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A Multipurpose Serological Survey in Kenya

1. Survey Methods and Progress of Field Work

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The need to develop methods for serological sample surveys has increased during recent years. The article describes the methods of sampling and blood collecting employed in a serological survey which was conducted in three different areas of Kenya.

The purpose of the survey was primarily to gather information about the age-specific prevalence of various infections which were thought to pose public health problems in the country. An attempt was also made to identify environmental factors which might be associated with variation in the prevalence of the different infections. This was done by collecting data about such factors at the same time as the serological specimens were obtained in the selected survey groups.

The experience gained during the field work showed that it is possible to achieve a high coverage of bleeding (80 %) in randomly selected population groups living in rural Kenya when proper incentives are given to the examinees. Venous blood could be obtained from subjects under field conditions down to the age of 2 years; from the babies only capillary blood could be obtained.

This paper describes how field work was planned and carried out in a multipurpose, serological, sample survey in Kenya. The laboratory findings are presented in two subsequent papers, one dealing with arbovirus antibody investigations (Geser et al., 1970), the other (to be published later) concerning other viral infections, as well as bacterial and treponemal infections.

The survey was carried out under the auspices of the WHO-assisted Global Surveillance Programme and the field work was completed between November 1966 and April 1968. The sera were collected by Kenya Government field teams assisted by the WHO Epidemiological Centre in Nairobi. The specimens were sent to co-operating laboratories in Entebbe, Uganda, Prague, Czechoslovakia, and Copenhagen, Denmark, for antibody determinations.

PURPOSE OF THE SURVEY

The main purpose of the survey was to determine the prevalence of infections which are of importance in Kenya and—with vaccination campaigns in mind—to find the proportion of people who are susceptible to these infections at various ages.

In addition, it was intended to study the geographical variation in the frequency of these infections and, if possible, to identify environmental factors associated with such geographical variations. For this purpose, areas that were ecologically very different were included in the survey and uniform methods of sampling and laboratory procedures were applied throughout.

CHOICE OF INFECTIONS

The number of antibody determinations which can be carried out on a single specimen of venous blood is limited, even at the present time when many micro-methods for immune reactions are available. When infections for inclusion in the survey were selected priority was given to diseases which may be of public health importance in Kenya and, in particular, to those diseases against which effective control measures exist. Due respect was also paid to the availability of suitable laboratory

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methods which require very small amounts of sera only (micro-methods). It was finally decided that the serum samples should be examined for antibodies to the following infections.

Virus diseases

Measles. Measles is responsible for a high mortality among young children in Kenya and anti-measles immunization campaigns are under consideration. The main question to be answered from the survey data is what age-groups are still sufficiently free from infection to warrant mass immunization.

Poliomyelitis. Epidemics of poliomyelitis have occurred repeatedly over the last few years in different parts of Kenya and extensive vaccination campaigns are being conducted against this disease. For the planning of immunization programmes, it is clearly of the greatest importance to know the extent to which the various age-groups in the population are already infected with the different strains of poliovirus.

Arboviruses. Yellow fever has not been seen in Kenya for many years but epidemics have occurred in Sudan and in Ethiopia, not far from the borders of Kenya. Various species of *Aedes* mosquitos are widespread all over Kenya and the question therefore arises whether a sufficient number of susceptible people is available to sustain an epidemic of yellow fever should the virus be introduced into Kenya. To answer this question, the serum samples were examined for the presence of yellow fever antibodies.

An epidemic of o'nyong-nyong fever spread from Uganda into the Nyanza Province of Kenya in 1959 (Haddow et al., 1960) but was not reported from other parts of Kenya. In order to investigate whether o'nyong-nyong transmission still takes place, antibody determination for this infection was also included.

The sera collected in the survey were also tested with various other antigens obtained from arboviruses isolated in East Africa, in order to study the geographical distribution of these infections. The following arboviruses were included under this heading: chikungunya, Sindbis, Bunyamwera, Zika, West Nile, Wesselsbron, Banzi and dengue. It was, of course, realized that the immunological cross-reactions which take place between the various arbovirus infections would permit only a rough screening for the occurrence of group A and group B viruses and not a detailed mapping of the individual infections.

Bacterial diseases and treponematoses

Diphtheria. Despite the absence of diphtheria immunization campaigns in the past, diphtheria is hardly ever reported in Kenya although bacteriological laboratories capable of isolating *Corynebacterium* exist in various parts of the country. In order to investigate whether the low incidence of laryngeal diphtheria is due to widespread immunity acquired at a very early age, the survey sera were examined for presence of diphtheria antitoxin.

Pertussis. Whooping-cough accounts for a considerable infant mortality in malnourished babies in Africa. Some immunization is already carried out in child health clinics in towns in Kenya and a large-scale pertussis vaccination campaign may be contemplated in the future. In order to determine the age of onset of infection, the sera were examined for antibodies against pertussis and para-pertussis.

Streptococci. Acute upper respiratory infections are extremely common in Kenya and are probably the most frequent causes of death in children under 2 years of age. In order to find out how much of this respiratory illness may be caused by streptococcal infection—which to a large extent is preventable—the anti-streptolysin O level was determined in a sample of the survey sera.

The interest in streptococcal infection was further stimulated by evidence indicating that rheumatic heart disease may be common in tropical Africa and may require urgent public health measures.

Typhoid and paratyphoid fever. Gastrointestinal infections are frequent in Kenya as elsewhere in the tropics. To what extent *Salmonella* infections contribute to these conditions is not known and the collected sera were tested for presence of antibodies to *S. typhi* and *S. paratyphi* in an attempt to assess the magnitude of the *Salmonella* problem in Kenya.

