MALARIA AND VITAL RATES IN THREE EAST AFRICAN BANTU COMMUNITIES*

I. INITIAL DEMOGRAPHICAL SURVEY

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In 1954 an experimental programme of malaria control was launched in the Pare Area of northern Tanganyika and in an adjoining area north of Lake Jipe in Kenya. One aim of this programme was to gauge the influence of 4 years' protection from malaria on the health of a rural Bantu population which had, until that time, been exposed to intense malaria transmission.

Among a series of investigations relevant to this aim, data on births and deaths were collected from families before and after the institution of malaria control. The population sample under study increased from a pre-control figure of 4,500 in 1954, to over 11,000 by 1958, the last complete year of the scheme. Vital data were recorded during half-yearly visits to each of the registered households. The results are summarized by Wilson (1960) in the Report on the Pare-Taveta Malaria Scheme. It is noted here that, during the period of malaria protection (1954-1958), the crude birth rate in the protected population increased from less than forty to nearly fifty, and that the annual ratio of livebirths to females aged between 15 and 49 years increased from around 100 to as much as 150 during the second and third of these years.

The infant mortality rate declined from 165 in 1955 to 78 in 1957 but then rose to 132 in 1958 (a year in which an epidemic of whooping cough swept through the community). Meanwhile the crude death rate fell from 24 in 1955 to almost half this figure in 1958. Though some improvement in child mortality and fertility had been anticipated, the apparent effect of malaria control seemed disproportionate when viewed against the trivial

changes observed in respect of other health indices measured concurrently.

Since 1959, when the last round of dieldrin residual spraying was carried out, malaria transmission has returned to the areas covered by the scheme. Hence, it was agreed, re-examination of vital statistics in these communities might show whether the changes summarized above were to be attributed to the 4 years' interruption in malaria risk, or whether they reflected—at least in part—a favourable socio-economic trend. In 1961, through the generous support of the Nuffield Foundation, the collection of data was resumed in the scheme area.

It is planned to broaden the scope of the original investigation and to collect data from which age-specific mortality and fertility rates can eventually be constructed for two distinct communities living in zones where malaria has returned. One of these communities inhabits the area of Taveta Forest in the Taveta sub-District of Kenya; the other is distributed along the swampy course of the Mkomazi River in the Pare Area of Tanganyika. The latter group is part of the Wa-pare tribe. It is also intended to carry out a parallel investigation in a section of the tribe that occupies the nearby, but malaria-free, uplands around Mamba, in the South Pare Mountains. The approximate position and boundaries of the three zones are indicated in the accompanying map.

Registration of the three populations was started in April, 1961, and was completed in December of that year. Field work began with a rough geographical reconnaissance, during which villages and scattered houses were grouped into convenient blocks. Each house in the block was then numbered and its number was painted on the door. A team of questioners visited each house recording the sex,

* Funds for this investigation were made available through a grant from the Nuffield Foundation.

name, age, and relationship of every member of the household. At least 1,500 households were registered in each Zone during 1961, and the Mkomazi Valley Zone was extended towards the end of 1962.

With effect from January, 1962, the collection of data is being undertaken by teams of two enumerators of proved reliability. One team is responsible for the Zones of Mamba and Taveta, respectively, while two teams operate in the largest Zone, the Mkomazi Valley. The teams will continue to visit each household in their Zones at intervals of approximately 4 months; they will record pregnancies, livebirths, stillbirths, deaths, and any changes in the composition of the household, that may have occurred since the previous visit. These data will be compiled, on a longitudinal basis, for a period of 5 years, by which time it is hoped that reliable age-specific vital rates will be available.

The assessment of age at the time of registration was as satisfactory as the limited time and other circumstances permitted. Age, however, carries a proportionate prestige and the span of years claimed by elders was frequently exaggerated. This error will need acknowledgement in due course when age-specific vital rates are under consideration. It was planned to base conclusions on data that could, more or less, be verified. No attempt was made, therefore, to obtain the previous reproductive history of the women by questioning. The relationship of surviving children to the females in the household was however noted at the time of registration.

