Annals of Tropical Medicine & Parasitology

ISSN: 0003-4983 (Print) 1364-8594 (Online) Journal homepage: http://www.tandfonline.com/loi/ypgh19

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To cite this article: D.J.B. Wijers (1977) Bancroftian filariasis in Kenya, Annals of Tropical Medicine & Parasitology, 71:4, 451-463, DOI: 10.1080/00034983.1977.11687211

To link to this article: http://dx.doi.org/10.1080/00034983.1977.11687211

Published online: 15 Mar 2016.

Annals of Tropical Medicine and Parasitology, Vol. 71, No. 4 (1977)

Bancroftian filariasis in Kenya
IV. Disease distribution and transmission dynamics

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Received 4 October 1976

In the rural areas of East Africa, bancroftian filariasis is mainly transmitted by *Anopheles gambiae s.l.* and *A. funestus*; in the towns and villages, *Culex pipiens fatigans* is the main vector (Nelson *et al.*, 1962; White, 1971; Wijers and Kiilu, 1977).

Between 1971 and 1973, the Coast Province of Kenya was surveyed for bancroftian filariasis by examining cluster samples of males over 14 years of age: microfilariae were counted in 0·1 ml day blood by means of the provocative test and a physical examination was made of the legs, genitals and groin lymph glands (Wijers, 1977).

In this paper, the unexpected distribution of the disease in the Coast Province will be discussed, as well as the factors which may influence transmission dynamics and the resulting degree of endemicity.

Climatic Conditions and Population Densities

Acton and Rao (1930) stated that the microfilaria rate in a population depends on (a) the density of the permanent population, (b) the numbers of mosquito vectors in the houses and (c) the effective period for transmitting the infection coinciding with the vector population.

Climatic conditions were thought to be very important in transmission. Rao and Iyengar (1930) showed that the optimum temperature for the development of *Wuchereria bancrofti* larvae in *C.p. fatigans* is between 26° and 32°C, but that a high humidity is even more essential for development. McGreevy *et al.* (1974) showed that a high humidity is also important for the transmission of infective larvae to the host, as these larvae escape from the proboscis into a drop of fluid exuded from the labium of the feeding mosquito and have to find their way into the probe channel before the fluid evaporates.

In Tanzanian villages with a microfilaria rate in adult males of over 30%, Jordan (1955) found higher average maximum and minimum temperatures, rainfall and average vapour pressure than in villages where the microfilaria rate was less than 30%. From his observations in the Lake Province of Tanzania, Jordan (1956) concluded that the highest microfilaria rates occur where mosquito and human population density are highest. In Liberia, Brinkmann (1972) found the highest microfilaria rates in the villages nearest to the sea.

In the Coast Province of Kenya, however, the distribution of the disease is quite different. Fig. 1 shows the areas in the rural parts of Kwale and Kilifi districts where the microfilaria rate in adult men was above 25%; data on rainfall and population density are taken from the National Atlas of Kenya (1970). Rates of over 25% were found mainly in inland areas with an annual rainfall between 750 and 1000 mm; rates were considerably lower in the 'coastal strip', which has a rainfall of over 1000 mm. The mean maximum temperature in the coastal strip is 26–30°C; further inland, it exceeds 30°C. In the whole area, mean minimum temperatures are over 22°C. Relative humidity at 06.00 is over

90% in the coastal strip and over 80% further inland; at 15.00 the humidity in the coastal strip does not fall below 60%, even in the driest months, but inland it may drop to 40%.

Population density is related to rainfall, which means that the highest microfilaria rates were generally found in areas with a population density of 10–40/km²; the rates were often much lower in areas with higher densities.

Temperature and humidity in the coastal strip are even more suitable for larval development in the mosquito and transmission to the human host than in the areas further inland, so that the population density of host or vector may be responsible for the low microfilaria rates found in the coastal strip.

Fig. 1 also shows the areas where disease foci were found, characterized by microfilaria rates in adult men of over 35% and a filariasis index (the proportion of men with evident signs of the disease or with a microfilaraemia) of over 65%. Except for the Muhaka focus, discussed later, these foci were found inland near permanent or semi-permanent rivers.

