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Malaria in the Maha Oya Basin

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Introduction

In a previous paper (Rajendram and Jayewickreme, 1951*a*) on 'Malaria in Ceylon', epidemic malaria in the combined catchments of the Maha Oya and the upper portion of the Deduru Oya was discussed. As the primary object of this paper was to show that epidemic malaria had been successfully controlled by the residual spraying of houses with DDT, it was found convenient to treat these two river catchments as a whole, as both fell within the Intermediate Zone (*vide infra*). Nowhere in Ceylon were such disastrous epidemics experienced as in these catchment areas. In this paper it is proposed to deal in considerably greater detail with various aspects of the malaria problem as it affects the Maha Oya Basin alone, leaving the Deduru Oya and other river basins to be dealt with later.

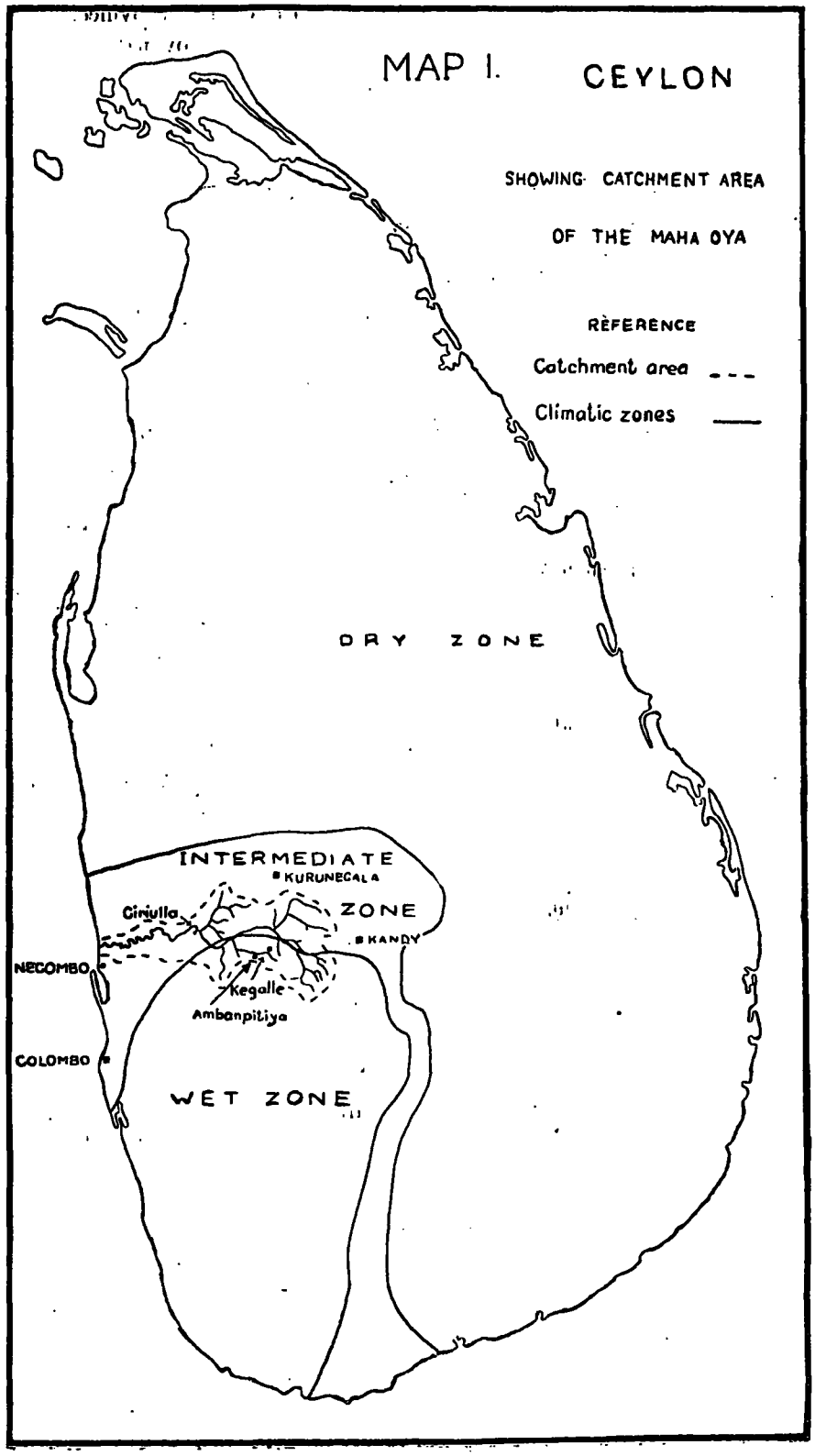
Although there are no historical references to malaria in the Maha Oya Basin, there is little doubt that it is not of recent origin. Briercliffe (1935) has summarised the available evidence for all epidemics prior to 1928-29 in his report on 'The Ceylon Malaria Epidemic, 1934-35'. This great epidemic was the subject of much discussion, of which the contribution made by Gill (1935), apart from Briercliffe's report, was probably the most important. Other papers dealing with this epidemic are referred to by Rajendram and Jayewickreme (loc. cit.).

The present paper deals with malaria conditions after the epidemic of 1934-35. Prior to this malaria control had only been carried out in certain towns in the Dry and Intermediate Zones. These were Anuradhapura, Puttalam, Chilaw, Kurunegala, Maho, Trincomalee and Badulla. It was only after the epidemic and as a result of the recommendations made by Gill (loc. cit.) that rural malaria control was commenced and a detailed account of the history of malaria control in Ceylon will be found in our previous paper.

The term morbidity rate as used in this paper refers to malaria attendances per 1,000 population.

THE MAHA OYA BASIN

(*a*) **Description and Boundaries of the Area.** The catchment area of the Maha Oya (Map 1), is approximately 562 square miles in extent. It embraces parts


MAP I. CEYLON
SHOWING CATCHMENT AREA
OF THE MAHA OYA
REFERENCE
Catchment area
Climatic zones
DRY ZONE
INTERMEDIATE ZONE
KURUNEGALA
KANDY
Ciriulla
NEGOMBO
Kegalle
Ambanpitiya
COLOMBO
WET ZONE

of four provinces (Map 2); the North-Western Province, Central Province, Sabaragamuwa and the Western Province. In the North-Western Province parts of the following revenue divisions fall within the catchment area—Pitigal Korale South, Katugampola Hatpattu, Dambadeni Hatpattu and Weudavili Hatpattu. In the Central Province small portions of Tumpane, Yati Nuwara and Udu Nuwara, and Udapalata are included. In Sabaragamuwa the whole of Kinigoda and Galboda Korales, a large portion of Beligal Korale and the eastern half and northern part of Paranakuru Korale come within the catchment. In the Western Province almost the whole of Hapitigam Korale, and the northern portions of Alutkuru Korale North A and Alutkuru Korale North B are included.

The Maha Oya is 78 miles long, and arises in the hills east of a line joining Kurunegala and Ambanpitiya at elevations of 500-1,000 feet, and where the average annual rainfall is above 100 inches a year. It eventually reaches the sea north of Kochchikade. The first part of the river, up to and slightly beyond Mawanella, is through a very rocky and relatively narrow bed. After reaching the plains the bed becomes wide, flat, sandy and shallow. In the middle reaches of the river the bed is rocky only at Rambukkana and Giriulla. In times of drought considerable pooling of the river occurs, and while the first part of the river passes through an area which is at most only moderately endemic, the middle and lower reaches of the river pass through highly endemic areas.

The Maha Oya Basin is a very well watered one as can be seen in Map 3, where only some of the principal tributaries of the river are named, and many minor ones omitted. It will be seen that the name Kuda Oya is given to a number of different tributaries.

The catchment comprises seventeen health areas or parts of health areas, each being under a Medical Officer of Health. The health areas and the revenue divisions to which they belong are given below:

1. Dankotuwa (Pitigal Korale South).
2. Pannala (Katugampola Hatpattu).
3. Narammala (Dambadeni Hatpattu).
4. Polgahawela (Dambadeni Hatpattu).
*5. Kurunegala (Weudavili Hatpattu).
*6. Galagedera (Tumpane).
*7. Kadugannawa (Yati Nuwara and Udu Nuwara).
*8. Daulagala (Yati Nuwara and Udu Nuwara).
*9. Nawalapitiya (Udapalata).
10. Aranayake (Paranakuru Korale).
11. Kegalle (Paranakuru Korale).
12. Rambukkana (Kinigoda Korale).
13. Mawanella (Galboda Korale).
14. Warakapola (Beligal Korale).
*15. Galigomuwa (Beligal Korale).
16. Yakkala (Hapitigam Korale).
17. Negombo (Alutkuru Korale North A and B).

As only small portions of the health areas of *Kurunegala, *Kadugannawa, *Daulagala, *Nawalapitiya and *Galigomuwa fall within this catchment, the malaria statistics for these areas will be discussed in future papers in connection with the main river basins to which they belong. The statistics for Galagedera are being excluded from this paper as the boundaries of this health area were considerably revised in 1944, as a result of which nearly a third of its population was transferred to Harispattu. The figures for the health areas of Kegalle and Aranayake are given together in Appendix III, as these areas have only recently been separated.

(*b*) **Temperature and Humidity.** Climatic conditions over Ceylon as a whole have been discussed in an earlier paper (Rajendram and Jayewickreme, loc. cit.), and there is little to add here as no main climatological station is located in the Maha Oya Basin. No data are therefore available for any discussion of temperature and humidity in this area.

(*c*) **Rainfall.** There are fourteen meteorological stations in the catchment. They are Hunumulla, Giriulla, Ambepussa, Poramadela, Kempitikande, Alagalla, Meddegoda, Aranayake, Ambanpitiya, Kegalle, Etnawela, Diwela, Polgahawela and Mawanella. In Table 1, is given the monthly rainfall calculated as an average for all these stations for the years 1935-50, together with the average rainfall calculated for the period 1911-46.

The Maha Oya Basin receives rainfall from both south-west and north-east monsoons. The south-west monsoon blows from May to September, and the north-east monsoon from November to March. At each monsoon after heavy rain in the first two months or so the monsoons begin to weaken. August and early September are relatively dry periods with only occasional rain, and similarly, during the north-east monsoon period a dry spell ensues from about the middle of January till the middle of March. In these dry periods *A. culicifacies* breeds heavily in rock pools and sand pools which are formed in the river beds, while the seasonal rises of malaria follow shortly after the first heavy rains that end these periods of drought. These rains are experienced in April and October, both months of thunderstorm activity. Approximately the same amount of rain is received during each monsoon, but the south-west monsoon is spread over a longer period. The dry period which ends the north-east monsoon, is relatively longer as it often begins late in December. Unfortunately, both monsoons tend to fail, and when this happens conditions for the breeding of the vector become very favourable owing to the pooling of rivers. Conversely, even when there is little rain over that part of the basin which lies in the plains, heavy rain in the hills particularly in the Kegalle and Aranayake areas tends to flush the river and its tributaries and obliterate the pools. But like most Ceylon rivers, the raging torrent of today may be reduced to a narrow channel of flowing water in a few days, with pooling taking place in the bed on both sides of it.

