

RAT AND FLEA CONDITIONS IN A RURAL ENDEMIC PLAGUE AREA IN KENYA

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(With 4 Figures in the Text)

THE survey of rats and fleas in the main endemic plague area of Kenya (Keruguya) has been continued over a further period of two years, September 1935 to August 1937, with the following results.

A. DOMESTIC RATS AND FLEAS

Table I

	Rainfall in.		<i>Rattus rattus</i> trapped					
			♂♂		♀♀		Totals	
	1935-6	1936-7	1935-6	1936-7	1935-6	1936-7	1935-6	1936-7
Sept.	3.76	2.44	218	317	358	429	576	746
Oct.	4.06	7.18	291	254	441	360	732	614
Nov.	10.13	7.05	260	236	334	356	594	592
Dec.	2.36	2.96	245	199	296	287	541	486
Jan.	2.49	0.50	292	207	367	216	659	423
Feb.	7.14	0.68	344	125	437	188	781	313
Mar.	2.86	5.41	298	133	418	205	716	338
Apr.	17.26	14.13	337	190	492	275	829	465
May	11.89	10.96	265	154	419	192	684	346
June	2.27	3.84	279	190	416	229	695	419
July	1.38	1.38	354	199	401	234	755	433
Aug.	1.74	1.74	240	148	288	218	528	366
Total	67.34	58.27	3423	2352	4667	3189	8090	5541

Table II. *Xenopsylla brasiliensis* rates

	<i>X. brasiliensis</i> on male <i>Rattus</i>				<i>X. brasiliensis</i> on female <i>Rattus</i>			
	♂♂		♀♀		♂♂		♀♀	
	1935-6	1936-7	1935-6	1936-7	1935-6	1936-7	1935-6	1936-7
Sept.	549	455	370	289	764	562	530	361
Oct.	181	299	101	140	288	320	165	158
Nov.	267	75	190	64	332	108	264	79
Dec.	378	254	302	173	423	371	350	209
Jan.	475	453	339	239	600	447	455	258
Feb.	537	171	259	90	606	283	334	111
Mar.	398	257	215	127	522	310	336	185
Apr.	456	246	278	229	701	376	358	297
May	774	322	551	318	1013	357	761	302
June	824	670	486	520	1217	818	692	652
July	604	520	448	330	735	573	504	379
Aug.	565	250	310	134	549	419	374	199
Total	6008	3972	3849	2653	7750	4944	5123	3190

Table III. Ratios of numbers of *X. brasiliensis* on male to female rats

	♂♂		♀♀	
	1935-6	1936-7	1935-6	1936-7
Sept.	4.2	3.4	3.6	2.1
Oct.	0.9	1.4	1.0	1.3
Nov.	1.7	0.5	1.8	0.5
Dec.	2.8	2.1	2.6	2.0
Jan.	2.8	3.3	2.9	3.2
Feb.	2.3	2.0	2.1	2.0
Mar.	2.0	3.0	2.0	2.4
Apr.	2.2	2.5	2.2	2.5
May	5.0	4.0	4.2	3.4
June	4.7	6.3	4.6	6.4
July	3.0	4.2	3.1	4.0
Aug.	3.6	2.5	3.2	2.9
Average	2.9	2.9	2.8	2.6