Considerable public confidence was generated locally during the course of the Pare-Taveta Malaria Scheme. With the intention of fostering this asset the enumerators carry with them a few simple, but efficacious, remedies.

The main object of the present paper is to provide a preliminary description of the communities under study; to record their age-composition, and to summarize available data on the size and composition of households in the three Zones. The geographical conformation of the whole area is shown in the map in Fig. 1 (opposite).

THE PEOPLE AND THE ENVIRONMENT

(1) THE MAMBA ZONE

The households under study in the Mamba Zone lie within an area of some 15 square miles, between 4,000 and 6,000 feet, on the eastern slopes of the South Pare Mountains. The Zone overlooks the Mkomazi Valley, from which it is separated by a steep escarpment. The Mamba rainfall is hardly more than the 25 to 35 inches received annually along the hill-foot, but the climate is cool and humid and the area is liberally watered by perennial streams and

irrigation furrows. The Zone is part of the "heart-lands" of the Wa-pare, a Bantu tribe whose individuality presumably derives from ancient concentrations of families in the refuge of mountain and forest that the district afforded. The division into an upland, agricultural community and a more scattered, largely pastoral, section on the surrounding plains, must, however have taken place many years ago because the former is predominantly Christian and the latter predominantly Islamic—an indication that Wa-pare settlements have existed on the plains since the years of Arab domination. Pagan families are nowadays confined to the more inaccessible country above 6,000 feet and are not represented in the Mamba Zone.

Wherever there is perennial surface water the uplands of the Pare Mountains are densely populated and in the Mamba Zone there appear to be about 500 persons to the square mile. There is increasing pressure on the land, leading to the cultivation of the steeper slopes and progressive soil erosion. Nevertheless the people of Mamba give an impression of vigour and prosperity. Houses are soundly constructed, often with walls of burned brick and with a corrugated iron roof, while their inhabitants are generally well dressed. The level of education is relatively high and there is a wide acceptance of the more important rules of hygiene. Thus maternity and child-health clinics, staffed by the local missions, are well patronized, and almost every house boasts a well-maintained latrine. Primitive attitudes of mind are giving way steadily, but ancient fears are easily re-kindled and certain traditions linger.

The main crops are maize, beans, bananas, and sugar-cane. On the lower slopes some cassava, rice, and yams can be grown, and temperate vegetables are gaining popularity in the cooler districts. Yields are generally good and surplus crops provide a cash income for the cultivator which may exceed £150 in a year of good rainfall. Hitherto little coffee has been grown in the Zone, although it is an important cash crop elsewhere in the Mountains. In accordance with traditional practice, a few stall-fed cattle may be kept indoors, but the milk yield is poor and meat and milk brought up from the lowlands are widely and effectively marketed.

A nutritional survey was carried out a few years ago among a group living in rather similar circumstances in the North Pare Mountains. The reports of this survey, which were kindly made available by the Director, East African Medical Research Institute, emphasized that, although the diet of the mountain people was adequate, the balance might be imperfect. Thus, owing to a shortage of locally-caught fish and

FIG. 1.—Map showing position of zones studied.

the generally low content of local vegetables, the diet may be calcium-deficient, and a prejudice against eating green leaves may render the diet of the poor, or more conservative, families deficient in vitamin A and ascorbic acid. Nowadays, the diet of the average Mamba family is certainly adequate in all important respects, with a generous animal protein and fat content.

Upland Wa-pare families are reluctant to settle in the plains, though many are obliged by economic pressure to do so. In addition to a fear of malaria there appears to be a conviction that women who live in the plains rear few children, an attitude which is shared by other montane communities in East Africa, that have never suffered from malaria. Absence of malaria transmission in the Mamba Zone was confirmed in 1962, when 522 primary school-children were found to be negative, with the exception of two boys who admitted to having paid a recent visit to a malarious district in the plains.

The registration of the households in the Mamba Zone was started in June, 1961, and completed early in December. Information so obtained is summarized later in this paper.