(*d*) **Climatic Zones.** Ceylon is divided into a Dry and Wet Zone by meteorologists ; but for malaria studies it has been found convenient to recognise a third or Intermediate Zone. The three zones (Map 1), are readily demarcated on the amount of rainfall received during the south-west monsoon. Thus the Wet Zone receives 40 inches of rain and upwards, the Intermediate Zone between 20-40 inches and the Dry Zone less than 20 inches of rain. The Dry Zone actually receives only one monsoon, the north-east monsoon.

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TABLE 1

Monthly rainfall in inches for the years 1935-1950 *calculated as an average for all Meteorological Stations situated in the Maha Oya Basin.*

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1935	1·69	1·19	11·85	10·66	4·54	8·15	3·35	6·97	2·83	18·47	12·50	7·48	89·68
1936	2·48	1·58	10·35	1·98	20·07	6·29	7·63	3·62	11·09	10·17	9·97	9·86	95·09
1937	5·39	4·23	7·37	7·82	16·95	5·11	8·69	7·45	8·38	11·83	17·20	3·64	104·06
1938	1·83	10·56	12·96	12·59	4·84	4·58	6·45	5·52	8·58	5·69	6·57	4·71	84·88
1939	5·88	0·29	3·03	13·51	10·96	11·21	8·35	13·12	6·62	12·17	13·82	4·76	103·72
1940	0·01	0·85	2·14	15·15	21·64	16·18	5·46	7·28	7·10	18·18	23·42	6·87	124·28
1941	1·61	2·90	4·51	7·52	14·60	11·42	4·37	9·84	9·68	19·07	20·53	6·38	112·43
1942	1·15	1·63	9·23	11·73	7·78	13·10	9·25	9·26	5·00	13·51	5·51	14·19	101·34
1943	4·04	1·95	3·20	8·57	21·66	11·61	5·08	5·73	3·92	21·09	21·39	8·72	116·96
1944	2·72	7·28	10·57	9·86	9·26	8·63	3·04	4·03	11·95	15·21	21·24	7·87	111·66
1945	0·44	0·41	4·62	5·38	1·06	8·76	4·14	3·55	2·84	19·27	11·10	10·29	71·86
1946	1·41	1·27	9·10	9·73	5·53	8·11	4·56	9·25	7·03	12·13	20·15	21·52	109·79
1947	7·69	1·81	10·18	2·30	3·69	9·46	7·22	19·68	8·18	15·17	2·40	5·21	92·99
1948	2·37	1·10	11·69	6·33	5·07	11·41	7·71	5·62	2·92	12·77	8·88	7·33	83·20
1949	2·20	1·17	4·14	7·84	12·20	12·92	15·20	14·98	4·71	10·43	8·64	4·93	99·36
1950	1·05	6·51	5·95	7·57	7·40	9·66	8·55	5·09	9·11	14·80	7·38	2·52	85·59
Average 1911-1946	4·75	2·49	7·08	9·70	10·90	11·49	7·60	6·18	7·71	15·95	13·85	6·57	104·27

The major portion of the Maha Oya Basin, particularly that part which is highly endemic, falls within the Intermediate Zone. The Kegalle and Mawanella areas, which are also severely affected in epidemic years, lie in the Wet Zone. The upper reaches of the river around Aranayake, also lie in the Wet Zone, and are relatively healthy or only moderately endemic.

MALARIA PREVALENCE AND RAINFALL

There are five hospitals, seven rural hospitals and eight dispensaries in the Maha Oya Basin, and their location is indicated in Map 3. They are as follows:

1. Hataraliyadde—Dispensary (Tumpane).
2. Kegalle—Hospital (Paranakuru Korale).
3. Aranayake—Hospital (Paranakuru Korale).
4. Hemmategama—Rural Hospital (Paranakuru Korale).
5. Mawanella—Rural Hospital (Galboda Korale).
6. Rambukkana—Rural Hospital (Kinigoda Korale).
7. Warakapola—Rural Hospital (Beligal Korale).
8. Nelundeniya—Dispensary (Beligal Korale).
9. Niyandurupola—Dispensary (Beligal Korale).
10. Giriulla—Hospital (Dambadeni Hatpattu).
11. Narammala—Rural Hospital (Dambadeni Hatpattu).
12. Alawwa—Rural Hospital (Dambadeni Hatpattu).
13. Polgahawela—Dispensary (Dambadeni Hatpattu).
14. Makandura—Dispensary (Katugampola Hatpattu).
15. Dankotuwa—Rural Hospital (Pitigal Korale South).
16. Negombo—Hospital (Alutkuru Korale North A).
17. Kochchikade—Dispensary (Alutkuru Korale North A).
18. Halpe—Dispensary (Alutkuru Korale North A).
19. Mirigama—Hospital (Hapitigam Korale).
20. Ambepussa—Dispensary (Hapitigam Korale).

At all three types of institution malaria cases are clinically diagnosed and the error in diagnosis at dispensaries, manned by Apothecaries, would tend to be higher, particularly in non-epidemic times. It is a fact that almost any fever case in malarial districts tends to be diagnosed as 'malaria'. But during epidemics this error would be at its lowest. In Table 2, is summarised the monthly malaria attendance and the morbidity rate per 1,000 population at all these hospitals and dispensaries for the period 1937-50. These figures include first and subsequent visits of patients, as it is not possible to separate them satisfactorily. Patients often forget to bring their check tickets on subsequent visits and are then regarded as coming for treatment for the first time. The population figures have been calculated on the basis of the 1921 and 1946 census figures according to revenue divisions. But only that fraction of a revenue division which falls within the Maha Oya Basin has been taken into account. Thus for Pitigal Korale South only 25 per cent. of the total population for the revenue division has been included in the general population figure of the basin, as this is approximately the area which comes within it. The population

TABLE 2

Monthly Malaria Attendance at Hospitals and Dispensaries for the years 1937-1950.

Year	Population (calculated)	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		Total for year	
		Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate	Attend-ance	Rate
1937	575331	21354	37	18720	33	20867	36	18746	33	17412	30	19790	34	18296	32	16274	28	16829	29	12920	22	13851	24	17674	31	212733	370
1938	576811	23311	40	22163	38	26524	46	22320	39	20802	36	17392	30	14247	25	13157	23	13983	24	15733	27	15564	27	16847	29	222033	385
1939	578291	24914	43	23176	41	26320	46	55483	96	124620	215	124993	216	71955	124	43921	76	27671	48	26075	45	23606	41	25380	44	598114	1033
1940	579771	22244	38	17819	31	18630	32	20709	36	45628	75	71879	124	52159	90	34055	59	22507	39	20968	36	17126	30	17716	31	361440	624
1941	581251	17134	29	13999	24	14053	24	15056	26	17055	29	17758	31	20829	36	17480	30	14326	25	15123	26	14595	25	18134	31	195542	336
1942	582731	19913	34	12833	22	14844	25	15177	26	17103	29	18085	31	15468	26	11201	19	9659	17	9438	16	10747	18	12205	21	166673	286
1943	584211	13118	22	11696	20	15078	26	33204	57	48825	84	49909	85	31124	53	15831	27	10998	19	8995	15	12844	22	14040	24	265662	455
1944	585691	11663	20	16723	29	10866	19	9003	15	12390	21	11572	20	11732	20	8402	14	6668	11	8373	14	10210	17	19138	33	136740	233
1945	587171	22217	35	16384	28	16695	28	29357	50	34464	59	37815	64	53885	92	57865	98	33992	58	34736	59	47165	80	126426	215	511001	870
1946	588651	98003	166	57119	97	47495	81	40588	69	52921	90	46058	78	34067	58	28053	48	19140	32	19048	32	18441	30	22847	39	483780	822
1947	590131	19826	34	17477	30	15994	27	11691	20	13765	23	11699	20	13522	23	10063	17	8851	15	8585	15	8655	15	8442	14	148570	252
1948	591611	8281	14	7229	12	7467	13	7734	13	10711	18	7884	13	7062	12	5735	10	4414	8	4247	7	4455	8	4174	7	79393	134
1949	593091	4546	8	4429	7	4273	7	4102	7	4049	7	4212	7	6391	11	3694	6	3761	6	3444	6	4001	7	4060	7	50962	86
1950	594571	3456	6	3701	7	3832	7	4344	8	3981	7	4576	8	5908	11	4428	8	2640	5	2437	4	4576	8	3274	6	47133	85

Rate = Malaria attendance per thousand population.

of each revenue division in the basin has similarly been calculated. Graph 1, shows the combined monthly morbidity rate for all hospitals, rural hospitals, and dispensaries and the average monthly rainfall figures, calculated for all meteorological stations in the Maha Oya Basin for the years 1937-50 (Table 1).

(*a*) **Seasonal Malaria.** There are two fever seasons. The first follows the inter-monsoonal rains which end the dry period of late January, February and early March. The fever index begins to rise in April and generally keeps on rising until June, and thereafter begins to decline. The second fever season follows the inter-monsoonal rains of October, which break the dry spell of August and September. Here the morbidity curve begins to rise in November and reaches its peak in January and declines thereafter.

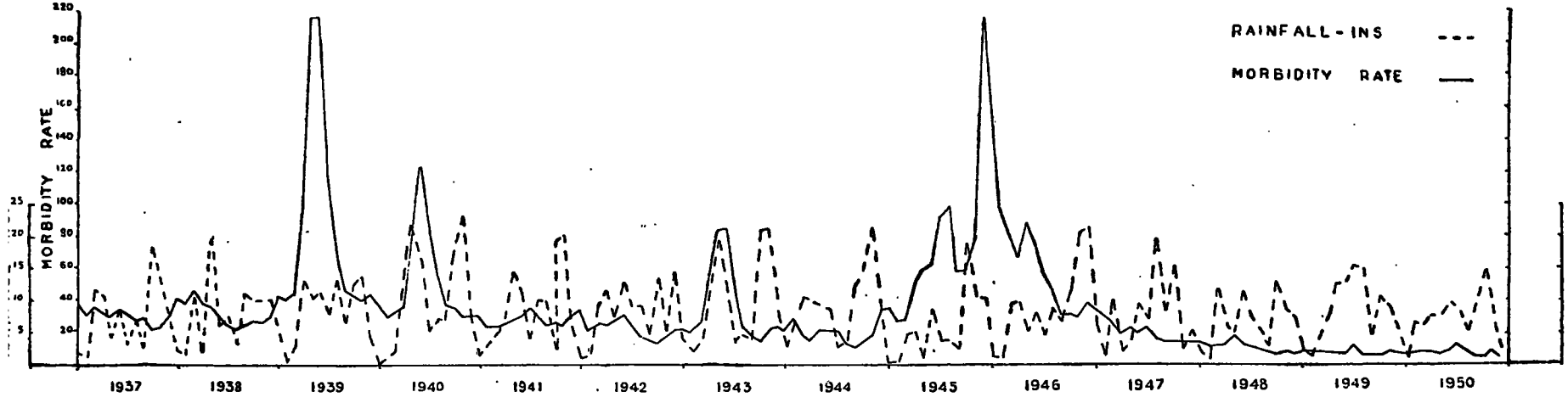
In Graph 1, the first seasonal or spring rise of malaria can be seen for 1937, 1938, 1941 (peak reached in July), and 1942. The second seasonal or autumnal rise is evident in 1937, 1938, 1941, 1942, 1943 and 1944. The correlation with rainfall is fairly close ; but monthly rainfall figures tend to be misleading, particularly in dry months. Here one heavy burst of rain on a single day may double the month's average rainfall. Weekly malaria attendance and rainfall for the period under review would have resulted in such a formidable graph that it had to be excluded.