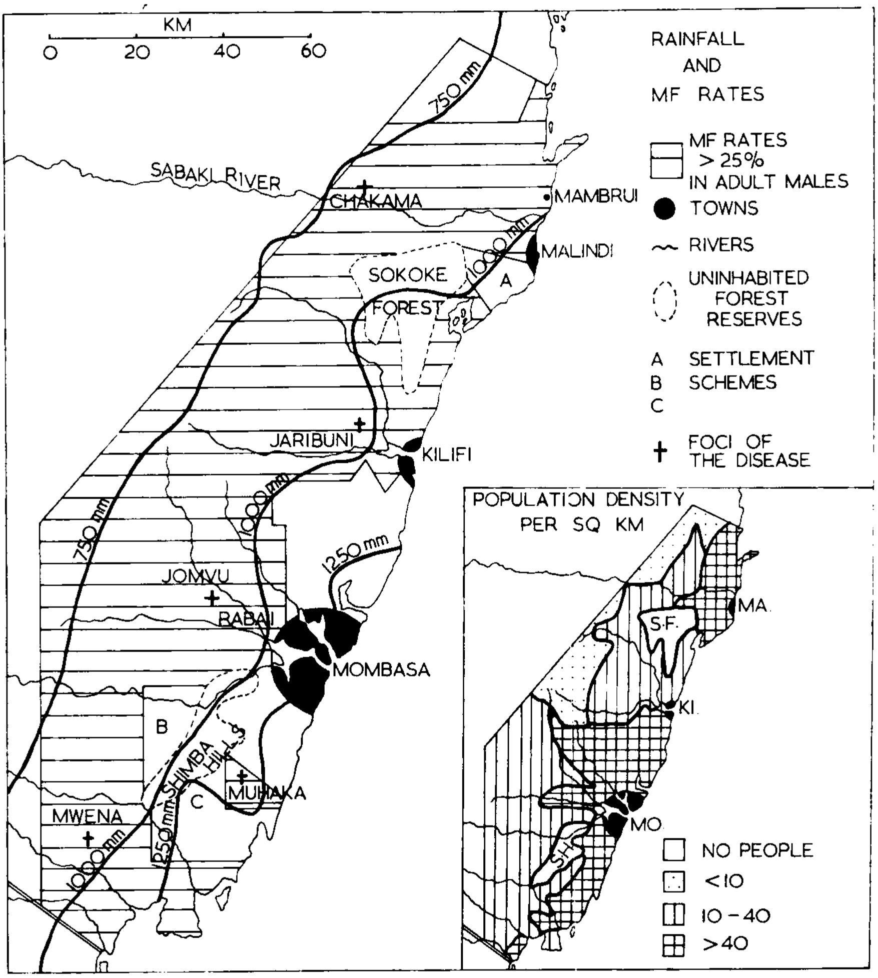

Fig. 1. Map of the Kwale and Kilifi districts (Coast Province), their population density and annual rainfall, areas with a microfilaria rate of over 25% in adult males and the five rural foci of bancroftian filariasis.

Epidemiological investigations in the Jaribuni focus showed that here the prevalence of the disease was related to vector density, for the people living within one mile of the Jaribuni river had more signs and higher microfilaria rates than people living further away (Wijers and Kinyanjui, 1977), while the number of mosquito bites per person per night decreased with increasing distance from this main breeding site (Wijers and Kiilu, 1977).

In West Africa, Brengues (1973) also related the prevalence of the disease to vector density. Here, the highest prevalence was not found in the rain forest belt, but in savanna areas with a rainfall of over 750 mm. Brengues suggested that this was due to a decrease in suitable breeding sites for the anopheline vectors in dense forest regions.

The Kenya coastal strip has no forests and the soil is generally sandy, leaving little surface water. People obtain their water mainly from wells or a piped supply water. The land has subsided in the past and the sea has filled former river beds, so that the present rivers tend to reach the sea several kilometres inland from the true sea shore. Of the more important rivers (Fig. 1) only the Sabaki in the north and those in the extreme south break through the coastal strip.

Little is known about the densities of anopheline mosquitoes in these areas, but lower densities, caused by a scarcity of breeding sites, may be partly responsible for the lower prevalence in the coastal strip. The few coastal areas south of Mombasa which have a microfilaria rate above 25% are sugar cane areas; possibly the irrigation, necessary for sugar culture, has increased the number of potential breeding sites considerably.

Nevertheless, the vector density is not the main factor which determines the prevalence of the disease in Coast Province, for this prevalence is also very low in the low hills north of Mombasa, which have high rainfall and many potential breeding sites. These hills are densely populated, and the relation between host and vector density determines endemicity. One may assume that, if a certain population of an anthropophilic vector depends for its blood meals on small groups of scattered people, the number of bites per person will be much larger than if such a population could search for blood in an area with a dense human population; the reservoir of infective larvae in these mosquitoes would probably become more evenly spread over a dense population than over scattered groups of people.

The situation is more complicated in the towns and villages, where *C.p. fatigans* is the main vector. This species tends to concentrate in certain parts of the town (White, 1971; Wijers and Kiilu, 1977) and seems to disperse very little if the environment is favourable (Subra, 1972). Hence, in one part of even a very small town, the prevalence of filariasis may be very high (Wijers and Kinyanjui, 1977), mainly due to the larger number of *C.p. fatigans* bites per person per night.

Thus, in areas where climatic conditions allow development of *W. bancrofti* larvae in the mosquito, it is not primarily the optimum temperature or humidity which determines the prevalence, but an optimal relation between host and vector density.

Decreasing and Increasing Endemicity

Changes in human behaviour and the movements of people may considerably influence the transmission of bancroftian filariasis, and the microfilaria rate found in a population does not always reliably reflect the endemicity.

