diesfeld, H. J. (1969). Die geomedizinische Darstellung der regionalen Haufigkeitsverteilung von 5 Darmhelminthen in Kenia. *Zeitschrift für Tropenmedizin und Parasitologie*, **20**, 483-494.

Diesfeld, H. J. & Hecklau, H. K. (1978). *Kenya: Regional Studies in Geographical Medicine* H. J. Justaz (Editor). Geomedical Monograph Series Vol. 5. Berlin: Springer-Verlag.

Elliott, T. C. (1980). *Iron Intervention Studies on Kenyan Roadworkers*. M. S. Dissertation: Cornell University, New York, USA.

Hall, A. (1981a). Quantitative variability of nematode egg counts in faeces: a study among rural Kenyans. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **75**, 682-687.

Hall, A. (1981b). *Aspects of Parasitic Infection and Host Nutrition*. PhD Dissertation: University of Cambridge.

Hall, A., Latham, M. C., Crompton, D. W. T. & Stephenson, L. S. (1981). *Taenia saginata* (Cestoda) in western Kenya: the reliability of faecal examinations in diagnosis. *Parasitology*, **83**, 91-101.

Highton, R. B. (1974). Schistosomiasis. In: *Health and Disease in Kenya*, L. C. Vogel, A. S. Muller, R. S. Odingo, Z. Onyango & A. De Geus (Editors). Nairobi: East African Literature Bureau, pp. 347-355.

Kinoti, G. K. (1971a). The prevalence of helminth infections in the Kisumu area of Kenya. *East African Medical Journal*, **48**, 490-495.

Kinoti, G. K. (1971b). Epidemiology of *Schistosoma haematobium* on the Kano Plain of Kenya. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **65**, 637-645.

Kwamina Duncan, J. W. (1978). Prevalence rates of intestinal disease agents in stools examined at Kenyatta National Hospital Laboratories, Nairobi, 1972-1976. *East African Medical Journal*, **55**, 216-222.

Latham, M. C., Stephenson, L. S., Crompton, D. W. T., Elliott, T. C., Hall, A., Jansen, A. A. & Wolgemuth, J. C. (1981). *Kenya: Health, Nutrition and Worker Productivity Studies*. Mimeographed report for World Bank, Washington.

Latham, M. C., Stephenson, L. S., Hall, A., Elliott, T. C., Wolgemuth, J. C., Crompton, D. W. T. & Arnold, S. E. (1982). A comparative study of nutritional status, parasitic infections, and health of male roadworkers in four areas of Kenya. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **76**, 734-740.

McCullough, F. S. (1972). The distribution of *Schistosoma mansoni* and *S. haematobium* in East Africa. *Tropical and Geographic Medicine*, **24**, 199-207.

Nation (1979). Report of 1979 population census. Nairobi: *Daily Nation*, 26th November 1979.

National Atlas of Kenya (1970). Nairobi: Survey of Kenya.

Nelson, G. S., Teesdale, C. & Highton, R. B. (1962). The role of animals as reservoirs of bilharziasis in Africa. In: *Bilharziasis*. Wolstenholme, G. E. W. & O'Connor, M. (Editors), Ciba Foundation Symposium. London: J. & A. Churchill, pp. 127-149.

Ojany, F. F. & Ogendo, R. B. (1973). *Kenya: A Study in Physical and Human Geography*. Nairobi: Longmans, Kenya.

Pavlovsky, E. N. (1966). *Natural Nidality of Transmissable Diseases*. Translated by F. K. Plous. Urbana & London: University of Illinois Press.

Rees, P. H., Mngola, E. N., O'Leary, P. & Pamba, H. O. (1974). Intestinal parasites. In: *Health and Disease in Kenya*. Vogel, L. C., Muller, A. S., Odingo, R. S., Onyango, Z. & De Geus, A. (Editors), Nairobi: East African Literature Bureau, pp. 339-346.

Rijpstra, A. C. (1975). Results of duplicated series of stool-examinations for all intestinal parasites by five different methods in schoolchildren in East Africa with remarks on serological aspects of amoebiasis and schistosomiasis. *Annales de la Société belge de médecine tropicale*, **55**, 415-425.

Seligman, C. G. (1966). *The Races of Africa*. London, Oxford & New York: Oxford University Press.

Teesdale, C. (1962). Ecological observations on the molluscs of significance in the transmission of bilharziasis in Kenya. *Bulletin of the World Health Organization*, **27**, 759-782.

Thorson, R. E. (1970). Direct infection nematodes. In: *Immunity to Parasitic Animals*. Jackson, G. J., Herman, R. & Singer, I. (Editors). New York: Appleton-Century-Crofts, pp. 913-961.

Wijers, D. J. B., Kinyanjui, H. & Rijpstra, A. C. (1972). Intestinal parasites found in children attending a school in Bahati (Nairobi) by direct examination of stool smears. *East African Medical Journal*, **49**, 989-995.

Wolgemuth, J. C. (1981). *The Effect of Health and Nutrition Interventions on Worker Productivity of Road Construction Laborers in Kenya*. Ph.D. Dissertation: Cornell University, New York, USA.

Wolgemuth, J. C., Latham, M. C., Hall, A., Chesher, A. & Crompton, D. W. T. (1982). Worker productivity and the nutritional status of Kenyan road construction laborers. *American Journal of Clinical Nutrition* (in press).

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