(*b*) **Epidemic Malaria.** Epidemics of malaria every few years have long been known in the Maha Oya Basin. From Briercliffe (loc. cit.), one gathers that prior to 1900 such epidemics occurred in 1877, 1880, 1884, 1887, 1891, 1892 (?), 1894 and 1895 (?). In each of these years the Negombo District is specifically mentioned as having been involved in the epidemic. Only in 1892 and 1895 does he mention the Western Province as having been affected, so that it is not certain whether the Maha Oya Basin was also involved. Thus excluding the doubtful years or 1892 and 1895, epidemics have occurred, involving part or whole of the basin, every three years (thrice) or four years (twice).

After 1900, epidemics have occurred in 1906, 1911, 1919, 1923, 1928-29, 1934-35, 1939-40, 1943 and 1945-46. Thus the first wave of these epidemics has occurred every two years (once), four years (twice), five years (twice) and six years (once). The gap of eight years between the malaria epidemics of 1911 and the influenza pandemic in 1919, was bridged by a severe epidemic in 1914 in the Eastern Province and Uva. Whether the Maha Oya Basin was also involved is not quite certain. Gill (loc. cit.) believes that during the influenza epidemic of 1919 there was also a malaria epidemic in January and February.

Of all these epidemics none was so unexpected nor so disastrous in its effect as the epidemic of 1934-35. This has been so fully reported that it is not proposed to discuss it any further here. The various steps taken to deal with future epidemics by organising malaria control measures in rural areas have already been described (Rajendram and Jayewickreme, loc. cit.). Thus when the spring epidemic of 1939 occurred, an organisation was available for the first time to deal with such an outbreak in rural areas. But it must be emphasized that the organisation was not fully equipped and was yet short of trained personnel. It was only at the end of 1939 that the Malaria Field Training Centre was set up at Kurunegala, while the entomological measures for forecasting epidemics were put into effect only after the first

GRAPH 1



Malaria Morbidity and Rainfall, 1937-50.

wave of the epidemic was over. These measures were entirely directed towards the detection of the larva of *A. culicifacies* in rivers and streams in all parts of the Intermediate and Wet Zones, at ' detector stations ' called Subsidiary Observation Sites. These sites along rivers were mainly examined by Sanitary Inspectors once a fortnight. These examinations were to prove in future years of the utmost importance in the control of malaria in Ceylon. No sooner was the vector reported breeding at any of these sites oiling of all streams within a three-mile radius was undertaken. If a number of contiguous sites were involved and the situation was deemed dangerous a whole area was put under oil, until conditions improved. In this way later epidemics were undoubtedly minimised, although never completely controlled.

1. *The Epidemic of* 1939-40.—Rustomjee (1944) has described briefly the epidemics of 1939 and 1943 as they affected the whole of the Intermediate and Wet Zones. As such these accounts deal with the Maha Oya Basin only in a general way.

In 1938 the south-west monsoon had been considerably below average, the rainfall in September alone being above average (Table 1). The inter-monsoonal rains of October were over 10 inches short of the average and the north-east monsoon which followed was also a failure. In every month except January, when there was a slight excess, a deficit was recorded for the period November 1938 to March 1939. In spite of the slight excess recorded in January 1939, the period January to March was one of acute drought and great distress, and the pooling in all rivers and streams was resulting in a very high incidence of *A. culicifacies*. (The entomological data will be discussed in a later section).

The oiling of rivers was begun on March 1st, 1939, but the organisation was not capable of dealing with the epidemic that followed, which, though not so severe in its effect as the 1934-35 epidemic, was more extensive in its distribution. It is also obvious now that the oiling was begun too late, but this was probably due to factors such as lack of spraying equipment, storage drums, and trained personnel in sufficient numbers to deal with the vast area involved. The drought was so severe throughout the island that for the first time Colombo's water supply had to be cut off for several hours a day as the reservoir, Labugama, situated in a very wet area with a rainfall of about 150 inches a year, had sunk to an unprecedentedly low level.

Towards the end of March (between the 23rd and 28th) light rain was experienced, and in the first fortnight of April rain fell almost every day. There appears to be a close correlation between the time of onset of epidemics and the normal seasonal rises of malaria. According to Rustomjee (unpublished report), although the autumnal rise of malaria in 1938-39 was not marked in the middle and lower catchments, the numbers attending hospitals and dispensaries were on a moderately high level (600-800 a day), until the attendance began to rise significantly almost everywhere on April 15th, 1939. According to him the malaria incidence was maintained at a high level from the first week of January, 1939. The morbidity rates over the whole basin were 95·9 in April, 215·4 in May and 216·2 in June. In the upper catchment the morbidity rate was over 10 times the normal along the river from Kegalle to Aranayake. Over the rest of the upper catchment it was 6-10 times the normal. In the middle catchment, within the Giriulla-Ambepussa-Mirigama belt, the morbidity rate was 3-5 times in excess. In the lower catchment from Makandura to the coast the rate was 6-10 times the average. Thereafter the epidemic declined

steadily and the south-west monsoon was well up to average. Rustomjee estimated that the epidemic lasted from 145-163 days, the peak having been reached in 90 days.

In October and November 1939 average rainfall was again experienced, but from then on till the end of March, 1940 conditions of drought again prevailed over the entire catchment, to be broken once more by very heavy rains in April. From October 1939 to April 1940 the morbidity rate had ranged from 44·9 to 35·7. But in May 1940, when the second wave of the epidemic commenced, the rate went up to 75·1 and in June it reached the peak level of 123·9. In July the rate began coming down and thereafter the epidemic declined. This second wave of the epidemic was of a much smaller magnitude, and its duration was also considerably less. Both waves affected the whole of the Maha Oya Basin.

2. *The Epidemic of* 1943.—After the epidemic of 1940 conditions came back gradually to normal. The years 1941 and 1942 were exceptionally healthy, with only the spring and autumnal fever seasons in evidence. The south-west monsoon of 1942 was a little below average, while the November rainfall was very poor. To compensate for this the rainfall in December was more than double the average. In January, February, March and April of 1943 the rainfall in each month was slightly below average. Thus there is no comparison with the rainfall conditions which preceded the 1939 epidemic, when the north-east monsoon was a failure and relatively dry conditions prevailed up to the end of March 1939. In this case a partial drought in October and November was followed by heavy rains in December, while the January to April rains were almost up to average. The only unusual meteorological feature of this epidemic appears to have been the heavy rains which preceded it in December 1942.

Although in Table 2 the epidemic is seen to have commenced in April over the whole basin, Rustomjee (unpublished report) found that in the upper catchment the earliest rise in morbidity took place about April 3rd, and about February 12th in the lower catchment. The sudden rise in morbidity took place on April 17th and April 10th in the upper and lower catchments respectively. One feature in common with the 1939 epidemic was that the sharp rise in morbidity took place about 3 weeks after the first heavy rains of late March. The initial rise of morbidity in February in the lower catchment was possibly related to the light rainfall which fell in this month from the 1st-4th and 9th-13th day respectively.

The incidence of malaria which began to show a steep rise in April when the morbidity rate rose to 56·8, rose to 83·5 in May and reached a peak figure of 85·4 in June. From July, when the rate dropped to 53·2, the epidemic declined gradually. Rustomjee estimated that in the upper catchment the duration of the epidemic was 17 weeks, from the commencement of the initial rise to the return to normal, and 25 weeks in the lower catchment. The peak of the epidemic was reached in 6 and 13 weeks in the upper and lower catchments. In the 1939 epidemic the peak was reached more quickly (2-7 weeks). But if the sudden rise in April is considered the real starting point of the epidemic in the lower catchment, then the peak was really reached in 5 weeks.

Unlike in 1939, there was no second wave and 1944 was an exceptionally healthy year. The distribution of the epidemic was similar to that of 1939, except that Udu Nuwara and Yati Nuwara were not involved.

3. *Spring and Autumnal Epidemics of* 1945-46.—The year 1944 was exceptionally malaria-free. In January 1944 the possibilities of a spring outbreak of malaria were not remote, as conditions were very dry. But in February very heavy rains fell which continued up to the end of June (Table 1). In July and August rainfall was below average but was compensated for by exceptionally heavy rains in September. This was followed by a normal October and a very wet November, and these heavy rains continued up to the middle of December. From then on up to the end of February severe conditions of drought were experienced, and it was apparent that an epidemic was most likely no sooner appreciable rains were experienced. Intensive oiling of rivers had been in progress throughout the dry spell, with disinsectisation of houses with pyrethrum sprays in certain areas also actively carried out.

The drought was finally broken in March 1945 with light rainfall which was below average, to be followed by moderate rain in April. These rains were sufficient, however, to precipitate the epidemic and the morbidity rate began to rise in April, when it was 49·9, to the peak figure of 98·4 in August (Table 2). The epidemic therefore was of long duration, reaching its peak at a later stage than in any previous spring epidemic. On the face of it all the control measures that had been put into operation were failures, but it should not be forgotten that the morbidity rate might have been even higher but for them. The whole of the basin was involved in this epidemic.

While this epidemic was in progress in 1945 the south-west monsoon had been below average in every month from May to September. It was so below average as to be reckoned a total failure. From then on the rainfall of October, November and December was exceptionally heavy, and the second or autumnal wave of the epidemic commenced in November. The morbidity rate in November was 80·2, rising sharply to 215·3 in December and beginning to come down in January 1946, when the rate was 166·4. The oiling of rivers was seriously interfered with by heavy rain in October, November and December. The epidemic began to wane from then on but after the inter-monsoonal rains of April 1946, there was a sudden spring rise of malaria in May, but thereafter the epidemic declined gradually and conditions were back to normal by the end of the year.

There were some unusual features about the epidemics of 1945-46. Never before had a spring rise been followed by an autumnal rise in the same year. Nor had a spring epidemic followed an autumnal one. The cycle of epidemics, spring-autumn-spring, had never been known before. Another unusual feature was that the second or autumnal wave of malaria in 1945 was more severe than the earlier spring rise. This was the reverse of what had been experienced before. The spring epidemic of 1946 was a very mild one and was not taken very seriously at the time. But the statistical evidence for it given in Table 2 and shown in Graph 1 is quite clear.

(*c*) **The Effect of Residual Spraying of Houses with DDT.** While the epidemic of 1945 was in progress DDT was being used for the first time as a residual spray for the control of adult *A. culicifacies* in houses at Anuradhapura in November 1945 (Rajendram and Jayewickreme, 1951*b*). The stocks of DDT at this time were controlled by the Army authorities, and it was not until March 1946 that sufficient DDT was made available for spraying in the Maha Oya Basin. But this was only

sufficient for a single round of spraying in the Narammala, Pannala, Polgahawela, Kegalle and Rambukkana areas. It was perhaps this round of spraying which stopped the incipient spring rise of malaria in 1946. By 1947 DDT had become available to the Civil authorities, and uninterrupted spraying in the basin was carried out throughout the year, and subsequently in 1948, 1949, and 1950.