Lagraulet *et al.* (1973), working in the Pacific, recognized four different epidemiological types:

1. High microfilaria rates and densities; many clinical signs.
2. High microfilaria rates and densities; few clinical signs.
3. Low microfilaria rates and densities; many clinical signs.
4. Low microfilaria rates and densities; few clinical signs.

They considered types 1 and 4 'normal', type 2 due to relatively recently imported filariasis, and type 3 due to the emigration of the young, healthy people, leaving behind the old people with their clinical signs. Brunhes (1975), however, suggested that type 2 occurred in areas with increasing transmission and type 3 in areas with decreasing transmission.

In Kenya, the same four epidemiological types were found. Elephantiasis is rare in Coast Province and may be partly non-filarial in origin (Wijers, 1977), so that microfilaria (mf.) rates have been compared with the hydrocele rate (proportion of men with a hydrocele at least 6 cm in length). With our methods of examination these two rates were about equal in adult males. For the whole rural area of the districts Kwale and Kilifi, where 5004 men in 73 cluster samples were examined, the mf. rate was 28·4% and the HC rate 29·9%; in 17 of the 73 samples the difference did not exceed 2%.

Type 3, however, characterized by a HC rate more than twice the mf. rate, was found in several villages in the very sparsely populated areas north of Kilifi district, particularly along the Tana river, as well as in settlement areas and in some of the towns (Table 1, Fig. 2). In the towns, the attendance rate of people called to be examined was so low that the results must be regarded with caution; nevertheless, the general picture here was so similar to that of the Tana river villages and settlement areas that the data from these towns have been included in this paper.

Fig. 3 shows the correlations of the mf. and HC rates with age in the type 3 areas and, as a comparison, in the total rural area of Kwale and Kilifi. The mf. rates in the type 3

TABLE 1

Microfilarial rates, hydrocele rates and geometric mean microfilarial density in adult men in the Tana river villages, the settlement areas and some of the towns where transmission is thought to be decreasing

	Number examined	*Mf. rate*	*HC rate*	*Mf. density*	*Attendance rate*
TANA RIVER VILLAGES					
Hola	54	11	28		57
Wenje	62	19	15		76
Wema	64	5	27		84
Garsen	50	4	22		55
Idsowe	34	12	38		79
Ngao	76	13	34		77
Semikaro	63	0	10		100
Total/mean	403	9·2	24·1	3·6	
SETTLEMENT SCHEMES					
Mabuani	55	2	16		43
Milafenyi	55	15	45		79
Nguluku	82	13	28		82
Total/mean	192	10·4	29·7	4·7	
TOWNS					
Malindi	42	10	17		28
Kilifi-Takaunga	131	8	15		est. 55
Rabai	86	6	19		56
Total/mean	259	7·3	16·6	4·9	