Treponematoses. An anti-yaws campaign was carried out in Kenya some time ago and the general opinion is now that yaws has ceased to be a public health problem in the country, whereas transmission of venereal syphilis is on the increase. Treponemal antibody determinations were included in the present investigations in order to see how far these hypotheses are correct.

Other investigations

Posterity studies. The WHO Serum Reference Bank in Prague has preserved a small amount (about 0.2 ml) of each serum for future use. These sera will be stored in the lyophilized condition in order to preserve certain biological characteristics, including immunological properties. The sera may be investigated in the future for presence of antibodies to newly detected infections with a view to determining whether these infections also occurred in the past.

Co-operating laboratories

The laboratory investigations were carried out at the following laboratories:

Bacterial and viral (except arbovirus) infections. The Institute of Microbiology and Epidemiology, Prague.

Arbovirus infections. The East African Virus Research Institute, Entebbe.

Treponematoses. Statens Seruminstitut, Copenhagen.

ENVIRONMENTAL CONDITIONS AND GEOGRAPHICAL VARIATION IN PREVALENCE OF INFECTION

By conducting the survey in different ecological situations, it was thought that substantial variations in prevalence rates would occur from area to area and that it might be possible to identify some environmental factors which are associated with such variations.

The environmental factors of interest obviously vary greatly for different types of infection. In the case of arbovirus infections, for instance, the density of winged vectors may be the most important environmental variable determining the rate of infection, whereas the transmission of intestinal infections may depend on such environmental conditions as the nature of the water supply and pollution of the environment, factors which are of no consequence for the propagation of arboviruses. Again, for diseases such as diphtheria, whooping-cough and acute respiratory infections, which are transmitted through direct person-to-person contact, it may be the degree of crowding in homes that determines the risk of transmission. Not all factors can be covered in one study but it was thought, nevertheless, that certain data (" core data ") on environmental conditions are pertinent to the epidemiology of most infections and that such data should be collected in any survey.

The problem of selecting environmental factors to be observed, and possibly measured, during field work is of great concern in the planning of a disease survey. As many variables as possible should be included, even though some of them subsequently may prove to be of no use in the particular study. The cost of making observations in each group during the survey is small but great efforts and expense may be incurred in re-visiting the various survey points later if it is found that certain important data have not been collected.

In view of the purpose of the present study, and also considering the practical difficulties in observing and measuring epidemiological variables, it was decided that the following core data should be collected in connexion with the serological survey.

For each survey area. As will be explained in a subsequent part of this report, the survey was carried out in three separate geographical areas which differ considerably with respect to climate, geography and ethnic grouping. The following core data were not collected especially for the survey, but were obtained from existing reports of various government departments for each area as a whole: rainfall, humidity, mean temperatures, altitude, and rock and soil formation.

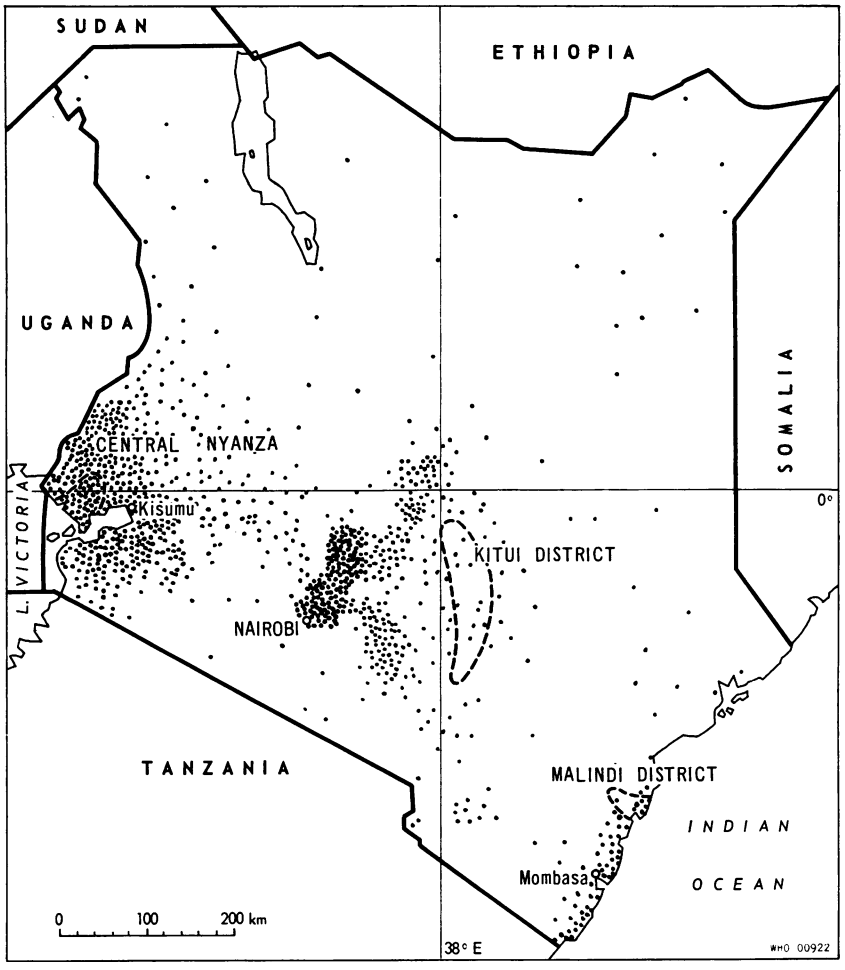
The environmental factor of the greatest importance for the interpretation of the arbovirus findings—namely, *entomological data* for the survey areas—could not be assessed during the survey owing to the lack of trained staff. The three survey areas were deliberately chosen in areas where the Division of Insect-borne Diseases (DIBD) of Kenya has, for a number of years, maintained field units for the control of insect-borne diseases. The teams are trained in systematic entomological investigations and could, at a later stage, be used to collect data on arthropod vectors if the results of the serological testing should justify the additional field work.