(2) THE MKOMAZI VALLEY ZONE

The eastern slopes of the South Pare Mountains, including those around Mamba, form the main catchment area of the Mkomazi River. The streams from there water a strip of cultivated land below the hill-foot before entering the swampy country that marks the River's slow course along the Valley. Where irrigation is practicable, villages have sprung up, and the more important of these, such as Kisiwani, Gonja, Ndungu and Kihurio, are sited on the Tanga-Moshi road. As shown in the accompanying map the survey communities are usually sited some distance from the road, except for a section near Mkomazi, where the river and road nearly coincide.

The Zone covers some 60 square miles of flat terrain a little less than 2,000 feet in altitude. Rainfall close to the Mountains may exceed 30 inches, but away from the hill-foot it is slight and capricious; and the arid Mkomazi area actually lies in a rain-shadow. The annual mean temperature is around 24°C., with a pleasantly cool, dry season between May and September.

The people are predominantly of the Wa-pare tribe with a few families from neighbouring Bantu groups, such as the Wa-sambaa and Wa-kamba. Unlike Mamba, the onus for providing schools and medical services has fallen mainly on the Native

Authority, and such facilities as do exist are thus less sophisticated than those accessible to the people of the uplands. The standard of housing is also relatively poor: the village *banda* is typically a flimsy structure made of a framework of light poles roughly filled in with mud plaster. A grass thatch keeps the *banda* pleasantly cool in daytime, but the interior is usually gloomy and unhygienic. Because of the depredation of termites and the damage done during the seasonal floods the life of a *banda* is limited to a few years. The swamp communities are traditionally pastoralists and the surrounding thorn bush is grazed by herds of cattle and smaller numbers of sheep and goats. At night the animals are herded into thorn enclosures close to the houses. Although stock is plentiful meat is not usually eaten more than once a week. However fish, locally available from Lakes Kalimawe and Karamba, is a regular item of diet. The staple food is maize. In a year of good rainfall—the exception rather than the rule—two crops of this cereal can be grown around the fringe of the swamps. The area under rice cultivation in the Valley has doubled in the last decade and this crop has replaced cotton as the main cash crop in the valleys. Rough estimates indicate that the cash income of an average cultivator may have increased from about £10 in 1956 to nearly £50 per annum in 1962. Beer, known as *puya*, is brewed extensively from locally grown sugar-cane. The consumption of *puya* in the Valley is heavy, one estimate placing this at 20 gallons per head per year. Such an intake of fermented liquor may provide an appreciable and useful dietary supplement, but its social consequences cannot be entirely beneficial.

The registration of households began in April, 1961, and the area originally selected was completed by mid-July. This Zone was re-visited between August and December, when the villages of Mpirani and Shughulu were included for the first time. Further accessions around Kisiwani and Mkomazi have lately extended the area under study to some 60 square miles, with a rough population density of rather less than 100 persons per square mile.

Before 1956 the Valley was intensely malarious. Year round transmission was maintained by large numbers of *A. funestus*, which bred in the swamps, assisted seasonally by *A. gambiae*. Draper and Smith (1957) estimated, on entomological grounds, that the population in swamp villages was exposed to around forty infective bites per person per year.

Dieldrin residual spraying was introduced into the Valley and surrounding country in 1956 and, by 1957, *A. funestus* was eliminated and *A. gambiae* greatly reduced. The final round of residual spraying was completed in March, 1959. Since 1960 there has been a general resumption of malaria transmitted by

A. gambiae but, because *A. funestus* has not yet re-established itself, malaria is still seasonal and of only moderate intensity.

It had been hoped that it would be possible, in due course, to draw useful comparisons between the vital rates among the malaria-infected Valley people with those of the same tribe living nearby in the healthy uplands. However, closer examination of the two groups has revealed important difference in many of the environmental influences to which they are exposed. The Valley, with its alternation of drought and flood, affords only a precarious livelihood to the cultivator, and to the vagaries of a fickle climate must be added the relative prevalence of illiteracy, poverty, and intemperance. Valley society is thus exposed to a variety of stresses to which the Mamba community is much less prone. Such stresses are doubtless to blame for the restlessness displayed by the young adult population of the Valley, to which reference will be made later in this paper in a comparison of the demographical data so far collected.