Table IV. Embryonic rates for *Rattus rattus* 1935-6

No. of embryos per pregnant female													Total no. of females
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
1	3	—	—	—	—	—	1	—	3	1	—	—	8
2	1	1	—	—	1	3	3	3	3	1	1	—	18
3	1	7	2	2	2	—	3	2	5	4	3	—	31
4	8	11	2	6	6	8	8	10	4	4	4	4	75
5	13	23	6	9	11	20	22	22	17	6	8	15	172
6	11	21	19	20	10	17	17	24	28	11	14	17	209
7	24	29	26	24	20	42	38	47	30	17	16	20	333
8	20	21	33	21	21	22	30	30	17	15	15	10	255
9	32	25	17	21	15	27	26	23	26	15	15	18	260
10	6	10	11	9	5	11	16	12	7	3	3	8	101
11	2	5	6	1	3	1	3	1	4	—	2	—	28
12	—	1	5	—	2	1	3	2	1	1	—	—	16
13	—	1	—	1	—	—	—	1	—	—	—	—	3
14	—	—	—	—	—	—	—	1	1	—	—	—	2
15	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	1	—	—	—	—	—	1
17	—	—	1	—	—	—	—	—	—	—	—	—	1
Total no. of females pregnant	121	155	129	114	96	152	171	178	146	78	81	92	1513
Average per female	7.2	7.0	7.8	7.3	7.3	7.1	7.3	7.0	7.0	7.0	7.0	7.1	7.2

Table V. Embryonic rates for *Rattus rattus* 1936-7

No. of embryos per pregnant female													Total no. of females
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
1	2	—	1	—	—	—	—	—	—	—	—	—	3
2	2	—	—	—	—	1	—	—	1	—	—	—	4
3	2	—	3	2	1	1	—	4	—	1	1	—	15
4	5	7	7	6	5	1	6	8	10	3	20	3	81
5	16	16	14	14	7	8	8	6	12	5	15	4	125
6	17	22	30	17	18	12	9	15	10	9	17	4	180
7	38	32	23	17	12	15	11	14	8	17	10	8	205
8	21	13	30	25	9	8	13	16	9	8	4	14	170
9	36	24	26	21	11	7	9	8	9	16	8	10	185
10	13	6	16	12	6	4	8	7	10	4	19	3	108
11	5	—	2	2	2	2	3	4	—	1	2	1	24
12	—	—	—	—	1	—	—	1	—	3	2	—	7
13	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	1	—	—	—	—	—	1
Total no. of females pregnant	157	120	152	116	72	59	68	83	69	67	98	47	1108
Average per female	7.4	7.1	7.1	7.3	7.1	7.0	7.4	7.0	6.8	7.6	7.0	7.5	7.2

Table VI. *Plague mortality in rats and man*

	Plague				<i>X. brasiliensis</i> index		Male <i>Rattus</i> percentages	
	Rat		Man		1935-6	1936-7	1935-6	1936-7
	1935-6	1936-7	1935-6	1936-7				
Sept.	13	8	9	1	3.8	2.2	38	42
Oct.	9	3	8	2	1.0	1.3	40	41
Nov.	9	3	2	2	1.8	0.5	44	40
Dec.	12	3	27	—	2.7	2.0	45	41
Jan.	10	4	5	6	2.2	3.3	44	47
Feb.	8	2	3	2	2.2	2.0	44	40
Mar.	7	4	4	1	2.0	2.6	42	40
Apr.	10	1	14	—	2.2	2.5	41	41
May	19	—	22	—	4.5	3.7	39	44
June	21	3	7	2	4.6	6.3	40	46
July	21	6	9	1	3.0	4.0	47	46
Aug.	11	2	5	13	3.4	3.0	45	40
Total	150	39	115	30	Average 2.8	Average 2.6	Average 42	Average 42

The following species of fleas were also collected from *Rattus* during 1935-6 and 1936-7:

1935-6

30 ♂♂	42 ♀♀	<i>X. cheopis</i>	12 ♂♂	596 ♀♀	<i>E. gallinaceus</i>
1511 ♂♂	892 ♀♀	<i>X. robertsi</i>	30 ♂♂	34 ♀♀	<i>C. felis</i>
16 ♂♂	22 ♀♀	<i>D. lypsus</i>	11 ♂♂	11 ♀♀	<i>S. tortus</i>
104 ♂♂	168 ♀♀	<i>C. cabirus</i>	5 ♂♂	9 ♀♀	<i>L. segnis</i>