After the epidemic of 1945-46 the morbidity rate kept coming down gradually, but at the end of the year there was an autumnal rise with its peak in December 1946. From then on morbidity has steadily declined in the Maha Oya Basin. The fever seasons have scarcely been in evidence, though small peaks can be seen in Graph 1 in 1948 (May), 1949 (July) and 1950 (July and November). The highest of these peaks showed only a rate of 18·1 in May 1948. In years prior to 1946 such a rise would have been considered insignificant, as it would have been well below the normal usually experienced at that time of the year.

The incidence of fever during the period 1948-50 has declined to levels never known before. Thus the annual morbidity rate of 85·0 in 1950 may be compared with that of 1944, a very healthy year, when the rate was 233·4. Or it may be compared with that of 1941, another healthy year, when the rate was 336·3 to show to what a low level malaria incidence has been reduced. On the other hand, in the epidemic years of 1939, 1943 and 1945 the annual morbidity rate recorded in the basin was 1,032·9, 454·7 and 870·2 respectively. Thus in 1948 after a spring epidemic had been averted the morbidity rate fell to only 134·1. And after allowing for errors in clinical diagnosis already referred to, it is quite possible that the dispensary attendances recorded in 1948-50 may not have been due solely to malaria.

The rainfall experienced after the 1945-46 epidemic needs comment. The north-east monsoon of 1946 was well above average. In 1947 the south-west monsoon was not up to average, particularly in May, but there were very heavy and unusual rains experienced on two days in the middle of August, which caused devastating floods in many parts of the island. The October rainfall was above normal, but the north-east monsoon which followed was a failure. Thus conditions were ideal for a spring epidemic in 1948, which, however, did not arise.

SPLEEN AND PARASITE SURVEYS

(*a*) **Spleen Surveys.** In the surveys described in this paper, all degrees of enlargements of spleens have been classed together for the sake of convenience, although at the time the examinations were carried out they were placed in their respective categories. These examinations were carried out at village schools in March and September, and the results are summarised according to revenue divisions in Table 3 (March surveys, 1936-50), and Table 4 (September surveys, 1946-49). The March surveys were carried out without interruption from 1936 to 1941, and after that there was a break due to the war from 1942 to 1946. The surveys were resumed in 1947 and have been carried out ever since. The September surveys were an innovation in 1946, and have also not been interrupted. The months of March and September have been selected as coming just prior to the spring and autumnal fever seasons, when morbidity is generally at its lowest ebb. These months are also just in advance of the spring and autumnal epidemic outbreaks. For purposes of future reference the data in regard to these surveys for all the schools in each health area

TABLE 3

Spleen rates among School Children by revenue divisions—March Surveys, 1936-1950.

Revenue division	1936			1937			1938			1939			1940			1941			1947			1948			1949			1950		
	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.
Tumpane	288	254	88·2	413	240	58·1	440	186	42·3	417	93	22·3	399	109	27·3	336	103	30·7	220	48	21·9	244	20	8·2	472	8	1·7	604	4	0·7
Yati Nuwara	111	12	10·8	195	5	2·6	201	7	3·5	242	3	1·2	191	1	0·5	238	1	0·4	329	0	0	451	0	0	223	0	0	241	0	0
Paranakuru Korale	669	384	57·4	739	277	37·5	726	160	22·0	757	70	9·2	772	119	15·4	643	43	6·7	752	18	2·4	1069	14	1·3	1138	8	0·7	1353	15	1·1
Galboda Korale	786	666	84·7	765	393	51·4	626	194	31·0	626	61	9·7	621	92	14·8	625	83	13·3	—	—	—	1697	112	6·6	1824	45	2·4	1793	20	1·1
Kinigoda Korale	807	720	89·2	870	519	59·7	972	456	46·9	897	270	30·1	901	426	47·3	856	350	40·9	786	112	14·2	919	31	3·4	821	37	4·5	811	16	2·0
Beligal Korale	369	211	57·2	438	98	22·4	368	105	28·5	305	65	21·3	382	171	44·8	394	144	36·5	644	23	3·6	828	12	1·4	642	0	0	881	2	0·2
Dambadeni Hatpattu	2908	2226	76·5	2846	1219	42·8	2401	914	38·1	2889	715	24·7	2546	767	30·1	2839	873	30·8	2666	174	6·5	3577	88	2·4	3967	18	0·5	4023	47	1·2
Weudavili Hatpattu	219	164	74·9	207	141	68·1	250	58	23·2	270	78	28·9	260	54	20·8	244	23	9·4	295	66	22·4	314	34	10·8	393	17	4·3	338	4	1·2
Katugampola Hatpattu	805	519	64·5	866	267	30·8	801	151	18·9	780	55	7·1	863	151	17·5	753	53	7·0	718	68	9·7	965	62	6·4	1030	22	2·1	1042	11	1·1
Pitigal Korale South	283	172	60·8	274	103	37·6	172	36	20·9	331	43	13·0	322	45	14·0	360	40	11·1	359	20	5·6	458	7	1·5	443	5	1·1	449	1	0·2
Alutkuru Korale North A	155	44	28·4	150	46	30·7	118	28	23·7	147	12	8·2	145	9	6·2	—	—	—	106	8	7·5	133	6	4·5	169	0	0	—	—	—
Hapitigam Korale	796	365	45·9	981	128	13·0	1163	104	8·9	1093	117	10·7	1014	168	16·6	1159	181	15·6	1627	32	1·9	1126	12	1·1	1184	68	5·7	1755	1	0·1
Total	8196	5737	70·0	8744	3436	39·3	8238	2399	29·1	8754	1582	18·1	8416	2112	25·1	8447	1894	22·4	8502	569	6·7	11781	398	3·4	12306	228	1·9	13290	121	0·9

TABLE 4

Spleen rates among School Children by revenue divisions—September Surveys, 1946-1949.

Revenue division	1946			1947			1948			1949		
	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.
Tumpane	170	28	16·5	293	25	8·5	320	16	5·0	671	5	0·7
Yati Nuwara	209	0	0	426	0	0	506	0	0	232	0	0
Paranakuru Korale	630	27	4·3	1153	22	1·9	1177	12	1·0	1436	7	0·5
Galboda Korale	721	70	9·7	1594	175	11·0	1607	87	5·4	1873	20	1·1
Kinigoda Korale	677	136	20·1	811	38	4·7	823	16	1·9	1021	23	2·3
Beligal Korale	511	90	17·6	748	9	1·2	835	2	0·2	826	3	0·4
Dambadeni Hatpattu	2597	448	17·3	2464	66	2·7	3482	43	1·2	3382	6	0·2
Weudavili Hatpattu	246	76	30·9	326	50	15·3	384	21	5·5	377	12	3·2
Katugampola Hatpattu	699	55	7·9	956	80	8·4	1043	33	3·2	1097	26	2·4
Pitigal Korale South	362	52.	14·4	384	11	2·9	414	2	0·5	452	2	0·4
Alutkuru Korale North A	93	2	2·2	122	8	6·6	153	0	0	122	0	0
Hapitigam Korale	987	37	3·7	1677	15	0·9	1914	103	5·4	1368	1	0·1
Total	7902	1021	12·9	10954	499	4·6	12658	335	2·6	12857	105	0·8

are given in Appendix I A (March surveys, 1936-50) and in Appendix I B (September surveys, 1946-49). The position of the schools in the various revenue divisions is shown in Map 2.

The data recorded in Table 3 show that spleen rates tend to be highest immediately after an epidemic, and that they tend to diminish progressively until the next outbreak as pointed out by Sivalingam and Rustomjee (1941). Thus, except for the schools in the revenue division of Yati Nuwara, spleen rates ranging from 28·4 (Alutkuru Korale North A) to 89·2 (Kinigoda Korale) were recorded in 1936. In fact in nine of the twelve revenue divisions spleen rates over 50 were recorded in this year. These high rates were a consequence of the major epidemic of 1934-35. In 1937 in only four revenue divisions were spleen rates of over 50 recorded. They were Weudavili Hatpattu (68·1), Kinigoda Korale (59·7), Tumpane (58·1) and Galboda Korale (51·4). A spleen rate of 42·8 was recorded in Dambadeni Hatpattu, usually one of the worst affected areas in any epidemic in the Maha Oya Basin. In 1938 in no revenue division was a spleen rate of over 50 recorded. The mean spleen rates for the period 1936-39 were 70·9 in 1936, 39·3 in 1937, 29·1 in 1938 and 18·1 in 1939. In 1939 five revenue divisions had spleen rates below 10. They were Yati Nuwara (1·2), Katugampola Hatpattu (7·1), Alutkuru Korale North A (8·2), Paranakuru Korale (9·2) and Galboda Korale (9·7). Hapitigam Korale (10·7) and Pitigal Korale South (13·0) had spleen rates between 10-20. The remaining revenue divisions had spleen rates ranging between 21·3 and 30·1.

In March 1940 after the spring epidemic of 1939 the mean spleen rate had risen to 25·1. Only Tumpane (0·5) and Alutkuru Korale North A (6·2) had spleen rates below 10. Five revenue divisions had spleen rates between 10-20, and in the rest they ranged from 20·8 to 47·3. In March 1941, following the second wave of the epidemic in 1940, the mean spleen rate dropped slightly to 22·4. Four revenue divisions had spleen rates below 10, and the highest rate was 40·9 in Kinigoda Korale. Further March surveys were then interrupted owing to the war.

The spleen surveys from March 1947 onwards are of great interest. They followed the spring-autumn-spring epidemics of 1945-46. But the mean spleen rate was only 6·7. In March 1948, 1949 and 1950 the mean spleen rates were only 3·4, 1·9 and 0·9 respectively. These figures may be read in conjunction with the September surveys begun in 1946 (Table 4). In September 1946 the rate of 12·9, definitely showed the effect of the epidemic which had only recently begun to subside. But from 1947-49 the mean spleen rate has progressively declined from 4·6 in 1947 to 0·8 in 1949.

(*b*) **Parasite Surveys.** These surveys were carried out in schools in March for the years 1938-41 and 1948-50, and in September from 1946-49. The results are summarised according to revenue divisions in Tables 5 and 6. The complete results, tabulated according to schools in each health area, are given in Appendix II A for the March surveys and in Appendix II B for the September surveys.

The mean parasite rate each March during the period 1938-41 for the whole basin was 3·3 in 1938, 5·2 in 1939, 6·1 in 1940, and 4·3 in 1941, only Alutkuru Korale North A registering a rate of zero for each of the years 1938-40. In 1938, in addition to Alutkuru Korale North A, Tumpane and Yati Nuwara also recorded no infections.

MAP 2.

MAHA OYA BASIN
SHOWING THE POSITION OF SCHOOLS
IN THE VARIOUS REVENUE DIVISIONS.