For each survey group. The following information was recorded in each survey group: ethnic group (tribe), density of population, presence of domestic animals, nearness of potential insect breeding grounds, source of water supply, distance from nearest health centre and hospital, past experience with vaccination campaigns and main food supplies.

For each household. Size of household, water supply, presence or absence of a latrine and distance from river, lake, swamp or forest.

For each individual. Age and sex, relationship to head of household, occupation, length of stay

FIG. 1
LOCATION OF SURVEY AREAS IN KENYA AND POPULATION DENSITY



in the group, educational status and vaccination status (both arms were inspected for presence of BCG and smallpox vaccination scars but no interrogation was carried out).

THE SURVEY AREAS

For practical reasons the survey was confined to districts covered by field units from the DIBD. In order to ensure a wide range in prevalences of infections as well as in environmental conditions, three ecologically very different areas were selected among the available areas; they were: Central Nyanza in the Lake Victoria area, Kitui District in the dry central plains and Malindi District at the coast.

The position of the three survey areas is shown in Fig. 1 and some of the most striking differences between the survey areas are given in Table 1. The locations of the various clusters which were subse-

TABLE 1
GEOGRAPHIC AND DEMOGRAPHIC DATA FOR EACH OF THE THREE AREAS INCLUDED IN THE SURVEY

Survey area	Population density per square mile (2.6 km²)	Altitude (feet; metres)	Daily mean temperature (°F; °C)	Annual rainfall (inches; cm)	Tribe	Prevailing vector-borne diseases
Central Nyanza	366	3 500–4 000; 1 067–1 219	72–76; 22–24	40– 50; 102–127	Luo (Nilotic)	Malaria and trypanosomiasis
Kitui District	24	1 500–3 500; 457–1 067	80–87; 27–31	10– 30; 25– 76	Kamba (Bantu)	Malaria and kala-azar
Malindi District	52	Sea level	77–86; 25–30	40– 50; 102–127	Giriama (Bantu)	Malaria and filariasis

quently selected for the survey within each area are shown in Fig. 2–4. It can be seen that the groups were well scattered over the areas included in the survey.

In spite of the differences in environmental conditions reflected in Table 1, living conditions appeared to be more or less uniform throughout all the survey groups. The vast majority of people in all the areas live as poor subsistence farmers in simple huts scattered over the tropical bushland. The environmental conditions were not fundamentally different from area to area but varied only in degree. Many of the variables such as density of habitation, nearness to natural water sources and crowding in homes were measured in the survey groups in order to study the correlation between environmental conditions and risk of infection.

SURVEY METHODS

Sampling procedures

In each of the three survey areas, groups of people were selected at random for inclusion in the survey. It was decided that a sample group should consist of three subgroups, each comprising 50 persons living in close proximity. It was thought that 50 persons could be dealt with in a day by a team. In view of the manpower and time available for the survey it was decided that 10 sample groups should be examined in each of the three survey areas, corresponding to 90 team days of field work in the entire survey.

In each survey area, the 30 sample subgroups were selected by means of a two-stage random selection scheme, which was as follows.

First stage: selection of sublocations. The smallest administrative area for which census data are available in Kenya is the sublocation, which was therefore used as the initial sampling unit. In each of the three survey areas, 10 sublocations were selected at random from the 1962 census list. In this selection, the sublocations were weighted according to the size of population so that all persons living in the survey area had the same chance of being included in the survey.

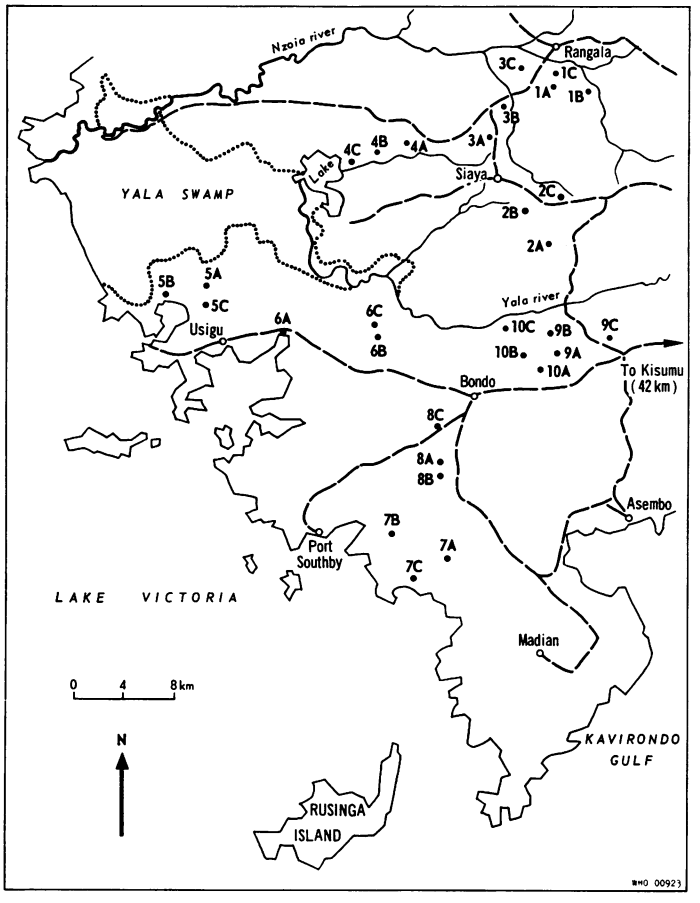
Second stage: selection of starting points. Once a sublocation had been selected, it was necessary to determine the starting point for each of the three subgroups. This was done from the list of taxpayers which is available for each sublocation. The lists are kept by the sublocation chiefs and it was found that they were up to date in nearly all instances and that practically all households had a taxpayer registered in the lists, whether he actually paid tax or not. In each sublocation 3 starting points were thus chosen by the random selection of 3 taxpayers from the list.