1936-7

4 ♂♂	3 ♀♀	<i>X. cheopis</i>	39 ♂♂	457 ♀♀	<i>E. gallinaceus</i>
1231 ♂♂	598 ♀♀	<i>X. robertsi</i>	22 ♂♂	30 ♀♀	<i>C. felis</i>
3 ♂♂	10 ♀♀	<i>D. lypsus</i>	8 ♂♂	5 ♀♀	<i>S. tortus</i>
103 ♂♂	111 ♀♀	<i>C. cabirus</i>		1 ♀	<i>C. fasciatus</i>

The higher numbers of *X. cheopis* in 1935-6 are due to trapping in a wood and iron store in a chief's village. This occurred in November 1935, when 28 ♂♂ 33 ♀♀ *X. cheopis* were collected from *Rattus* trapped.

The behaviour of the new *Xenopsylla* species, *X. robertsi*, is interesting. The following table shows its erratic occurrence on *Rattus*.

	1934-5		1935-6		1936-7		1937	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
Sept.	—	—	332	214	373	228	21	6
Oct.	27	8	725	469	439	231	135	48
Nov.	2	—	237	112	383	208	77	60
Dec.	37	22	—	—	35	11	53	24
Jan.	3	1	7	2	1	—	—	—
Feb.	—	—	179	84	—	—	—	—
Mar.	—	—	—	—	—	—	—	—
Apr.	2	2	—	—	—	—	—	—
May	14	4	—	—	—	—	—	—
June	19	18	—	—	—	—	—	—
July	65	32	3	2	—	—	—	—
Aug.	104	73	28	9	—	—	—	—
Total	273	160	1511	892	1231	678	286	138

The following graphs give a comparison between the results obtained in the three periods. From these it can be seen that the factor exercising the greatest

influence on the incidence of plague is the *Rattus* population density. When the *Rattus* population density remains low, the incidence of plague has diminished considerably as seen in the figures for 1937. The flea index figures have remained fairly constant over the three years.

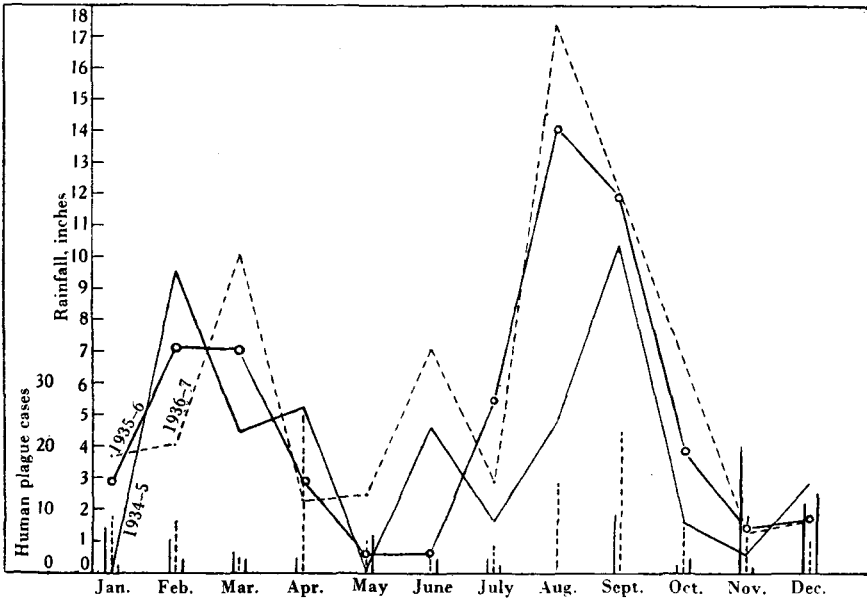


Fig. 1. Rainfall and human plague (vertical lines).