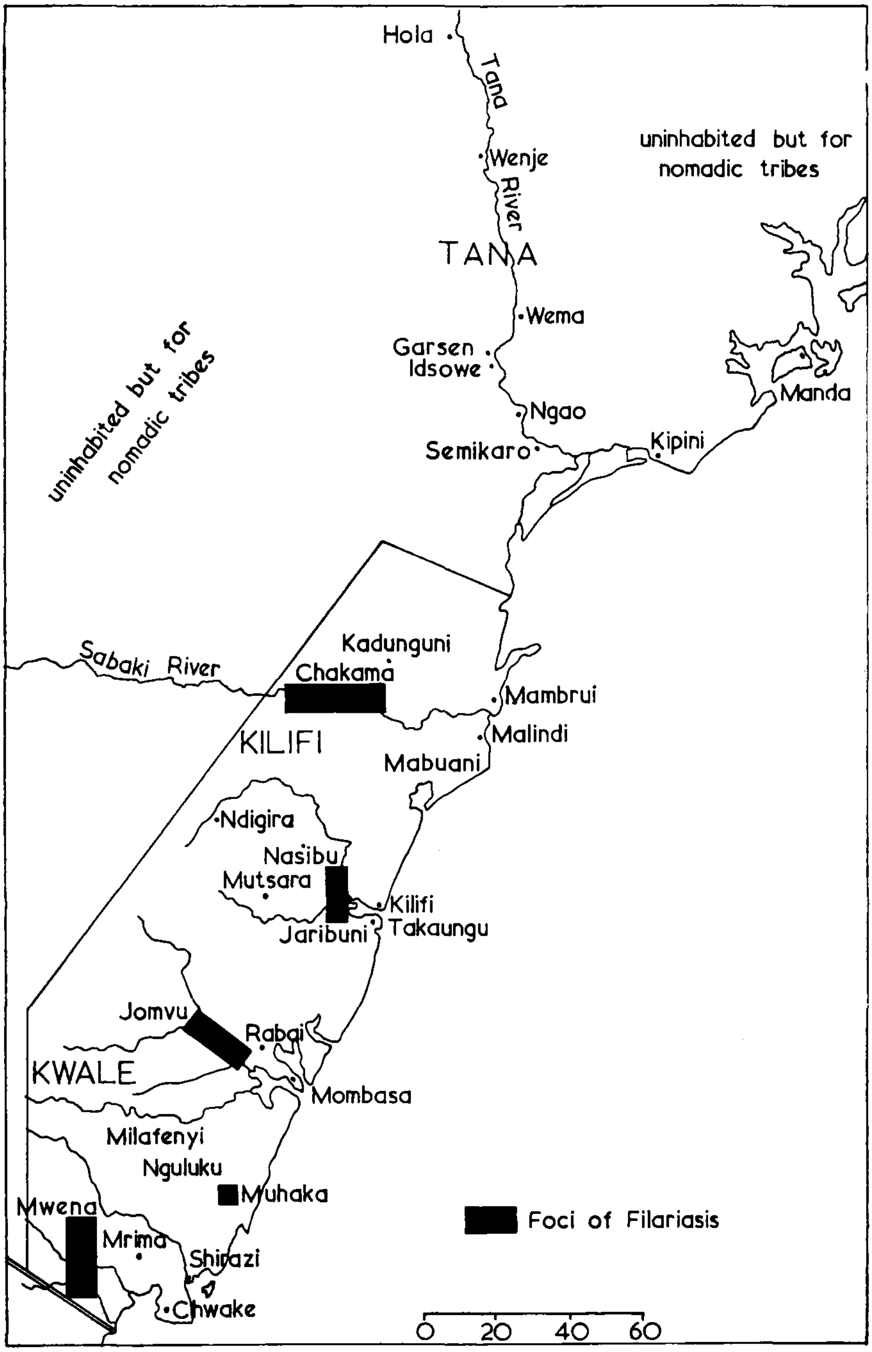

Fig. 2. Map of Coast Province and the village areas mentioned in the text.

areas are much lower and remain low in all age groups. HC rates are high in the older age groups, but few hydroceles are found in men under 30. The geometric mean of the mf. densities in the type 3 areas is also very low.

These low mf. rates and densities and the paucity of hydroceles in young men indicate, as Brunhes suggested, that the epidemiological type 3 is caused by a decrease in transmission, resulting in a decrease in mf. rates in all age groups, while the young men, growing up, are much less prone to develop hydroceles than formerly; hydroceles are therefore mainly found in older men.

The decrease in transmission in these parts of Coast Province is not caused by emigration, as may have been the case in the Pacific, but, at least in the towns and settlement areas, by immigration of young, mainly uninfected people, who dilute the human reservoir of disease and so reduce the proportions of infected and infective mosquitoes. This hypothesis is supported by entomological data collected in Mambrui, a small town with very little immigration and an mf. rate of 31% in adult men, and in Kilifi town, the district capital, with a large immigrant population and an mf. rate of only 6% in adult, indigenous males. In Mambrui, 216 of 3823 *C.p. fatigans* caught on human bait contained filarial larvae (Wijers and Kiilu, 1977), while none of 2000 *C.p. fatigans* caught in the morning by hand from walls in Kilifi houses harboured larvae (Van Seventer, personal communication). Other factors, such as the tendency to build modern houses with ceilings in the towns and settlement areas, may also play an important role in the transmission decrease.