A subgroup was then defined by beginning with the household containing the selected taxpayer and from there proceeding to the nearest house and then to the nearest again until at least 50 persons had been registered. All persons belonging to the last household were to be registered and examined even though the number examined in the subgroup might thereby exceed 50.

Table 2 shows the size of the population and the number of sublocations in each of the three survey areas. The size of the total population differed from area to area and, as the sample size ($30 \times 50 = 1500$ persons) was kept constant in each area, it follows

FIG. 2

POPULATION GROUPS EXAMINED IN THE SEROLOGICAL SURVEY IN NYANZA PROVINCE, KENYA



Secondary road

River

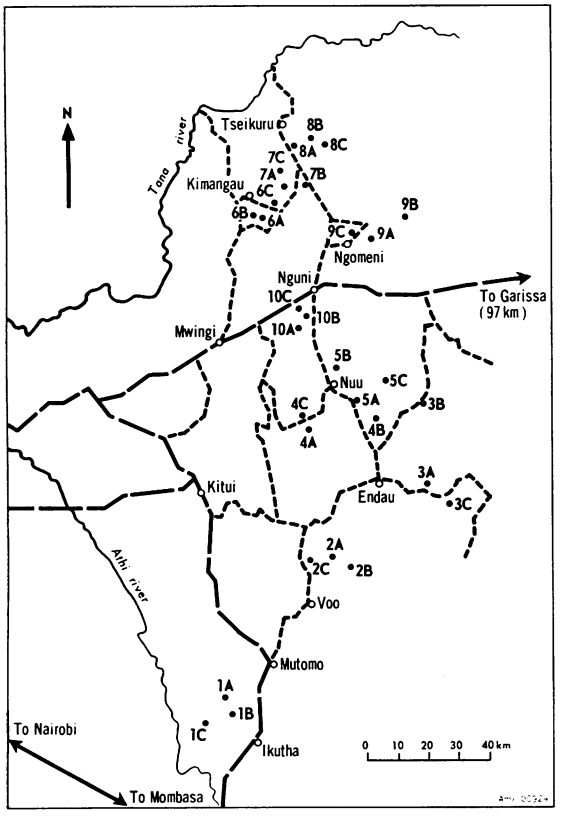
Boundary of swamp

o Village

• Sample subgroup

FIG. 3

POPULATION GROUPS EXAMINED IN THE SEROLOGICAL SURVEY IN KITUI DISTRICT, KENYA



Main road

Secondary road

Other road

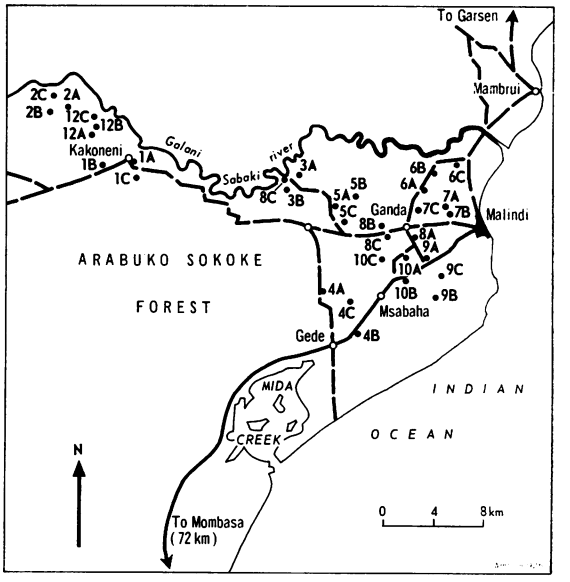
River

Town or village

Sample subgroup

FIG. 4

POPULATION GROUPS EXAMINED IN THE SEROLOGICAL SURVEY IN MALINDI DISTRICT, KENYA



Main road

Secondary road

River

Town

Village

Sample subgroup

that the sampling fraction varied from area to area. This was done deliberately since it was thought that a comparison of prevalence rates between areas would be easier if the number of persons examined was the same in each area.

TABLE 2

POPULATION SIZE AND NUMBER OF SUBLOCATIONS IN EACH OF THE THREE SURVEY AREAS

Survey area	Total population	Covered by Division of Insect-borne Diseases	
		Sublocations	Population
Central Nyanza	664 000	46	114 000
Kitui District	285 000	81	94 000
Malindi District	248 000	21	31 000

Registration of the survey population and recording of observations

During the actual field work the household was the unit of registration and all persons living in the selected households at the time of the survey (the *de facto* population) were eligible for examination.

On the day of the examination each potential examinee was first registered on an "individual form" (Fig. 5). A team member accompanied by a representative of the sublocation chief went from house to house and interviewed an adult member of each household in order to obtain information regarding all its members. Relevant data such as name, father's or husband's name, age, sex, family status and tribe were recorded, and consecutive numbers were allocated to the households, this household number being recorded on the form together with a serial number for each individual. Individual forms were also used for recording the following data: years of school attendance, length of stay in a sublocation, presence of a BCG or smallpox vaccination scar, date of examination and type of specimen obtained (venous or capillary blood).