(3) THE TAVETA ZONE

This Zone lies some 40 miles to the north of the last Zone, in the Taveta sub-District of Kenya, where a group of large springs emerges to the south-east of Kilimanjaro. Thick forest has covered the areas of high subsoil water around these springs and along their distributaries as they drain southwards into Lake Jipe. During the last three or four centuries Taveta Forest has become the home of a small but distinctive Bantu tribe, the Wa-taveta. The population under study in this zone includes the whole of this tribe as well as a few neighbouring communities in the Lumi Delta on the Pangani River as far west as Kileo, and the fishing village of Mata on the shore of the Lake. The latter groups are relatively recent immigrants to the district from local Bantu tribes, Wa-pare, Wa-chagga, Wa-teita, and Wa-kamba. The Zone covers an area of some 20 square miles, in which the average population density is about 300 persons per square mile. The altitude is about 2,500 feet, sloping gently from north to south. The Taveta climate is somewhat hotter and dryer than that of the Mkomazi Valley, the rainfall rarely exceeding 20 to 25 inches and the annual mean shade temperature approaching 26°C.

The chief crops of the Wa-taveta—maize, sugarcane, cotton, cassava, and beans—are irrigated, while bananas are grown within the Forest. Bee-keeping and the collecting of honey is a time-honoured but declining occupation. During the second world war

a scheme for the irrigation of rice was started at Kimorigo and a number of Wa-kamba families settled in that area, but because of a rise in soil salinity the scheme has been abandoned and the families who still remain at Kimorigo depend to a greater extent on small flocks of sheep and goats than on the meagre produce of the soil. In the whole area, however, fish is plentiful and cheap. On the basis of a rough nutritional survey carried out in 1955, the opinion was recorded that the Wa-taveta then enjoyed a diet that was more wholesome and better-balanced than that normally available to the plains people of the region. Conditions of life for the Wa-taveta have not deteriorated since that time, rather the reverse, although the standard of living of other communities in the Zone is more variable.

The traditional dwelling of the Wa-taveta is a "bee-hive" hut, thatched from peak to ground level with banana leaves. These were sited, normally in small groups, in clearings in the Forest. The level of comfort and hygiene offered by these structures was not enhanced by the custom of tethering a couple of stall-fed cattle inside. Outwardly the environment is changing nowadays: the finer forest trees have been felled for timber and the lighter growth cleared for the planting of maize and cotton; meanwhile the "bee-hive" huts are disappearing in favour of the more convenient rectangular *banda* (Smith, 1962).

The vicinity of Taveta Forest has long been recognized as one of the most malarious localities in Kenya. The local epidemiological features have been discussed by Kauntze and Symes (1933), Heisch (1948), and Smith and Draper (1959). The last authors estimated that the people in the Forest were exposed to 12 to 26 infective bites per person per year. As in the Mkomazi Valley, residual spraying operations carried on in the Taveta area between 1956 and 1959 resulted in the total disappearance of the principal malaria vector, *A. funestus*. Owing to the continuing absence of this species, malaria transmission had not, by 1962, resumed at anything approaching its former intensity.

Registration in the Taveta Zone was started at the end of August, 1961, and the work was completed before the end of December. A few additional villages in the Lumi Delta were added to the Zone during April, 1962. There is much circumstantial evidence to suggest that children with sickle-cell trait are less severely affected by malaria than children with normal haemoglobin. Conclusive data, based on comparative mortality studies of the two types, have not been obtained. In view of the prevalence of sickle-cell trait in the Wa-taveta, the community is currently under study with the intention of filling

this gap in our knowledge. Thus all Wa-taveta infants are being screened for the presence, or otherwise, of the trait, and the subsequent mortality of the two types will be followed through childhood as part of the work of the vital statistics survey.

PRELIMINARY DEMOGRAPHIC INFORMATION

(1) AGE AND SEX COMPOSITION.—The age and sex composition of the three populations are detailed in Table I. For the most part the populations are grouped in five-year age groups up to the 74th year, and a more detailed break-down of infants and children is attempted.