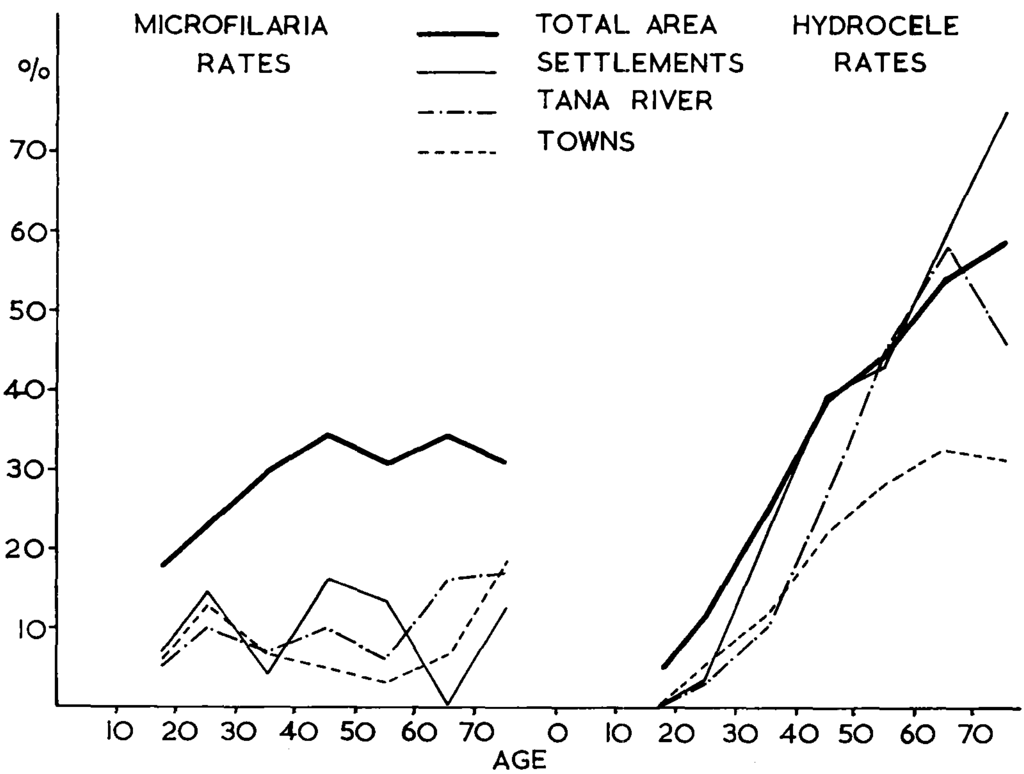

Fig. 3. Microfilaria rates and hydrocele rates in adult men of different age groups in the Tana river villages, the settlement areas and some of the towns where transmission is thought to be decreasing, and, as a comparison, in the total rural area of Kwale and Kilifi.

The Tana River district is one of the very few areas where, despite better methods of examination, lower mf. rates were found in the 1971–73 survey than in a survey carried out by Nelson *et al.* (1962). Immigration of uninfected people, however, is not the cause of this decrease. Here, since World War II, people have begun to protect themselves with mosquito nets against the evening attacks by the *Mansonia* mosquitoes which breed in the Tana river swamps. Kipini, the only village where mosquito nets were not used, lies at the mouth of the Tana river, where *Mansonia* is probably very rare. This was also the only village with mf. (29%) and HC rates (23%) similar to those in the villages in Kwale and Kilifi.

If a decrease in transmission is the cause of the type 3 epidemiology, the decrease may have started in the settlement areas about the time Kenya obtained its independence and when many new settlers began to move in; the decrease may have started in the Tana river villages after World War II, when cheap mosquito nets were available, and in the towns long before World War II. This chronological difference is perhaps reflected in the decreasing HC rates in the older men (Fig. 3).

Type 2, with mf. rates more than twice the HC rate, was found only on Manda island, in the extreme north, and in two sugar cane areas south of Mombasa. The data of the four cluster samples taken in traditional villages in the sugar cane areas are given in Table 2 and Fig. 4.

In all four areas the mf. rate drops sharply in men aged at least 50 years, contrary to the general rule. Chwake has the lowest mf. rates, but also the largest difference between mf. and HC rate. In the other three areas, the mf. rate has reached a ceiling of around 40%, but in Shirazi the HC rate is twice as low, in Mrima slightly lower and in Muhaka higher than the mf. rate. Mf. densities are also lowest in Chwake and highest in Muhaka. This suggests a sequence in increasing transmission: initial stage in Chwake, where the mf. rate has increased but hydroceles are only just beginning to develop, of longer duration in Shirazi and Mrima, where the mf. rates have already reached their ceiling and where hydroceles are now developing rapidly; in Muhaka the process has ended, resulting in a focus of bancroftian filariasis (see below). The only signs which show that the Muhaka focus is relatively recent are the fall in mf. rate in men of 50 years and older and the low rate of leg elephantiasis (2·1%) compared with that in other foci.

As suggested previously, increasing transmission in the sugar cane areas may be due to increasing numbers of vector breeding sites in the irrigation channels. In Muhaka, mosquitoes were caught from walls on a day at the end of the hot, dry season, when mos-

TABLE 2

Microfilaria rates and hydrocele rates in adult men of different age groups and the geometric mean microfilarial density in four traditional villages in the sugar cane area thought to represent a sequence in increasing transmission

				Age groups							
				15–29		30–49		50 *and over*			
	No. ex.	*Mf. rate*	*HC rate*	*Mf. rate*	*HC rate*	*Mf. rate*	*HC rate*	*Mf. rate*	*HC rate*	*Mf. density*	*Attendance rate*
Chwake	104	26	7	19	0	34	10	17	11	4·6	80
Shirazi	80	40	21	31	10	53	13	33	48	7·6	76
Mrima	87	40	31	36	28	47	28	35	38	6·8	52
Muhaka	97	41	54	22	22	51	60	41	70	11·2	77