The registration clerk also filled in two other forms as follows.

Household form (Fig. 6). One such form was completed for each household, giving information about the serial number of a household, name of the head of household, number of persons belonging to the household, nearness to other houses, type of water supply, presence of a latrine and distance from house to swamp, river, lake or sea.

Cluster report (Fig. 7). For each subgroup (cluster), a sketch map was drawn to show the distance between the selected houses. The following information was recorded on the cluster report: size of community (number of inhabitants), road conditions and means of transportation, distance from the nearest health centre, topography, animal husbandry, crops grown in the locality, and past experience of vaccination campaigns.

Organization of survey work

Staff. The field work was carried out by technicians from the DIBD, trained and supervised by staff members from the WHO Epidemiological Centre in Nairobi. In each survey area a new team was formed comprising the following members: 1 registration clerk, 2 technicians for bleeding, 1 assistant for drug distribution, 1 driver and 1 laboratory technician for separation of the sera. The team was transported in a vehicle kindly made available by the Government of Kenya.

Work procedures. The day prior to work in a given subgroup, a team member and the local sublocation chief, or his representative, visited the selected taxpayer and his neighbours and informed the whole group about the work, requesting everybody to be present on the following day.

In order to encourage people to participate, the team distributed antimalarial drugs, vitamins and other medicaments (aspirin, penicillin, eye ointment, etc.) to persons who reported for examination. It was explained to the chiefs and the population that the present survey would help the Government to plan future vaccination campaigns and other health services and that it was, therefore, in the interest of the community that all persons called upon should co-operate fully.

Techniques

The following techniques of collecting, separating and transporting blood specimens were employed in the course of field work.

Vein puncture. It was realized that it would be of particular interest to collect venous blood from young children but in the first survey (Central Nyanza) vein puncture was not attempted in children under the age of 5 years since this procedure was thought to be too difficult to carry out in small children under field conditions. However, as the team gained more confidence it was found that satisfactory specimens of venous blood could be obtained from children down to the early years of life and in the other two survey areas (Kitui and Malindi) no age limit for vein puncture was fixed.

About 10 ml blood was collected from a cubital vein with the help of a Vacutainer and a disposable needle (20-gauge). The skin was not cleaned but venous stasis was established before puncture by means of rubber tubing. The serial number of each examinee was marked on the Vacutainers by means of a grease pencil and was also written on the rubber stopper with a ball-point pen.

After collection, the specimens were left standing in the shade for about 1 hour for coagulation to take place. They were then placed in an insulated cardboard box together with a tin containing ice. At the end of the day's work, the containers were taken by vehicle to the field laboratory over distances which varied from 20 to 50 miles (32 km–80 km).

FIG. 5

INDIVIDUAL FORM USED IN THE KENYA SEROLOGICAL SURVEY

K E N Y A	Serological Survey	Individual Form

Identification

1. Name of individual: ..... 4. Individual no.: .....
2. Name of father/husband: ..... 5. Household no.: .....
3. Relationship to head of household: .....

6. Sex: Male ☐
Female ☐

7. Age: ..... years

8. Tribe: .....

9. No. of years attending school .....

10. Length of stay in sub-location:
..... years

Vaccination scar

	Yes	No	Doubtful
11. Smallpox	☐	☐	☐
12. BCG	☐	☐	☐

13. Type of specimen: Serum ☐ Rondelle ☐ No specimen ☐ because .....
14. Date: ..... 15. Blood taken by: .....

Specimens forwarded:

	ABV	VDT	BD	Pol	Other	Clot
16. Aliquot:	☐	☐	☐	☐	☐	☐
17. Rondelle:	☐	☐	☐	☐	☐	

18. Remarks:

FIG. 6

HOUSEHOLD FORM USED IN THE KENYA SEROLOGICAL SURVEY

Serological Survey, Kenya

HOUSEHOLD FORM

1. Name of head of household:	2. Size of household	3. Survey No.	4. Sub-location No.	5. Household No.

6. Concentration:

No. of houses within a radius of 200 metres:

☐ None ☐ 1-2 ☐ 3-5 ☐ 6-10 ☐ More than 10

7. Type of wall construction:

☐ Mud ☐ Brick ☐ Wood ☐ Other, specify .....

8. Type of water supply:

☐ Stream ☐ Other surface ☐ Open well ☐ Closed well ☐ Rainwater ☐ Other

Distance to specified water supply: .....

9. Latrine:

☐ present, specify type: .....

☐ not present

10. Distance to:

River: ..... Sea: .....

Swamp: ..... Forest: .....

Lake: ..... Other: ..... specify .....

11. Remarks:

12. Date reported:	13. Reported by:

FIG. 7

CLUSTER REPORT FORM USED IN THE KENYA SEROLOGICAL SURVEY

Serological Survey, Kenya

CLUSTER REPORT

1. Survey No.	2. Sub-location No.	3. Name of sub-location:	4. Date(s) of work:

5. Location (see map):
.....
.....

6. Communication:
.....
.....

7. Demography:
Type of community: .....
Size of community: .....

8. Topography:
.....
Altitude: ..... feet Surface: ..... Soil: .....

9. Climate:
Rainy seasons: 1 ..... 2..... Present temperature ...
Rainfall: 1 ..... 2..... Present humidity .....

10. Vegetation:

11. Main crops:

12. Animal husbandry:

13. Main occupations:

14. Staple diets:

15. Distance to nearest:
Out-patient clinic: ..... Hospital: ..... Market: .....

16. Vaccination campaigns in area (state when and to whom):
BCG:..... Smallpox: .....
Diphteria: ..... Polio: .....
Whooping Cough: ..... Other: .....
Tetanus: ..... (specify) .....