In Fig. 2 (opposite), population pyramids have been constructed from these data. These indicate the number of males and females in each 5-year age group, adjusted to the number present per thousand in each community.

There are considerable differences in the age-composition of the three communities: in Mamba over one-fifth of the population is under 5 years of age, and half is under 15 years; by contrast, in the malarious Mkomazi Valley, half the population is

over 24 years of age. The even taper of the population pyramid for Mamba is suggestive of a settled stable population, and the breadth of the base in relationship to the whole is indicative of a high current fertility. On the other hand the Mkomazi pyramid is irregular in shape, and similar irregularities, of lesser degree, occur in the Taveta pyramid. While minor irregularities could be due to periods of unusually high or low mortality affecting particular age groups, they are more likely to be due to one or other of two factors: errors in estimating the age of individuals, and movements of special groups out of, and into, the Zone. Thus the considerable deficit of adolescent and young adult males in the Mkomazi population is due mainly to an exodus of part of this group in search of employment more rewarding than the Zone can offer to a young, ambitious fellow. A reason for the deficit of young girls from the Mkomazi Zone is less obvious, other than the likelihood that some accompany the young men who leave the Zone. In most respects the population of Taveta seems to occupy an intermediate position between the prosperous, upland people of Mamba and the communities exposed to the harsher conditions of life in the Mkomazi Valley.

TABLE I
AGE COMPOSITION OF THE THREE COMMUNITIES IN THE SURVEY

Age Group (yrs)	Mamba			Mkomazi Valley			Taveta		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Less than 6/12	85	84	169	39	44	83	57	60	117
6-11/12	93	66	159	47	35	82	56	61	117
12-17/12	108	105	213	54	56	110	67	60	127
18-23/12	66	76	142	54	57	111	58	49	107
2	93	81	174	85	100	185	64	61	125
3	118	142	260	62	80	142	92	110	202
4	148	133	281	80	70	150	140	117	257
Total 0-4	711	687	1,398	421	442	863	534	518	1,052
5-9	631	628	1,259	313	336	649	536	478	1,014
10-14	495	509	1,004	249	191	440	307	287	594
Total 5-14	1,126	1,137	2,263	562	527	1,089	843	765	1,608
15-19	399	352	751	183	202	385	257	238	495
20-24	227	321	548	165	242	407	128	254	382
25-29	217	242	459	176	218	394	197	247	444
30-34	194	191	385	198	172	370	151	148	299
35-39	137	151	288	226	171	397	227	177	404
40-44	120	125	245	166	177	343	129	159	288
45-49	125	115	240	196	113	309	135	110	245
Total 15-49	1,419	1,497	2,916	1,310	1,295	2,605	1,224	1,333	2,557
50-54	69	77	146	126	117	243	92	82	174
55-59	46	44	90	85	62	147	71	22	93
60-64	54	45	99	86	66	152	51	60	111
65-69	33	60	93	52	27	79	39	29	68
70-74	54	54	108	46	30	76	31	35	66
75+	79	62	141	57	23	80	49	29	78
Total 50+	335	342	677	452	325	777	333	257	590
Grand Total	3,591	3,663	7,254	2,745	2,589	5,334	2,934	2,873	5,807

FIG. 2.—Sex and age composition of populations of the three zones.

(2) SIZE OF HOUSEHOLDS.—The numbers of persons registered in each household during the initial survey are compared in Table II (overleaf).

As would be expected, households in the relatively crowded Zone of Mamba tend to be much larger than those of Mkomazi or Taveta. In the former the mode

is four persons per house, whereas in the other Zones the mode is only one.