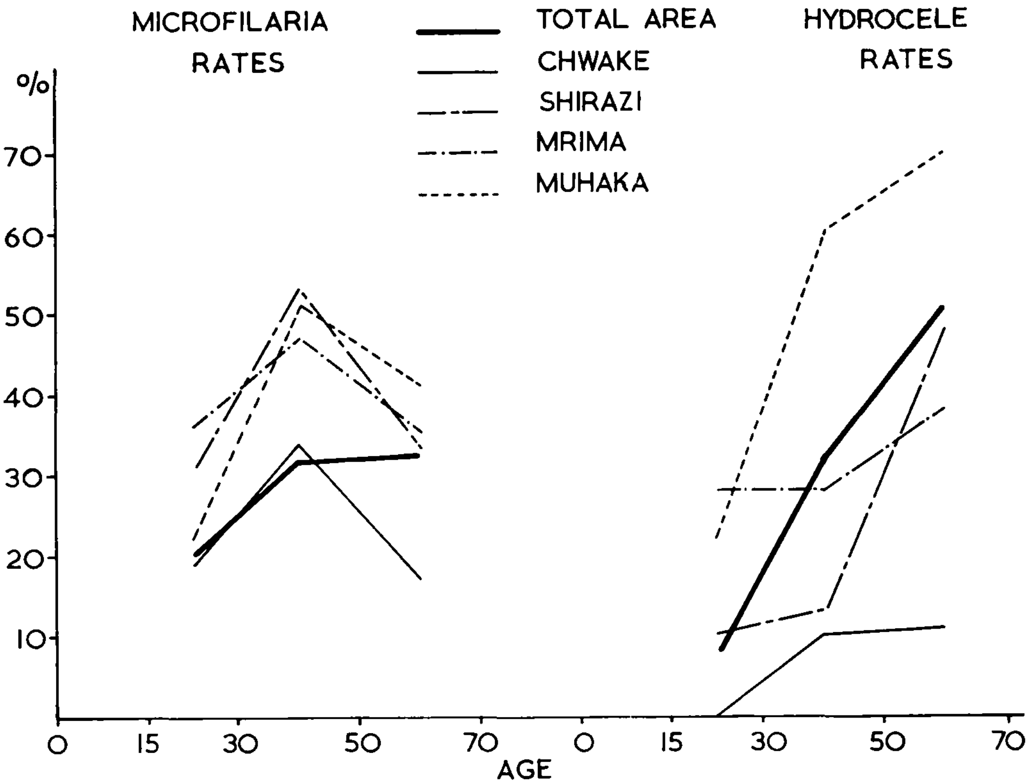

Fig. 4. Microfilaria rates and hydrocele rates in adult men of different age groups in four traditional villages in the sugar cane area thought to represent a sequence in increasing transmission, and, as a comparison, in the total rural area of Kwale and Kilifi.

quito densities are generally lowest (Wijers and Kiilu, 1977). Even at this time, the huts contained many resting *A. funestus* and four of the 60 dissected had filarial larvae.

However, it is not known why increasing transmission may have occurred in Manda Island in the north, and why an area with increasing transmission seems to be characterized by an unexpectedly low mf. rate in men over 50 years of age.

Foci of Bancroftian Filariasis

Assessment of mf. rates alone is of limited use in areas where transmission may be increasing or decreasing, and also in areas with a relatively stable transmission. It obscures the worst foci, because the mf. rates in adult men in Coast Province seem to peak at about 40%, while no such ceiling apparently exists for hydrocele rates, which may reach more than 50% in the worst affected areas. Moreover, most elephantiasis patients are found in these areas (Wijers, 1977).

Table 3 shows the mf. and HC rates in the centre of the five foci. Even if the rates are corrected for a possible preponderance of old men in the cluster samples, giving a biased high HC rate, the mf. rates in the foci remain around 40% and the HC rates around 50%. The mean mf. densities, however, are highest in the north and steadily decrease towards the south.

TABLE 3

Microfilaria rates, hydrocele rates and geometric mean microfilarial density in adult men in the centre of the five rural foci of bancroftian filariasis. (The correction is made for an eventual preponderance of older men in the samples)

					Corrected		
Focus	No. of clusters	Number examined	Mf. rate	HC rate	Mf. rate	HC rate	Mf. density
Chakama	3	172	41	52	40	51	18·7
Jaribuni	3	123	41	52	40	48	17·0
Jomvu	3	220	37	51	38	50	10·6
Mwena	2	159	39	52	38	48	8·3
Muhaka	1	97	41	54	40	49	11·2

Interrupted and Continuous Transmission

The opposite circumstance, a high HC rate with an even higher mf. rate, may also occur in areas with a relatively stable transmission. Examples appear in Table 4. Kadunguni is north of the Chakama focus, and the other three to the east of the Jaribuni focus. All four areas are notorious for their lack of water. During the dry seasons, the women may have to walk 15 km (often to the adjacent focus) to obtain water and so the local human population density is barely 10/km^2. Man-biting mosquitoes are apparently absent for several months of the year. Nevertheless, the mf. rates in the inhabitants of these areas are exceptionally high, while the mf. densities are even higher than in the adjacent foci. A similar, but less pronounced situation occurs in the dry areas north and east of the Jomvu focus.

Wijers (1977) found that in the rural areas of Kwale and Kilifi the mean mf. density showed no direct correlation with the mf rates, and in all age groups was about twice as high in the northern part of the surveyed area as in the south. The densities given in Table 3 also show this southwards decrease. The northern part of the area is no hotter than the southern part, but it is drier, for the rains in the north fall more often in erratic storms, while in the south they are more evenly distributed over the year.