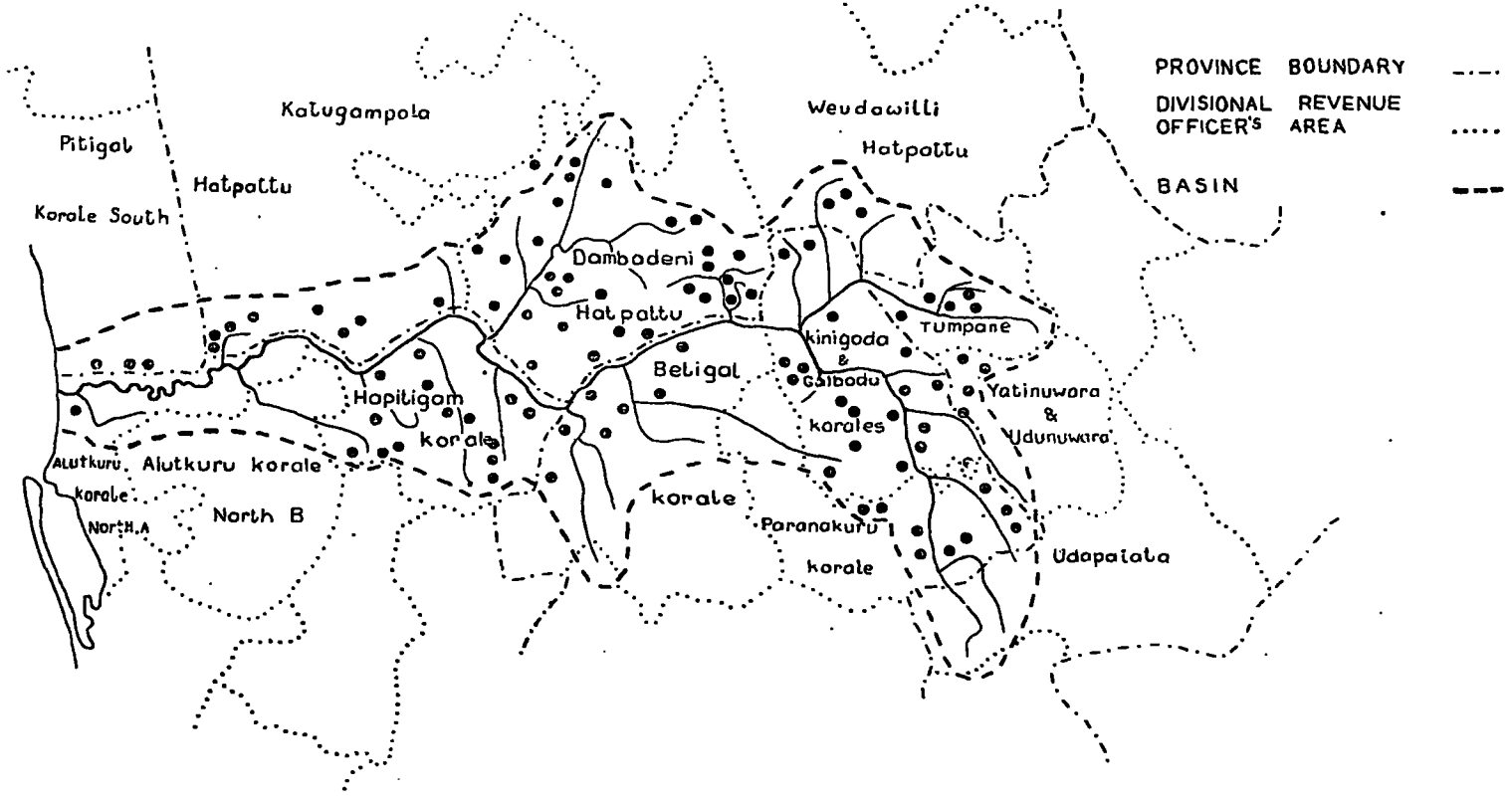


TABLE 5

Parasite rates among School Children by revenue divisions—March Surveys, 1938-1950.

Revenue division	1938			1939			1940			1941			1948			1949			1950		
	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.
Tumpane	57	4	7·0	51	1	2·0	39	2	5·1	34	1	2·9	70	0	0	36	0	0	64	0	0
Yati Nuwara	31	0	0	28	2	7·1	17	0	0	26	0	0	48	0	0	35	0	0	33	0	0
Paranakuru Korale	106	0	0	92	8	8·7	83	7	8·4	65	1	1·5	130	0	0	120	0	0	137	0	0
Galboda Korale	75	1	1·3	82	2	2·4	73	2	2·7	71	0	0	165	0	0	184	0	0	199	0	0
Kinigoda Korale	97	4	4·1	96	4	4·2	93	6	6·5	90	2	2·2	82	0	0	86	0	0	112	0	0
Beligal Korale	47	1	2·1	36	1	2·8	52	5	9·6	79	2	2·5	86	0	0	66	0	0	109	0	0
Dambadeni Hatpattu	303	17	5·6	307	23	7·5	288	20	6·9	316	20	6·3	367	3	0·8	415	0	0	421	0	0
Weudavili Hatpattu	40	3	7·5	29	1	3·4	26	0	0	26	0	0	40	0	0	43	0	0	34	0	0
Katugampola Hatpattu	77	1	1·3	76	7	9·2	87	1	1·1	75	12	16·0	120	0	0	110	0	0	145	0	0
Pitigal Korale South	18	0	0	35	0	0	32	5	15·6	37	2	5·4	44	0	0	46	0	0	45	0	0
Alutkuru Korale North A	11	0	0	14	0	0	15	0	0	—	—	—	13	0	0	10	0	0	8	0	0
Hapitigam Korale	111	1	0·9	127	2	1·6	135	10	7·4	131	1	0·8	112	0	0	119	0	0	190	0	0
Total	973	32	3·3	973	51	5·2	940	58	6·1	950	41	4·3	1277	3	0·2	1270	0	0	1497	0	0

TABLE 6

Parasite rates among School Children by revenue divisions—September Surveys, 1946-1949.

Revenue division	1946			1947			1948			1949		
	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.
Tumpane	21	0	0	115	0	0	118	2	1·7	72	0	0
Yati Nuwara	24	0	0	42	0	0	60	0	0	32	0	0
Paranakuru Korale	57	1	1·8	125	2	1·6	141	1	0·7	142	0	0
Galboda Korale	84	4	4·8	187	1	0·5	195	1	0·5	219	0	0
Kinigoda Korale	48	4	8·3	85	0	0	116	0	0	96	0	0
Beligal Korale	66	3	4·5	82	0	0	81	0	0	91	0	0
Dambadeni Hatpattu	434	50	11·5	282	1	0·4	335	1	0·3	348	0	0
Weudavili Hatpattu	28	7	25·0	37	1	2·7	41	0	0	42	0	0
Katugampola Hatpattu	53	6	11·3	87	0	0	114	2	1·8	142	0	0
Pitigal Korale South	22	2	9·1	24	0	0	40	0	0	45	0	0
Alutkuru Korale North A	22	2	9·1	14	0	0	5	0	0	—	—	—
Hapitigam Korale	102	0	0	106	0	0	219	0	0	137	0	0
Total	961	79	8·2	1186	5	0·4	1465	7	0·5	1366	0	0

In the rest of the revenue divisions there were wide fluctuations in parasite rates, and rates as high as 7·5 in Weudavili Hatpattu and 7·0 in Tumpane were recorded.

In 1939 the parasite rates were higher generally than in 1938. Katugampola Hatpattu had a rate of 9·2, Paranakuru Korale 8·7, Dambadeni Hatpattu 7·5, and Yati Nuwara 7·1. In 1940 after the spring epidemic of 1939 the mean parasite rate had gone up to 6·1, and although Yati Nuwara, Weudavili Hatpattu and Alutkuru Korale North A had no infections the number of blood films examined in each of these divisions was not very high. Seven revenue divisions had parasite rates of above 5, the highest being Pitigal Korale South with 15·6. In 1941 the mean parasite rate had come down to 4·3, Katugampola Hatpattu having a rate of 16·0. Only two other revenue divisions had rates above 5.

From 1947 parasite rates have been uniformly low. In September 1946 (Table 6) a mean parasite rate of 8·2 was recorded. This was the highest recorded up to then in any survey, and in Weudavili Hatpattu 28 blood films gave a parasite rate of 25·0. This was due to the aftermath of the epidemic, which was then beginning to subside. In September 1947 the rate had come down to 0·4, and from then on the rates have progressively declined, until in 1950 no infections were recorded at the March survey.

VITAL STATISTICS

The vital statistics for all health areas in the Maha Oya Basin, for the period 1939-50, are given in Table 7. The birth rates have become progressively higher, particularly in the period 1947-50, when it ranged between 34·1 and 35·3. A study of the previous years is also interesting. Rustomjee (loc cit.) said that birth rates tend to be higher just before an epidemic, and revert to normal within two years after an outbreak. The birth rates given in Table 7 bear out the truth of this statement. Thus in 1942, prior to the outbreak of 1943, the birth rate was 32·7. In 1944 it had dropped to 30·1. Again after the epidemic of 1945, the birth rate dropped to 27·3 in 1946, but by 1947 it had risen to 35·3 and has remained high ever since.

The crude death rates and the infant-mortality rates, given in Table 7, are highest in epidemic years, as one would expect. Thus the death rates in 1939-40 were 16·1 and 15·1 respectively. Thereafter in 1941 and 1942 the death rates dropped to 11·1 and 13·1 respectively. During the epidemic of 1943 it rose again to 16·2, and remained high at 15·7 in 1944. In 1945-46, also epidemic years, the death rates rose to 17·7 and 16·0 respectively. Thereafter they have been decreasing steadily, until in 1950 the crude death rate was as low as 9·6. The infant-mortality rates have shown an exactly similar trend and have been highest in epidemic years. In 1939 the rate of 170 was the highest for the period under review. But since 1947 the rate has been coming down steadily until in 1950 it was 67.

There is an unavoidable discrepancy in the population and morbidity figures given in Tables 2 and 7. In the former table the population has been calculated from the census reports of 1921 and 1946, and only that fraction of the population of any revenue division which falls within the Maha Oya Basin has been taken into account. The morbidity figures have been taken from all dispensaries and hospitals situated in the basin. The population figures in Table 7 are for all the health areas, in and around the catchment. These health areas may be verified from Map

TABLE 7

Vital Statistics.

Year	Population	Number of births	Birth rate	Number of deaths	Crude death rate	Number of infant deaths	Infant mortality rate	Malaria attendance	Malaria morbidity rate	Remarks
1939*	745584	20748	27·8	11975	16·1	3526	170	550111	738	*Warakapola figures not included
1940	815908	22637	27·7	12291	15·1	3018	133	460884	565	
1941*	796323	22972	28·8	8841	11·1	2351	102	235906	296	*Pannala figures not included
1942*	799701	26159	32·7	10509	13·1	2523	96	231021	289	*Pannala figures not included
1943	855694	29714	34·7	13917	16·2	3512	118	471258	551	
1944	849389	25598	30·1	13307	15·7	2842	111	195978	231	
1945	875220	25763	29·4	15518	17·7	3478	135	606660	693	
1946	889659	24362	27·3	14276	16·0	3403	140	517039	581	
1947	895313	31650	35·3	9285	10·3	2719	86	206561	230	
1948	893111	31369	35·1	9175	10·2	2473	79	123401	138	
1949	893555	31391	35·1	8692	9·7	2419	77	65748	73	
1950	905529	31301	34·5	8695	9·6	2080	67	51663	57	

2, which shows the river basin and the revenue divisions that come within it. As health areas correspond to revenue divisions, portions of some of them lie outside the catchment, and the population figures of such areas have not been excluded from the table. It is our intention to record all this data for future reference, summarised according to each health area. Similarly, the malaria attendances include hospitals and dispensaries which lie outside the catchment. In Appendix III is recorded the vital statistics for each health area, lying in and just over the border of the Maha Oya Basin.