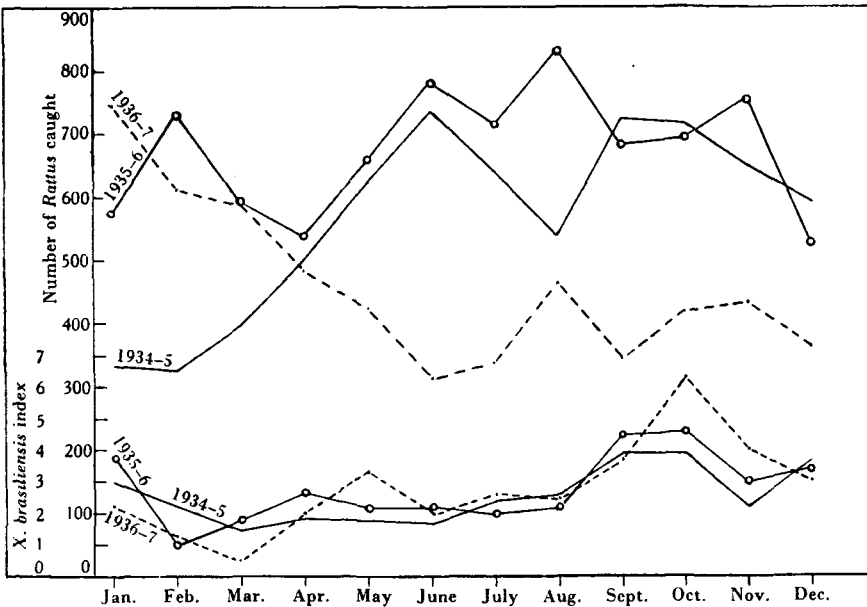


Fig. 2. Numbers of *rattus* and *brasiliensis* index.

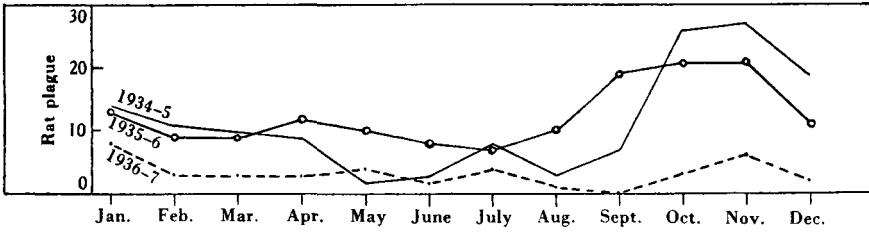


Fig. 3. Rat plague.

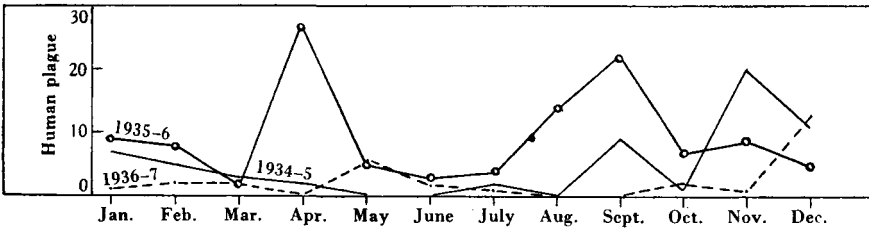


Fig. 4. Human plague.

B. FIELD RODENTS AND FLEAS

The total figures for the two yearly periods are given.

Mastomys coucha. 103 ♂♂ 54 ♀♀ = 157. 18 ♀♀ were pregnant with a total of 121 embryos. Average per female = 9.8.

<i>Fleas.</i>	9 ♂♂	21 ♀♀	<i>X. brasiliensis</i>	26 ♂♂	56 ♀♀	<i>C. cabirus</i>
	8 ♂♂	15 ♀♀	<i>X. cheopis</i>	6 ♂♂	18 ♀♀	<i>S. tortus</i>
	4 ♂♂		<i>X. robertsi</i>		1 ♀	<i>E. gallinaceus</i>
	23 ♂♂	21 ♀♀	<i>D. lypus</i>			

Otomys angoniensis. 109 ♂♂ 93 ♀♀ = 202. 62 ♀♀ were pregnant with a total of 134 embryos. Average per female = 2.1.