(3) COMPOSITION OF HOUSEHOLDS.—While the time available for the survey prevented any attempt being made to establish the detailed relationship

TABLE II
NUMBER OF INMATES PER HOUSEHOLD

Number living in Each House	Mamba		Mkomazi Valley		Taveta	
	No. of Houses	Per cent. of Total	No. of Houses	Per cent. of Total	No. of Houses	Per cent. of Total
1	187	13.1	420	25.2	357	22.3
2	120	8.4	367	22.0	294	18.4
3	148	10.4	280	16.8	206	12.8
4	195	13.6	218	13.1	233	14.5
5	190	13.3	148	8.8	172	10.9
6	158	11.1	113	6.8	152	9.5
7	130	9.1	53	3.2	87	5.4
8	123	8.6	31	1.9	46	2.8
9	69	4.8	18	1.1	26	1.6
10	54	3.8	11	0.7	13	0.8
11	21	1.5	6	0.4	5	0.3
12	10	0.7	1	0.06	6	0.3
13	8	0.6	0	0.0	1	0.06
14	3	0.2	0	0.0	0	0.0
15	0	0.0	0	0.0	0	0.0
16	2	0.1	0	0.0	1	0.06
17	1	0.07	0	0.0	1	0.06
Total No. of Houses	1,419		1,666		1,600	
Average Inhabitants per House . .		5.1		3.1		3.6

between various members of each household, the relationship between a mother and any surviving children who were living in the same house was recorded. The results of this study are summarized in Table III, where the average number of children living with their mother is presented in the penultimate column. In the final column the proportion of females who were without children in the same

household is also provided. This last column confirms the impression gained elsewhere that the fertility of the Mamba population is considerably higher than that in the malarious Zones where a high proportion of the older females seem to have no surviving children. Though the frequency of larger households, and even perhaps a degree of overcrowding, in Mamba would tend to reduce this ratio, it would be

TABLE III
NUMBERS OF CHILDREN CURRENTLY LIVING IN THE SAME HOUSE WITH THEIR MOTHER

Zone	Age Group of Mother (yrs)	Children living with Mother											Total Children	Total Mothers	Average Children per Mother	Percentage "Child-less" Females	
		0	1	2	3	4	5	6	7	8	9	10					11
Mamba	15-19	108	203	34	6	1								293	244	1.2	30.7
	20-24	66	109	96	41	9								460	255	1.8	20.6
	25-29	21	26	50	50	65	26	3	1					626	221	2.9	8.9
	30-34	5	8	16	24	45	41	28	17	6	1			841	186	4.5	2.7
	35-39	5	5	7	10	21	22	30	26	21	4			809	146	5.5	3.3
	40-44	14	3	6	13	14	17	20	17	14	4			614	111	5.5	11.2
45-49	20	5	8	14	10	14	18	13	6	4		2	2	537	95	5.6	17.4
Mkomazi Valley	15-19	146	47	7	2									67	56	1.2	72.2
	20-24	76	76	64	22	3	1							287	166	1.7	31.4
	25-29	45	40	44	50	28	10	1						446	173	2.6	20.7
	30-34	56	33	17	25	17	15	7	2					341	116	3.0	32.5
	35-39	60	22	30	15	17	12	7	4	4				357	111	3.2	35.1
	40-44	90	26	13	17	12	6	7	4	2				267	87	3.1	50.8
45-49	62	20	9	10	2	1							121	51	2.2	54.9	
Taveta	15-19	182	49	7										63	56	1.1	77.0
	20-24	45	72	87	39	10	1							408	209	1.9	13.8
	25-29	30	27	52	70	44	20	4						641	217	2.9	12.1
	30-34	16	16	22	23	35	26	2	5	2				472	132	3.6	10.8
	35-39	27	16	18	29	31	25	20	5	3	2		1	594	150	3.9	15.3
	40-44	41	29	21	19	10	16	12	1					327	108	2.1	32.1
45-49	43	19	20	9	7	8	2	1	1				181	67	2.7	39.1	

less liable to do so in the case of younger women. It does therefore appear that barren marriages are rare in Mamba, but are not uncommon in the other Zones.

Vital data currently being collected in the three communities will be reported in a later communication.

SUMMARY

- (1) A 5-year programme for the collection of vital data from one malaria-free, and two hyper-endemic, Bantu communities in East Africa was started in 1961.

- (2) A preliminary summary is offered of the environment, economy, and population composition of the three communities under study.

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