The morbidity rates given in Table 7 are noteworthy for two reasons. One the high rates prevailing in epidemic years, and the other the decline particularly from 1948 onwards. The rate of 57 in 1950 is probably the lowest ever recorded. It is certainly the lowest since statistical records were maintained.

BIONOMICS OF *ANOPHELES CULICIFACIES*

Since the first infected *Anopheles culicifacies* Giles was found by James and Gunasekera (1913) at Talaimannar no other mosquito has been found infected in Ceylon, except for a single gut infection in *A. hyrcanus*. In this section it is proposed to give an account of the bionomics of *A. culicifacies* from data gathered during the period 1935-50. These data record the monthly examinations made at Malaria Observation Stations situated in the Maha Oya Basin. The origin and nature of the work done at these stations has been described fully in our previous paper and it is not proposed to recapitulate it here. Suffice it to say that these Observation Stations were generally situated on or close to a river. The entomological observations included examination of dwellings by means of hand catches in the morning for adult mosquitos, trapping adult mosquitos from 6 p.m. to 8.30 p.m. in cattle-baited traps, trapping adult mosquitos in human-baited traps also from 6 p.m. to 8.30 p.m., the examination of a selected mile of river-bed for larval anopheline breeding in sand and rock pools and along the margins (banks) of the river, and finally the examination of various types of breeding places in the village, other than the main river or tributary, but including any minor streams. The results of the examination of minor streams have been included with the main river examinations to avoid unnecessary duplication of tables. It may be mentioned here that in general the smaller streams follow the same features of behaviour as the larger tributaries, and in times of drought show a greatly diminished flow of water, with consequent pooling of the bed. Human-baited trapping was carried out only from 1936-41.

At each Observation Station a selected number of houses was examined at monthly visits by a Entomological (Field) Assistant, who in addition to his headquarter station had three other stations allotted to him. These stations were worked in rotation by the Entomological Assistant, assisted by two Field Attendants. The adult mosquitos collected were despatched alive to the Colombo Laboratory for examination, together with the preserved larvae, collected from various types of breeding place. Control measures were promptly put into operation no sooner *A. culicifacies* was reported to be breeding at any station. These examinations, together with regular observations at larval dipping stations (Subsidiary Observation

TABLE 8

Malaria Observation Stations, 1935-1950.

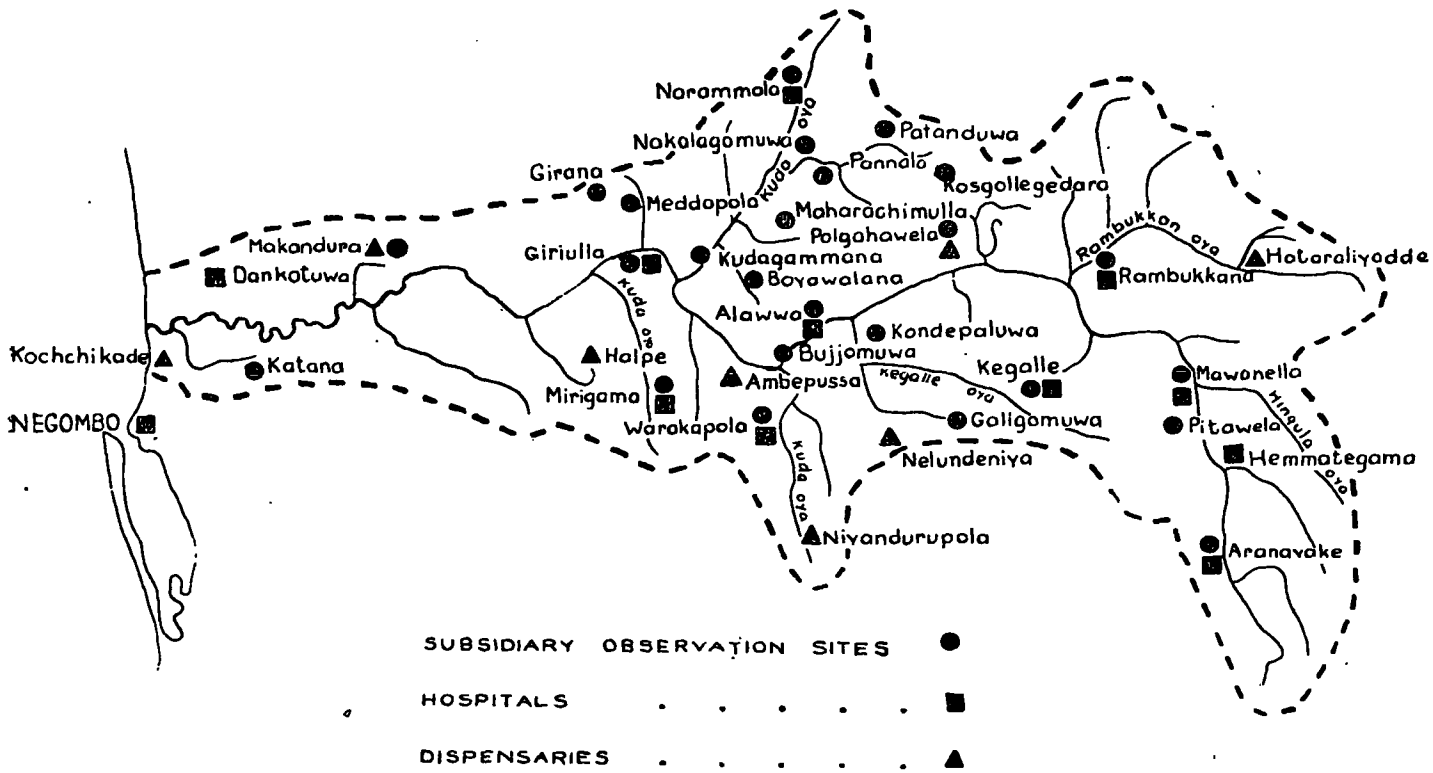
Station	Height above mean sea-level (feet)	River examined	Period of observation
Alawwa	164	Maha Oya	1935-49
Aranayake	1000	Maha Oya	1935-46
Boyawalana	176	*Kuda Oya	1947-49
Bujjomuwa	150-200	Maha Oya	1947-49
Galigomuwa	—	Galigomuwa Oya	1950
Girana	157	No river	1943-46
Giriulla	130	Maha Oya	1935-46
Katana	—	Batapat Ela	1950
Kegalle	650	Kegalle Oya	1935-48
Kondepaluwa	—	Maha Oya and Ragala Oya	1947-48
Kosgollegedera	300	No river	1947-49
Kudagammana	146	*Kuda Oya	1943-46
Maharachimulla	200	Pin Ela	1947-49
Makandura	58	Gal Oya	1937-40
Mawanella	800	Maha Oya	1935-48
Meddapola	300	No river	1943-46
Mirigama	180	Kuda Oya	1940-46
Nakalagamuwa	—	*Kuda Oya	1947-48
Narammala	189	*Kuda Oya	1940-48
Pannala	61	*Kuda Oya	1947-49
Pattanduwa	—	No river	1947-48
Pittawela	—	Maha Oya	1947-48
Polgahawela	252	Maha Oya	1947-49
Rambukkana	280	Maha Oya	1935-48
Warakapola	250	Ambepusse Oya	1935-36

*Same river—Kuda Oya

Sites) throughout the Wet and Intermediate Zones from 1940, were chiefly responsible for putting into operation river oiling measures. River oiling from 1935 to 1946 was the only anti-larval measure adopted. A list of the Malaria Observation Sites with the particular river examined and the duration of the observations made is given in Table 8 while their location is indicated in Map 3. The name Kuda Oya is given to a large number of different tributaries of the Maha Oya, and also to minor

MAP 3.

MAHA OYA BASIN



streams which are not included in Map 3. The various Observation Stations are also marked in this map.

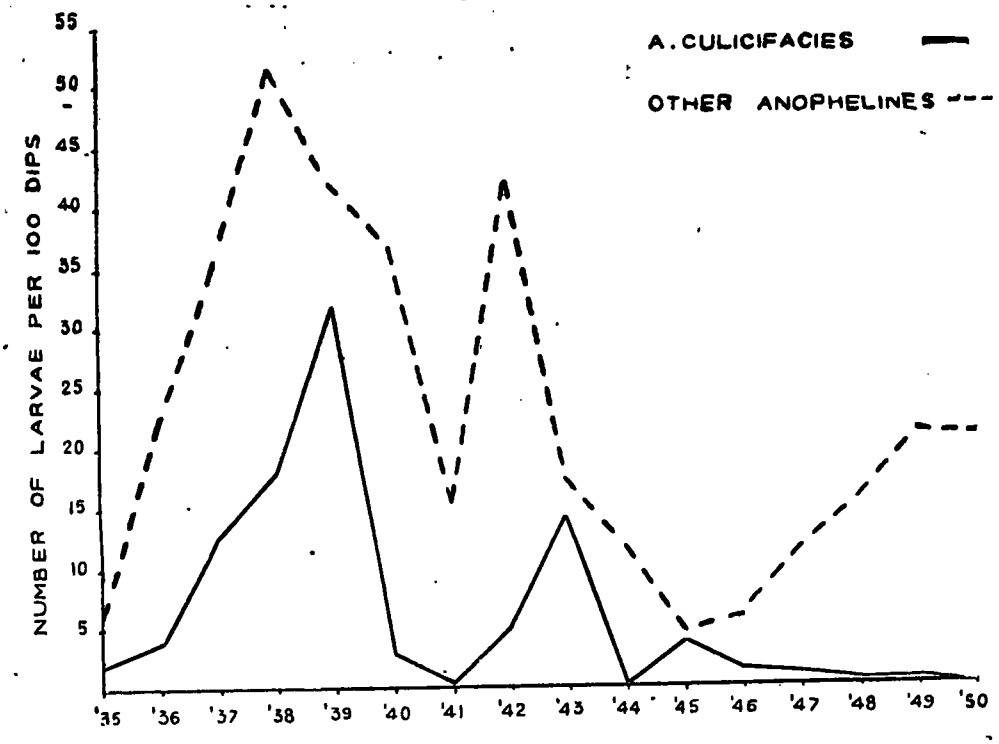
The larval rate as the term is used in this paper is defined as the number of larvae per 100 dips from a standard ladle. All references to the adult of *A. culicifacies* and other anopheline adults are confined to the female mosquito only.