Another observation was that in the Jaribuni focus the people living near the small, but permanent Jaribuni river had much lower mf. densities than the people living along the much larger Rare river which dries out during the dry seasons.

Thus, in areas with equal yearly transmission, interrupted transmission tends to promote the development of a microfilaraemia, a more continuous transmission the development of hydroceles and other signs of the disease.

TABLE 4

Microfilaria rates, hydrocele rates and geometric mean microfilarial density in adult males in dry areas with interrupted transmission adjacent to foci. (The correction is made for an eventual preponderance of older men in the samples)

				Corrected		
	Number examined	Mf. rate	HC rate	Mf. rate	HC rate	Mf. density
Kadunguni	61	48	43	44	37	26·1
Nasibu	63	57	43	56	42	20·4
Ndigiria	53	42	32	39	30	19·9
Mutsara	94	36	27	35	24	22·1

Wijers (1977) demonstrated a complex relationship between the development of a microfilaraemia and of a hydrocele (or elephantiasis): the more advanced and larger the hydrocele the less chance that the patient showed a microfilaraemia; the older the patient with a hydrocele or one of its premonitory signs, the greater the chance that he showed a microfilaraemia. This last observation confirmed that of Brunhes (1975). The simplest explanation for this paradox is to assume that the allergic reactions which cause the development of hydroceles and elephantiasis tend to suppress a microfilaraemia; presumably this tendency is strongest in people who develop signs at a young age and who may never show a microfilaraemia, but it decreases with age, so that of older men with genital signs, particularly in the beginning stages of development, an increasing number are microfilaraemic. Scrotal elephantiasis may have a quite different pathogenesis, for it always seems to be symmetrical and the mf. rate in such patients in Kenya was extremely high (Wijers, 1977).

If a more continuous transmission promotes the development of hydroceles and leg elephantiasis, and if such a development, particularly in young men, suppresses microfilaraemia, then the high mf. rates and densities in the drier areas with interrupted transmission may be due solely to a slower development of signs and, as a consequence, less suppression of the microfilaraemia. The possible existence of 'refractory' persons who will never show a microfilaraemia or signs of the disease, however many times they may become infected (Wilson and Ramachandran, 1971), does not invalidate this argumentation.

The hypothesis that in those areas with equal yearly transmission a more continuous transmission results in higher rates, was also suggested by Brengues (Subra, personal communication).

In the Tingrela focus in Upper Volta, where transmission is interrupted each year for several months during the long dry season, Brengues (1973) found that the potential number of larvae invading a person per year was approximately 239; the mf. rate in adult men in this focus was 50·8%, and the sign rate only 27·8%. In the part of the Jaribuni focus in Kenya where transmission was virtually continuous, the potential number of larvae invading a person per year was approximately 226 (Wijers and Kiilu, 1977), i.e. about equal to that in Tingrela. The mf. rate in adult men in this part was only 35·1%, but the sign rate was 37·7%.

Before concluding that these data seem to prove the hypothesis mentioned above, they should be compared with data from areas with a different yearly transmission.

Prevalence and Number of Infective Larvae Invading the Host Population

It seems reasonable to assume that the larger the number of infective larvae in the mosquitoes which feed on a population, the higher the prevalence of the disease in the population. In several foci, attempts have been made to calculate the average number of infective mosquitoes which bite a person per year and the number of infective larvae in these mosquitoes. Table 5 shows data from areas where mosquitoes were caught intermittently for a complete year, at least partly on human bait. Comparisons are hampered, however, by disparities in the methods used to obtain these data and in the presentation of the data collected. Most of the data in Table 5 are from indoor catches, but those from Tingrela and Rangoon also include figures from outdoor catches. Moreover, it is not certain whether the sites where mosquitoes were caught may be regarded as representative for the whole area (Wijers and Kiilu, 1977). Microfilaria rates were generally calculated from 20 mm^3 blood, but in Liberia 30 cm^3 was used, and in Kenya 100 mm^3. Hydrocele and elephantiasis rates, if mentioned, were generally simply stated, without any mention of the diagnostic criteria used.

From Table 5 it appears that in Africa the mf. rate in a population peaks at around 35% (50% in adult males). In such areas mf. rates increase with age without levelling off,

TABLE 5

Number of infective mosquito bites per person per year, the number of infective larvae in these mosquitoes, the microfilaria rate in the total population and the sign rate in adult males in different areas where intermittent mosquito catches were carried out for at least a year and at least partly on human bait