17. Remarks (re co-operation, insect breeding grounds, etc.):

18. Date reported:	19. Reported by:

In the laboratory, the specimens were immediately placed in a domestic refrigerator (temperature about 4°C) where they were left to stand overnight; no rimming of the clot was done.

Collection of capillary blood. From small children on whom vein puncture could not be performed, capillary blood was collected on "rondelles" of blotting paper from a cut in a finger or a toe. In Central Nyanza, 2 rondelles were soaked with blood from each child but this was found to be insufficient and in the two other survey areas 4 rondelles were obtained from each subject. After collection, the rondelles were left to dry by standing them in the fresh air, fixed to a table by means of a pin. After drying for approximately half an hour, the rondelles were placed in plastic envelopes which were carefully numbered for correct identification.

Handling of venous blood specimens. In each survey area, a temporary laboratory was established at the nearest health centre for the separation and dispatch of the sera. The laboratory was situated as near to the survey area as possible so that the specimens could be taken there every day. The centrifuge required electrical power and in one instance (Kitui District) the survey team had to bring a mobile generator from Nairobi since a general electricity supply was not available.

Good clot retraction was usually obtained by standing specimens overnight in the refrigerator; the specimens (still in the Vacutainers) were then centrifuged at a speed of 600 rev/min for 20 minutes and the serum was immediately removed by pipette and distributed in 2-ml plastic tubes. The intention was to prepare 4 portions (each about 1–1.2 ml) from each specimen: portion 1 for poliovirus antibody titration: portion 2 for investigation of bacterial diseases; portions 3 and 4 for treponematosis and arbovirus determinations, respectively. The portions were carefully numbered with a special marking-pen and then placed in an insulated container maintained at a temperature of about −196°C by means of liquid nitrogen.

Large steel containers each accommodating 30 litres of liquid nitrogen and about 800 portions of serum were used for the shipment of sera to the receiving laboratory in Europe. Before being taken to the field each container was filled with 30 litres of liquid nitrogen (which is manufactured in Nairobi). The charge was found to last well over a month, even in a tropical climate at high altitude (low atmospheric pressure) where the containers were opened daily for the introduction of new specimens. The containers were sent by air to the Institute of Microbiology and Epidemiology, Prague; from there, samples were sent to the Statens Seruminstitut, Copenhagen, for the determination of treponematosis antibodies. The portions destined for arbovirus investigations were sent by air directly from Nairobi to the East African Virus Research Institute, Entebbe, in insulated cardboard boxes containing ice.

PROGRESS OF FIELD WORK

Tables 3–6 show the amount of field work carried out in the survey and also the coverage achieved in the various groups and the proportion of satisfactory specimens obtained.

TABLE 3

DURATION AND AMOUNT OF FIELD WORK PERFORMED IN EACH OF THE THREE SURVEY AREAS

Survey area	Time of field work	No. of team-days in field	No. of persons registered [a]	No. of persons bled [a]		
				Vein puncture	Capillary bleeding	Total
Central Nyanza	Nov. 1966–March 1967	30	1 689 (56)	1 018	404	1 422 (47)
Kitui District	Oct. 1967–Feb. 1969	32	1 680 (56)	1 139	154	1 293 (43)
Malindi District	Feb.–April 1969	42	2 021 (48)	1 160	180	1 340 (32)
All areas	Nov. 1968–April 1969	104	5 390 (52)	3 317	738	4 055 (40)

[a] Numbers in parentheses are average number of operations per day.

TABLE 4

NUMBER OF PERSONS REGISTERED AND EXAMINED, AND COVERAGE OBTAINED, IN EACH SURVEY GROUP

Survey area	Group No.	No. registered	Temporarily absent	Eligible for examination	No. of persons examined			No. of persons not examined					Coverage [a]
					Venous blood	Rondelles	Total	Absent	Refused	Too sick	Vacutainer broken	Total	
Central Nyanza	101	165	11	154	84	36	120	15	11	1	7	34	77.9
	102	189	34	155	104	28	132	19	4	—	—	23	85.2
	103	167	7	160	100	37	137	21	1	—	1	23	85.6
	104	160	4	156	103	37	140	14	1	1	—	16	89.7
	105	172	6	166	115	40	155	11	—	—	—	11	93.4
	106	169	7	162	111	45	156	1	2	—	3	6	96.3
	107	169	10	159	94	47	141	15	1	1	1	18	88.7
	108	166	6	160	100	52	152	7	1	—	—	8	95.0
	109	160	6	154	102	39	141	7	5	1	—	13	91.6
	110	172	6	166	105	43	148	16	1	1	—	18	89.2
	Total	1 689	97	1 592	1 018	404	1 422	126	27	5	12	170	89.3
Kitui District	201	177	18	159	128	20	148	7	2	1	1	11	93.1
	202	168	6	162	108	18	126	33	3	—	—	36	77.8
	203	171	9	162	108	19	127	27	3	—	5	35	78.4
	204	164	4	160	113	15	128	27	5	—	—	32	80.0
	205	170	11	159	88	7	95	30	34	—	—	64	59.7
	206	165	4	161	129	14	143	14	3	1	—	18	88.8
	207	158	3	155	116	21	137	9	8	1	—	18	88.4
	208	166	1	165	141	12	153	10	2	—	—	12	92.7
	209	171	9	162	120	13	133	21	8	—	—	29	82.1
	210	170	1	169	88	15	103	19	46	1	—	66	60.9
	Total	1 680	66	1 614	1 139	154	1 293	197	114	4	6	321	80.1
Malindi District	301	182	6	176	149	18	167	5	2	1	1	9	94.9
	302	181	19	162	114	23	137	8	8	3	6	25	84.6
	303	172	15	157	93	21	114	4	35	3	1	43	72.6
	304	190	15	175	132	26	158	9	5	—	3	17	90.3
	305	223	29	194	144	17	161	—	30	2	1	33	83.0
	306	182	13	169	142	21	163	4	1	1	—	6	96.4
	307	172	12	160	91	18	109	2	46	—	3	51	68.1
	308	173	10	163	43	8	51	6	106	—	—	112	31.3
	309	199	20	179	114	16	130	11	36	2	—	49	72.6
	310	164	8	156	38	3	41	12	100	3	—	115	26.3
	312	183	18	165	100	9	109	11	43	—	2	56	66.1
	Total	2 021	165	1 856	1 160	180	1 340	72	412	15	17	516	72.2
All areas		5 390	328	5 062	3 317	738	4 055	395	553	24	35	1 007	80.1