In this paper no detailed reference is being made to anopheline mosquitos, other than *A. culicifacies*, as it is proposed to write an account of the mosquitos of the Maha Oya Basin at a future date. The anopheline mosquitos recorded in this river basin, apart from *A. culicifacies*, are *A. aconitus* Dönitz, *A. aitkeni* James, *A. annularis* Van der Wulp, *A. insulaeflorum* Swell. and Swell., *A. barbirostris* Van der Wulp, *A. hyrcanus* var. *nigerrimus* Giles, *A. jamesi* Theobald, *A. karwari* James, *A. leucosphyrus* Dönitz, *A. maculatus* Theobald, *A. pallidus* Theobald, *A. subpictus* Grassi, *A. tessellatus* Theobald, *A. vagus* Dönitz and *A. varuna* Iyengar.

(*a*) **Larval Habitat and Prevalence.** All the data relating to the larval bionomics of the vector are given in Tables 8-16.

1. *Sand Pools.*—In the Intermediate Zone *A. culicifacies* breeds prolifically in times of drought, whenever the river begins to pool. In this zone the vector can be regarded as being pre-eminently a pool breeder, showing no marked reference for either sand or rock pools. The annual variation in the prevalence of *A. culicifacies* and the total of all other anopheline larvae, expressed as a larval rate, is given in Table 9 and Graph 2. In 1935 observations commenced only in July, when the

GRAPH 2



The prevalence of *Anopheles culicifacies* and the total of all other anopheline larvae breeding in sand pools.

TABLE 9

Annual variation in the larval prevalence of A. culicifacies *and the total of all other anopheline larvae caught in sand and rock pools in rivers and streams at Malaria Observation Stations during the period* 1935-1950.

Year	SAND POOLS					ROCK POOLS				
	Number of dips	*A. culicifacies*		Other anopheline species		Number of dips	*A. culicifacies*		Other anopheline species	
		Number of larvae	Larval rate	Number of larvae	Larval rate		Number of larvae	Larval rate	Number of larvae	Larval rate
1935	8236	162	1·97	487	5·91	3969	112	2·82	383	9·65
1936	23397	914	3·90	5129	22·44	9855	2270	23·02	1411	14·32
1937	13046	1670	12·80	4589	35·18	9332	934	10·01	2036	21·82
1938	8130	1449	17·82	4196	51·60	4843	1022	21·10	2071	42·77
1939	7395	2338	31·62	3111	42·07	3430	988	28·80	1255	36·59
1940	11075	339	3·06	2958	26·73	5970	739	12·38	1449	24·28
1941	5380	22	0·41	837	15·55	4045	152	3·76	982	23·04
1942	4075	194	4·76	1722	42·26	5730	118	2·06	1531	26·70
1943	5725	811	14·16	1008	17·60	3970	488	12·29	746	18·79
1944	5430	1	0·02	645	11·88	7660	8	0·10	979	12·78
1945	15890	610	3·84	754	4·76	13995	544	3·89	409	2·92
1946	13925	178	1·28	817	5·87	11700	365	3·12	586	5·01
1947	12485	101	0·81	1534	12·29	6310	13	0·21	879	13·95
1948	20234	77	0·38	3022	14·94	4095	25	0·61	639	15·61
1949	8235	52	0·63	1730	21·00	175	0	0	39	22·29
1950	7170	0	0	1486	20·73	2895	0	0	675	22·31

second wave of the autumnal epidemic which commenced in 1934 was beginning to subside. The relatively high larval rates for *A. culicifacies* and the total of all other anopheline larvae recorded from 1936-38, which were non-epidemic years, were due to the fact that in these years control measures were spasmodic and poorly organised. In 1939, although emergency river oiling was carried out from March 1st, the organisation was still handicapped by lack of equipment and trained personnel, and it was not possible to avert an epidemic. The annual larval rate of 31·62 for *A. culicifacies* in 1939 was the highest recorded during the period under review. It is also interesting to note that the larval rate for the total of all other anopheline mosquitos was generally higher from 1936-39 (range 22·44-51·60), than at any other period except 1944, when it was 42·6.

From 1940 up to 1946 when river oiling became progressively better organised as a control measure, the larval rates for *A. culicifacies* never reached the high level of earlier days. The only exceptions were in the epidemic years of 1943 and 1945, when the larval rates were 14·16 and 3·84 respectively. In 1946, in the early part of which heavy breeding was going on, the larval rate was 1·28. In the period 1947-50 the larval rates were 0·81 in 1947, 0·38 in 1948, 0·63 in 1949 and 0 in 1950.

In Table 9 is summarised the annual variation in the prevalence of *A. culicifacies* for all the Observation Stations in the catchment. In Table 10 is given the annual variation in larval rates for each Observation Station. Up to 1939 some of these larval rates for individual stations were exceedingly high, even in a non-epidemic year such as 1938. Thus at Alawwa, Makandura and Rambukkana the larval rates in 1938 were 39·73, 26·40 and 20·45 respectively. In the epidemic year of 1939 some of the stations recorded even higher catches of *A. culicifacies*, and at Rambukkana, Giriulla and Mawanella larval rates of 69·50, 53·81 and 33·87 respectively were recorded. Since 1939 high larval rates were only recorded in 1943, when at six stations the rates ranged from 10·33 at Aranayake to 28·86 at Rambukkana. In the epidemic year of 1945, the highest larval rate was only 7·61 at Rambukkana. This was a year of almost uninterrupted river oiling in the basin from January to October. In the early part of 1946 there was still fairly heavy breeding of *A. culicifacies* taking place particularly at Giriulla and Rambukkana, when larval rates of 5·38 and 3·45 were recorded. After 1946 the only high larval rates for the vector have been at Bujjomuwa in 1947 (9·82) and 1948 (3·61), and at Boyawalana (5·21) in 1949.

In Table 11 is given the larval rates at monthly examinations made at Alawwa, Giriulla, Mawanella and Rambukkana in 1938 and 1942 (non-epidemic years), and 1939 and 1943 (epidemic years). In general, in a epidemic or non-epidemic year the larval rates are much higher in the period January-June, than in the period July-December. The stations selected are all notoriously unhealthy ones, and the heavy breeding of *A. culicifacies* in the early part of the year is due to the fact that the north-east monsoon is generally the weaker monsoon of the two and often dry conditions set in by late December or early January. During the second half of the year high catches in August and September are not unexpected, as these are relatively dry months. If the monthly examination were to be carried out in the second half of December high catches would not be uncommon, as pooling may have

TABLE 10

Annual variation in larval rates for Anopheles culicifacies *breeding in sand pools in rivers at Malaria Observation Stations during the period* 1935-1950.

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Alawwa	7·14	0·46	25·86	39·73	16·65	0·73	0·67	2·78	11·62	0	4·31	0·44	0·78	0·65	0	0
Aranayake	0	0·50	0·21	0·33	7·26	2·88	0	4·37	10·33	0	0	0				
Boyawalana													0	0·22	5·21	
Bujjomuwa													9·82	3·61	0	
Galigomuwa																0
*Girana									—	—	—	—				
Giriulla	5·85	1·20	9·44	3·27	53·81	4·64	1·14	6·86	21·87	0	3·96	5·38				0
Katana																0
Kegalle	0	11·57	0	10·24	1·84	0·32	0	0·29	14·64	0	0·90	0	0·18	0		
Kondepaluwa													0	0		
*Kosgollegedera													—	—	—	
Kudagammana									0	0	3·93	0·82	0	0·73		
Maharachimulla													0	0	NP	
Makandura			0	26·40	15·33	3·06										0
Mawanella	0	16·63	3·73	11·09	33·87	6·57	0	14·79	12·93	0·09	3·05	2·33	0·28	0		0
*Meddapola									—	—	—	—				
Mirigama						NP	NP	NP	NP	NP	0	0				

*No river.
Larval rate = number of larvae per 100 dips.
NP = no pooling of river.
A blank space indicates that the station was not worked in that year.

TABLE 10 (*Contd.*)

Annual variation in larval rates for Anopheles culicifacies *breeding in sand pools in rivers at Malaria Observation Stations during the period* 1935-1950.

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Nakalagamuwa													0	0		
Narammala						2·63	0	NP	0	0	0	0	0	0		
Pannala													0	0	0	
*Pattanduwa													—	—		
Pittawela													0	0		
Polgahawela													0	0	0·34	0
Rambukkana	0·91	23·63	31·85	20·45	69·50	5·55	0·60	0·15	28·86	0	7·61	3·45	0·07	0		0
Warakapola	0	0·24														

*No river.
Larval rate = number of larvae per 100 dips.
NP = no pooling of river.
A blank space indicates that the station was not worked in that year.

TABLE 11

Larval rates for Anopheles culicifacies *breeding in sand pools in the Maha Oya at monthly examinations made at Alawwa, Giriulla, Mawanella and Rambukkana (Hiriwaduna) in certain epidemic and non-epidemic years.*

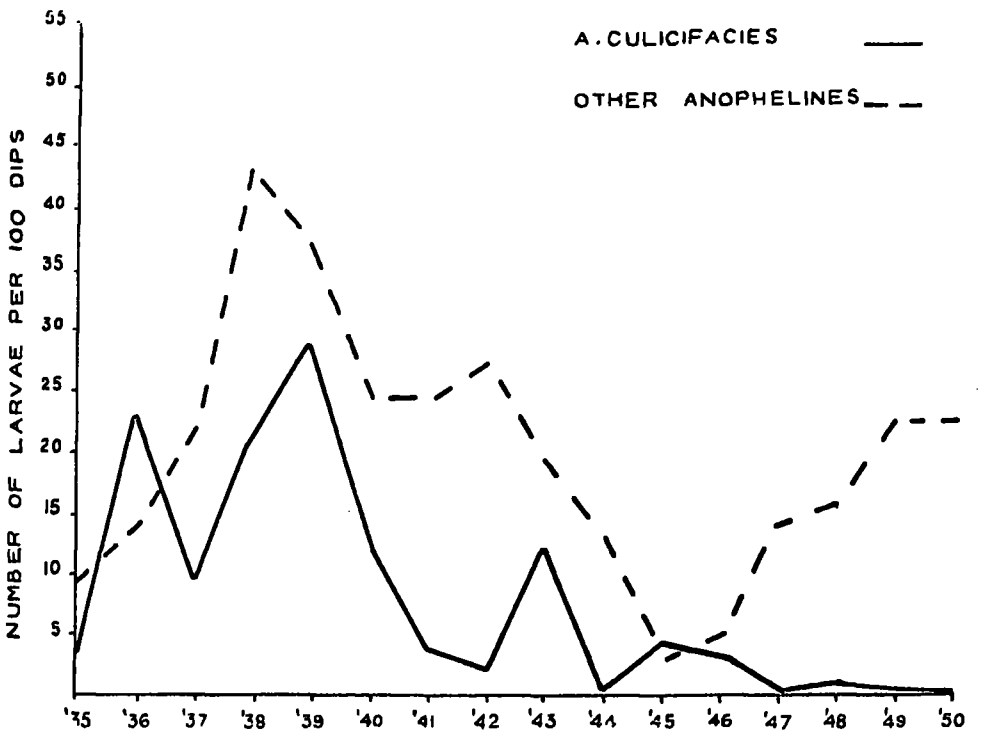
Station	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alawwa	1938	57·05								38·40		0	7·27
	1939		10·55	41·20			0	0	0	12·50			
	1942	8·57	0·66	1·73		5·27		0	0·80	0		0	
	1943	0	0	17·23		NE	0			0			0
Giriulla	1938								0	0		0	9·47
	1939	0	46·57	26·76						139·55	0		
	1942		12·00	0		0		NE					
	1943	NE	NE	36·66	7·27	NE	NE			13·33	NE	NE	NE
Mawanella	1938	0·74	0	0	0	0	0	0	10·77	0	0	1·00	83·43
	1939	94·44	17·54	1·36	0			0	0		0		
	1942	24·00	12·94	0·59		40·00		0	0	0			
	1943	0	5·83	0	47·37	0			0				
Rambukkana (Hiriwaduna)	1938	21·43	34·70	0	0	0·40	31·58	0·44	15·11	0	0·83	5·00	99·60
	1939	12·57	28·98	203·57	7·50	216·30			25·00	0	0		5·00
	1942	0	0			0·45	0		0	0	0	0	
	1943	55·55	0	0·56	111·33					0			100·00

NE = not examined.
A blank space indicates that no pooling had occurred during that particular examination.
Larval rate = number of larvae per 100 dips.
1939 and 1943—epidemic years; 1938 and 1942—non-epidemic years.

commenced by then. In Table 11 is recorded some exceedingly high larval rates, notably at Rambukkana in March and May 1939, when rates of 203·57 and 216·30 were recorded.