<i>Fleas.</i>	18 ♂♂	13 ♀♀	<i>X. brasiliensis</i>	61 ♂♂	75 ♀♀	<i>C. cabirus</i>
	3 ♂♂	2 ♀♀	<i>X. cheopis</i>	3 ♂♂	4 ♀♀	<i>S. tortus</i>
	1 ♂		<i>X. robertsi</i>	1 ♂	2 ♀♀	<i>C. felis</i>
	6 ♂♂	5 ♀♀	<i>D. lypus</i>		5 ♀♀	<i>E. gallinaceus</i>

Lemniscomys massaicus. 450 ♂♂ 350 ♀♀ = 800. 111 ♀♀ were pregnant with a total of 499 embryos. Average per female = 4.5.

<i>Fleas.</i>	87 ♂♂	81 ♀♀	<i>X. brasiliensis</i>	447 ♂♂	607 ♀♀	<i>C. cabirus</i>
	2 ♂♂	5 ♀♀	<i>X. cheopis</i>	5 ♂♂	13 ♀♀	<i>S. tortus</i>
	5 ♂♂	2 ♀♀	<i>X. robertsi</i>	1 ♂	2 ♀♀	<i>C. felis</i>
	13 ♂♂	15 ♀♀	<i>D. lypus</i>		1 ♀	<i>C. fasciatus</i>
					1 ♀	<i>E. gallinaceus</i>

Lophuromys aquilus. 352 ♂♂ 269 ♀♀ = 621. 127 ♀♀ were pregnant with a total of 316 embryos. Average per female = 2.5.

<i>Fleas.</i>	89 ♂♂	53 ♀♀	<i>X. brasiliensis</i>	235 ♂♂	305 ♀♀	<i>C. cabirus</i>
	5 ♂♂	4 ♀♀	<i>X. cheopis</i>	16 ♂♂	19 ♀♀	<i>S. tortus</i>
	6 ♂♂	9 ♀♀	<i>X. robertsi</i>	1 ♂		<i>C. felis</i>
	46 ♂♂	57 ♀♀	<i>D. lypus</i>		2 ♀♀	<i>C. fasciatus</i>
					6 ♀♀	<i>E. gallinaceus</i>

Arvicanthis abyssinicus. 1 ♂ 1 ♀ = 2. 1 female pregnant with 3 embryos.

Fleas. 1 ♂ *X. cheopis*. 2 ♂♂ 2 ♀♀ *C. cabirus*.

SUMMARY

The female percentage figures for *Rattus* for the three years are 57·8, 57·7 and 57·5 respectively. Pregnancy records were obtained by counting embryos sufficiently advanced to be recognizable to the naked eye. The average number of embryos per pregnant female agree closely for the three years, and the error of underestimating invisible embryos appears to be constant. There is a slight suggestion of two enhanced breeding periods for *Rattus* in the area, both periods being coincident with higher rainfall and the growing season. The main interest in these figures lies in the large number of embryos recorded over the nipple provision, the greatest number observed being seventeen.

The average number of fleas per rat shows that the period of their maximum incidence agrees closely with the higher incidence of plague.

The number of traps set out daily in huts has remained constant over the three years. Little reliance could be placed on detailed trapping figures as the trapping varies considerable from village to village and even hut to hut, and gross figures only can be employed. Not only do these figures demonstrate that endemic areas have a much higher *Rattus* density and higher breeding rates than plague-free areas, but they indicate that the incidence of plague, both in man and rats, is more closely associated with rat population densities than any other factor.

REFERENCE

- ROBERTS, J. I. (1936). Plague conditions in a rural endemic area of Kenya. *J. Hyg., Camb.*, **36**, 4.

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