[a] As percentage of persons eligible.

TABLE 5

NUMBER OF PERSONS REGISTERED AND EXAMINED, BY AGE AND SEX [a]

Sex	Age (years)	No. of persons registered	Temporarily absent	Eligible for examination	No. of persons examined			No. of persons not examined					Coverage [a]
					Venous blood	Rondelles	Total	Absent	Refused	Too sick	Vacutainer broken	Total	
Males	0	102	4	98	1	75	76	3	14	5	—	22	77.6
	1	88	—	88	3	82	85	1	2	—	—	3	96.6
	2	98	5	93	25	59	84	1	7	1	—	9	90.3
	3	76	—	76	33	38	71	—	5	—	—	5	93.4
	4	157	—	157	68	79	147	7	3	—	—	10	93.6
	5– 9	349	10	339	272	18	290	37	10	—	2	49	85.5
	10–14	287	10	277	207	6	213	47	15	—	2	64	76.9
	15–19	162	14	148	108	—	108	20	17	—	3	40	73.0
	20–24	112	19	93	68	—	68	15	10	—	—	25	73.1
	25–29	123	17	106	84	—	84	12	9	—	1	22	79.2
	30–39	235	24	211	155	—	155	42	11	—	3	56	73.5
	40–49	184	18	166	147	—	147	11	6	1	1	19	88.6
	50–59	137	4	133	119	—	119	9	5	—	—	14	89.5
	⩾60	164	—	164	142	2	144	9	6	3	2	20	87.8
	Unknown	242	56	186	2	—	2	38	146	—	—	184	1.1
	Total	2 516	181	2 335	1 434	359	1 793	252	266	10	14	542	76.8
Females	0	119	2	117	2	91	93	4	16	3	1	24	79.5
	1	97	3	94	10	77	87	3	4	—	—	7	92.6
	2	107	2	105	34	65	99	1	5	—	—	6	94.3
	3	91	—	91	38	49	87	2	1	1	—	4	95.6
	4	138	1	137	60	74	134	—	3	—	—	3	97.8
	5– 9	319	14	305	265	17	282	7	11	—	5	23	92.5
	10–14	235	11	224	195	2	197	18	8	—	1	27	87.9
	15–19	185	9	176	150	1	151	13	10	—	2	25	85.8
	20–24	221	6	215	187	—	187	15	11	—	2	28	87.0
	25–29	222	13	209	188	—	188	8	9	1	3	21	90.0
	30–39	329	5	324	296	—	296	14	10	1	3	28	91.4
	40–49	233	5	228	193	1	194	20	8	2	4	34	85.1
	50–59	166	10	156	138	1	139	7	8	2	—	17	89.1
	⩾60	130	3	127	112	—	112	3	8	4	—	15	88.2
	Unknown	261	61	200	6	—	6	28	166	—	—	194	3.0
	Total	2 853	145	2 708	1 874	378	2 252	143	278	14	21	456	83.2

[a] Excluding 21 whose sex was not recorded.

[b] As percentage of persons eligible.

TABLE 6
PROPORTION OF SPECIMENS OBTAINED BY VEIN PUNCTURE AMONG YOUNG CHILDREN, BY AGE AND SEX

Sex	Age (years)	Specimens obtained			
		Vein puncture		Rondelles	Total
		No.	Percentage [a]		
Males	1	3	3.5	82	85
	2	25	29.8	59	84
	3	33	46.5	38	71
	4	68	46.2	79	147
	1–4	129	33.3	258	387
Females	1	10	11.5	77	87
	2	34	34.3	65	99
	3	38	43.7	49	87
	4	60	44.8	74	134
	1–4	142	34.9	265	407

[a] Of all specimens collected in the age-group.

Work output

The dates of the survey and the number of days the team spent on actual field work are shown in Table 3 for each survey area. On an average, the team registered 53 persons per day and bled 40. The output was somewhat lower in Malindi District where unwillingness to participate necessitated repeated visits to some groups.

Coverage obtained

In no case had a selected subgroup to be given up because it was inaccessible or because the starting point could not be located.

On the whole, the response was favourable and satisfactory co-operation was obtained in most groups as can be seen in Table 4 which shows the coverage achieved group by group in each of the three survey areas.

The number of registrations exceeded 150 in all groups because registration continued in each subgroup until all persons in the household of the 50th registration had been registered. It was found that the registration was practically complete in all groups; the number of persons registered, therefore, gives a true estimate of the number of people living in the selected households.