Location	*Vector species*	*% of vectors infective*	*No. of infective bites per person per year*	*No. of infective larvae in these mosquitoes*	*Mf. rate in total population examined*	*Sign rate in adult men*	*Author*
Cow farm, Liberia	*A. gambiae*	1·7	498	1544	35	?	Maasch (1973)
Bassa Pt., Liberia	*A. gambiae*	2·0	190	475	36	?	Maasch (1973)
Sada, Comores	*C. fatigans* *A. gambiae*	1·9 0·6	400 15	1050	35	25	Brunhes (1975)
Tingrela, Upper Volta	*A. funestus* *A. gambiae*	1·3 1·8	56 58	239	35	28	Brengues (1973)
Jaribuni, Kenya	*A. funestus* *A. gambiae*	1·0 1·1	146 9	226	22	38	Wijers and Kiilu (1977)
Mambrui, Kenya	*C. fatigans*	1·0	46	155	20	31	Wijers and Kiilu (1977)
Rangoon, Burma	*C. fatigans*	0·4	298	1353	5	?	Hairston and De Meillon (1968)
Calcutta, India	*C. fatigans*	1·5	1850	5904	15	?	Gubler and Bhattacharya (1974)

and the rate in females equals that in males (Brunhes, 1975). In Tingrela (interrupted transmission) this ceiling is already reached with a relatively low input of larvae; in areas with continuous transmission, the ceiling is apparently reached only when the input of infective larvae is much higher (Cow farm, Bassa Point, Sada).

However, if continuous transmission promotes the development of signs, one would expect extremely high sign rates in Liberia and the Comores, and this does not seem so. The sign rate in Mambrui (155 infective larvae per person per year) is even higher than in Sada (over 1000 larvae). In Mambrui, all hydroceles at least 6 cm long were included in the sign rate, but in Sada all genital deformations 'undoubtedly of filarial origin' (Brunhes, personal communication). Different diagnostic criteria were used, but it is doubtful if this is the sole reason for the higher sign rates found in Kenya. It is possible that, with increasing transmission, the sign rate also finally reaches a ceiling; it may even decrease in the worst affected areas.

Very essential differences are found in Table 5 between the data from Africa and from the Indian subcontinent. Despite a large number of infective larvae per person per year, the mf. rates in Rangoon and Calcutta are much lower than in Sada and Mambrui, which also have *C.p. fatigans* as main vector. The proportion of adult men with a hydrocele or one of its premonitory signs was 30–40% in Calcutta, against 60% in Mambrui. Gubler and Bhattacharya (1974) suggest that immunization follows low doses of infective larvae coming in continuously, but the data from Cow farm and Sada seem to disprove this.

As well as the apparent inefficiency of the infective larvae in Rangoon and Calcutta, another difference between Africa and the Indian subcontinent is found in the main site where signs of the disease occur. Throughout Africa, even in areas with continuous transmission, hydroceles are much more common than elephantiasis. In India, this occurs mainly where transmission is interrupted in winter; in areas with continuous transmission, elephantiasis is generally the predominant lesion (Wolfe and Aslamkhan, 1972). It may be, therefore, that strain differentiation has occurred and that the epidemiology of bancroftian filariasis in Africa is not directly comparable with the epidemiology in the Indian subcontinent.

SUMMARY

In the Coast Province of Kenya, the prevalence of bancroftian filariasis is highest in areas with an annual rainfall between 750 and 1000 mm and with a population density between 10 and 40 km². In the 'coastal strip', with higher rainfall and higher population densities, prevalence rates are much lower. It is discussed that this may be due to a relative scarcity of breeding sites for anopheline mosquitoes in the coastal strip and that, in areas where climatic conditions allow the development of *Wuchereria bancrofti* larvae in the mosquito, it is not primarily the optimal temperature or humidity which determines the prevalence, but an optimal relation between host and vector density.

Four epidemiological combinations of high and low microfilaria rates with many and few clinical signs in the adult male populations are recognized. Low microfilaria rates with many clinical signs occur in areas where transmission is decreasing, while high microfilaria rates and few clinical signs are found in areas where transmission is increasing.

The foci with a high microfilaria rate and many clinical signs may be divided into (a) those near permanent or semi-permanent rivers, in which the sign rate is even higher than the microfilaria rate and where most patients with elephantiasis are found, and (b) adjacent, drier areas, where transmission is interrupted during the dry seasons, in which the microfilaria rate is even higher than the sign rate and where the highest microfilarial densities are found. Continuous transmission seems to promote the development of hydroceles and leg elephantiasis and this development tends to suppress a microfilaraemia, particularly in young men; the high microfilaria rates and densities in the areas with interrupted transmission may be due to a slower development of signs causing less suppression of the microfilaraemia.

If one compares different areas in Africa where investigations have been carried out into the number of infective mosquitoes which bite a person per year and the number of infective larvae in these mosquitoes, it seems that with increasing input of infective larvae both microfilaria rate and sign rate finally reach a definite ceiling.

The apparent inefficiency of the infective larvae in the Indian subcontinent, and the predominance of elephantiasis over hydroceles in many Asian areas with continuous transmission, suggest that bancroftian filariasis in Africa and the Indian subcontinent may be caused by two different strains.

ACKNOWLEDGEMENTS. I wish to thank the Director of Medical Services, Kenya, for his permission to publish this paper.

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