Table 4 also shows that, for the survey as a whole, 80.1% of the eligible persons were actually bled. The coverage was uniform throughout all groups in Central Nyanza and Kitui District, but it fell far below the average in two groups (No. 308 and 310) in Malindi District. In one subgroup in each of these two groups almost all the people refused to be examined: in one case because the local witch doctor advised very strongly against participation and in the other because it was rumoured that two children had died in a certain survey group after blood-drawing. The team eventually succeeded in obtaining the co-operation of the dissenting "local doctor" and in proving that no children had died in any survey group but the damage had been done and the coverage was as low as 26.3% in one group and 31.3% in the other. It was decided, therefore, to include an additional group (No. 312) in the survey, and this was done by means of an extension of the random selection scheme which had been applied in the initial selection.

Table 5 shows the coverage obtained in each age-group, separately for males and females and for each of the two methods of collecting blood. Of the eligible babies under 1 year of age, 78.6% were bled, practically all from finger or toe punctures. The coverage among children aged 1–4 years was

TABLE 7
DISTRIBUTION OF SERUM SPECIMENS BY NUMBER OF PORTIONS FROM EACH SPECIMEN, BY AGE, ALL GROUPS COMBINED

Age (years)	Portion of serum specimen				
	1	2	3	4	Total
0	—	—	—	3	3
1	—	1	1	11	13
2	3	3	4	50	60
3	2	4	4	62	72
4	1	4	22	102	129
5– 9	4	19	212	306	541
10–14	2	9	35	357	403
15–19	1	4	24	229	258
20–24	—	4	22	229	255
25–29	—	4	36	232	272
30–39	2	8	50	391	451
40–49	2	6	33	300	341
50–59	2	1	19	235	257
⩾ 60	—	4	16	234	254
Unknown	—	—	—	8	8
Total	19	71	478	2 749	3 317

very high for both sexes (90%–98%) and it appears from Table 6 that one-third of the specimens were obtained by vein puncture in this age-group. When it is recalled that vein puncture was not attempted in this age-group in the first part of the survey (Central Nyanza), it seems as if the proportion of successful vein punctures could be increased considerably among the youngest children and it is evident that in future surveys vein puncture should be attempted down to the age of 2 years.

The lowest coverage occurred among young males from 5 to 39 years of age, of whom only 78.2% participated. The main reason for this was that many of the boys were away at school and the active men were out working.

Amount of blood obtained from each subject

It was intended to collect about 10 ml of blood from each subject but not all vein punctures yielded enough blood for 4 portions. Table 7 shows the number of portions that could be prepared from the specimens of sera in the various age-groups. It can be calculated from Table 7 that, in the 1–4 years age-group 82.1% of all specimens were large enough to yield 4 portions and that this proportion was as high as 92.1% among subjects over 60 years of age.

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RÉSUMÉ

ENQUÊTE SÉROLOGIQUE À FINS MULTIPLES AU KENYA: 1. MÉTHODES ET APPLICATION SUR LE TERRAIN

Le présent article expose les aspects méthodologiques d'une enquête sérologique à fins multiples menée dans des régions rurales du Kenya avec, comme objectif principal, d'établir la prévalence des infections importantes du point de vue de la santé publique dans ce pays. On a recherché dans les sérums recueillis à cet effet la présence d'anticorps dirigés contre les agents de maladies bactériennes (diphtérie, coqueluche, streptococcies, salmonelloses), de maladies virales (rougeole, poliomyélite, arboviroses) et des tréponématoses. Le matériel d'étude a été acheminé par air vers des laboratoires de Prague, de Copenhague et d'Entebbe.

On s'est efforcé en outre d'identifier les facteurs de milieu susceptibles d'influer localement sur la prévalence d'une infection donnée. Les enquêteurs ont donc rassemblé, pour chaque groupe étudié, des données relatives aux conditions climatiques, aux caractéristiques ethniques, à la densité de population, aux sources d'approvisionnement en eau et à la présence de conditions propices à la pullulation des insectes.

Les secteurs d'enquête, au nombre de trois, ont été choisis de façon à présenter une grande variété de situations écologiques: le premier dans le district du Nyanza central, près du lac Victoria; le deuxième sur le plateau aride du district de Kitui, au centre du Kenya; le troisième dans le district de Malindi, sur le littoral de l'océan Indien. Dans chacun de ces secteurs, on a constitué, par échantillonnage aléatoire, 10 groupes de 150 personnes dont on a cherché à obtenir la coopération par l'entremise des autorités coutumières locales et grâce à la distribution de médicaments.

Des sujets appartenant à tous les groupes d'âge ont été inclus dans l'enquête, les prélèvements de sang étant effectués soit par ponction veineuse soit, en cas d'échec — particulièrement chez les jeunes enfants —, par prélèvement de sang capillaire au doigt ou à l'orteil. Les sérums obtenus ont été répartis en fractions aliquotes et expédiés dans l'azote liquide (−196°C) aux laboratoires chargés des examens. Le sang capillaire a été recueilli sur papier buvard.

L'équipe chargée des prélèvements, formée de 6 techniciens, a travaillé pendant 104 jours au total. Sur 5390 personnes recensées, on a recueilli 3317 échantillons de sang par ponction veineuse et 738 spécimens de sang capillaire. Compte tenu des absents, l'enquête a couvert 80,1% de l'ensemble de la population des trois secteurs, avec de notables variations suivant les endroits (72,2% dans le district de Malindi; 89,3% dans le district du Nyanza central). Le taux de participation le plus élevé a été enregistré parmi les enfants de 2 à 9 ans, dont plus de 90% ont fourni un échantillon de sang.

L'enquête a démontré qu'il était possible d'obtenir un concours suffisant d'une population rurale du Kenya pour mener à bien des sondages séroépidémiologiques.

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