2. *Rock Pools.*—*A. culicifacies* breeding in rock pools is summarised in Table 9. It will be seen that the annual larval rates are highest in the epidemic years of 1939-40, 1943 and 1945-46, apart from the period 1935-38 when *A. culicifacies* was breeding virtually unchecked in both sand and rock pools. In Graph 3, the larval

GRAPH 3



The prevalence of *Anopheles culicifacies* and the total of all other anopheline larvae breeding in rock pools.

rates for *A. culicifacies* and the total of all other larval anopheline breeding in rock pools is given for the period 1935-50.

In Table 12 is recorded the annual larval rate recorded for *A. culicifacies* at Aranayake, Giriulla, Kegalle, Kudagammana, Mawanella, Rambukkana and Warakapola. These are the seven Observation Stations in the Maha Oya Basin where the river-bed is rocky. At Rambukkana very heavy breeding of *A. culicifacies* has occurred, particularly from 1935-41. It was at this station, Giriulla and Mawanella that one could invariably obtain *A. culicifacies* larvae, as some of the rock pools are high above the level of the river-bed, particularly at Giriulla, and were often evaded by oiling gangs.

The larval rates recorded for *A. culicifacies* at monthly examinations of rock pools at Giriulla, Mawanella and Rambukkana in 1936, 1938 and 1942 (non-epidemic

TABLE 12

Annual variation in larval rates for Anopheles culicifacies *breeding in rock pools during the period* 1935-1950 *at those Malaria Observation Stations in which rock pools were present in the river-bed.*

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Aranayake	0	0·36	5·11	—	—	0	0	1·57	0·20	0	0	0				
Giriulla	14·37	16·93	2·49	28·08	31·27	19·38	0	6·47	28·41	0	2·11	2·79				
Kegalle	0	3·65	0	1·22	2·64	0·65	0	0·13	0·28	0	1·91	0	0	0		
Kudagammana									RS	RS	0	16·26	0	0		
Mawanella	0·13	38·56	1·34	17·21	10·00	13·12	0·19	2·43	14·95	0	3·78	1·74	0·25	0		0
Rambukkana	0	33·13	27·85	37·49	59·36	26·17	20·14	8·45	20·72	0·78	10·81	1·29	0·29	0		0
Warakapola	0	0														

Larval rate = number of larvae per 100 dips.
RS = river full and rock pools covered.
In 1938 and 1939 the rock pools at Aranayake were not examined.
A blank space indicates that the station was not worked in that year.

TABLE 13

Larval rates for Anopheles culicifacies *breeding in rock pools in the Maha Oya at monthly examinations made at Giriulla, Mawanella and Rambukkana (Hiriwaduna) in certain epidemic and non-epidemic years.*

Station	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Giriulla	1936	0	0	2·00	94·29	NE	122·86	0	4·20	3·43	0	NE	NE
	1938	40·00						0	11·67	31·03		33·33	58·18
	1939	0	40·00	4·00						73·33	0		
	1942	0	4·44	0					0				
	1943			41·67	34·09					0			
Mawanella	1936	0	0	0	8·20	18·60	9·68	0	24·87	320·27	121·38	0	NE
	1938	90·00	0	0	0	0	0	0	0	0	0	0	0
	1939	5·22	27·50	0				0	0				
	1942	10·67	1·43	0	0	12·67	0	0	0	0	0		0
	1943	0	5·00	11·11	57·00	0	0		7·50			0	
Rambukkana (Hiriwaduna)	1936	5·16	12·28	31·67	26·34	NE	171·03	102·22	0	53·63	0	0	0
	1938	80·00	155·00	0	1·11	0	18·82	2·40	10·00	0	0		31·00
	1939	5·00	65·81	97·60	25·00	192·22			190·00	0			33·33
	1942	25·45	0	0	3·33	0	25·00			0	0	5·00	
	1943	37·27	0	0	131·00			0		15·56			1·67

NE = not examined.
A blank space indicates that no pooling had occurred during that particular examination.
Larval rate = number of larvae per 100 dips.
1939 and 1943—epidemic years; 1936, 1938 and 1942—non-epidemic years.

years), and 1939 and 1943 (epidemic years) are given in Table 13. Once again it will be seen that breeding in the first half of the year is more general than in the second half of the year. At Rambukkana in 1939 very heavy breeding was taking place in several months of the year, notably in August and December, when larval rates of 192·22 and 190 respectively were recorded.

3. *Margins (banks) of Rivers.*—The occurrence of *A. culicifacies* along the banks of rivers is usually of negligible importance, compared with its prolific breeding in sand and rock pools. The larval rates for the period 1935-50 are summarised in

TABLE 14

Annual variation in the larval prevalence of A. culicifacies *and the total of all other anopheline larvae caught along the margins of rivers and streams at Malaria Observation Stations during the period* 1935-1950.

Year	Number of dips	*A. culicifacies*		Other anopheline species	
		Number of larvae	Larval rate	Number of larvae	Larval rate
1935	31815	470	1·48	3276	10·30
1936	51531	221	0·43	17124	33·22
1937	45324	289	0·65	15831	34·93
1938	48700	242	0·50	25943	53·27
1939	49785	1432	2·88	15746	31·63
1940	59445	380	0·64	9177	15·44
1941	58650	25	0·04	8135	13·87
1942	58360	42	0·07	10883	18·65
1943	64490	213	0·33	9744	15·11
1944	75840	27	0·03	11524	15·16
1945	67310	284	0·42	5375	7·99
1946	59305	52	0·08	5381	9·07
1947	70515	17	0·02	7673	10·88
1948	69985	45	0·06	6913	9·88
1949	52965	50	0·09	4269	8·06
1950	46065	0	0	3898	8·46

Table 14. In 1939 a larval rate of 2·88 was recorded, but since then larvae have been found in insignificant numbers.

4. *Village Breeding Places.*—The prevalence of the vector in all types of village breeding places, summarised in Table 15, shows that its presence in such situations is of even less importance than along the margins of rivers and streams. In practice these breeding places were never treated at all. In Table 16, is given a summary of the results of examination of different types of village breeding place

TABLE 15

Annual variation in the larval prevalence of A. culicifacies *and the total of all other anopheline larvae caught in village breeding places at Malaria Observation Stations during the period* 1935-1950.

Year	Number of dips	*A. culicifacies*		Other anopheline species	
		Number of larvae	Larval rate	Number of larvae	Larval rate
1935	12711	605	4·76	9610	75·61
1936	42740	203	0·47	33092	77·43
1937	40100	184	0·46	30337	75·67
1938	37677	209	0·55	28021	74·37
1939	56342	942	1·67	39877	70·79
1940	66196	342	0·52	36710	55·46
1941	71419	108	0·15	36819	51·54
1942	74483	39	0·05	35514	47·66
1943	85459	100	0·12	22752	26·62
1944	80412	9	0·01	36147	44·94
1945	81656	755	0·92	32556	39·87
1946	78803	74	0·09	28544	36·21
1947	136158	4	0·003	38749	28·34
1948	102308	33	0·03	24963	24·41
1949	110055	0	0	16494	14·96
1950	148851	0	0	17018	11·44

at Alawwa in the epidemic year of 1939. The highest larval rate was only 2·25 in pools, while that for the total of all other anopheline larvae was as high as 79·83. The larval rate of 2·25 in pools may be compared with some of the very high rates recorded in sand and rock pools in 1939 (Tables 11 and 13), to show how negligible was the incidence of the vector in village breeding places.

(*b*) **Adult Prevalence.** The examination of dwellings for *A. culicifacies* and other anopheline mosquitos has always been carried out from 7 a.m. to 12 noon. The results of these hand catches, showing the variation in catching rate per hour for all Malaria Observations, is given in Table 17. The fact that the catching rate for *A. culicifacies* has never exceeded one, even in a epidemic year such as 1939, when the larval rate was as high as 31·62, can be explained by the peculiar habit of this mosquito in secreting itself in cracks and crevices, first recorded by James and Liston (1911). The wattle and daub dwellings in rural Ceylon, thatched with the woven fronds of the coconut palm, are ideal for this purpose and it is not surprising that the catches of adults in the Maha Oya Basin are low. This is proved by the results of the spray and hand catches given in one of our previous papers (Rajendram

TABLE 16

Larval rates for Anopheles culicifacies *and the total of all other anopheline species caught in all types of village breeding places at Alawwa in* 1939.

Type of breeding places	Number of examinations	Number of dips	*A. culicifacies*		Other anopheline species	
			Number of larvae	Larval rate	Number of larvae	Larval rate
Built wells	154	529	0	0	99	18·71
Unbuilt wells	260	1438	1	0·07	1600	111·11
Borrow pits	47	530	7	1·32	278	52·45
Swamps	52	1055	2	0·19	1526	144·64
Drains	87	1100	9	0·82	662	60·18
Pools	36	665	15	2·25	531	79·83
Soakage pits	16	270	0	0	143	52·96
Coconut trenches	24	330	2	0·60	229	69·04
Irrigation channels	36	1015	9	0·88	546	53·80
Paddy (fallow)	48	860	8	0·93	316	36·74
Paddy (planted)	20	400	0	0	256	64·00
Paddy (full-grown)	10	150	0	0	9	6·00

and Jayewickreme, 1951a). These observations showed that in the sprayed houses nearly thirteen times as many adult *A. culicifacies* were collected as in the unsprayed houses.

1. *Prevalence in Dwellings.*—In Table 17, is summarised the annual variation in the mean catching rate per hour for all Observation Stations examined each year. The only feature of note in this table is that, although the catching rates are exceedingly low, they tend to rise in epidemic years. Thus in 1939-40 the catching rates were 0·88 and 0·23; in 1943 it was 0·25, and in 1945-46, 0·24 and 0·13 respectively. The catching rates for all other anopheline mosquitos are also low. This is because, apart from *A. culicifacies*, the other predominantly domestic mosquito of Ceylon, *A. subpictus*, is not very prevalent in this river basin.

In Table 18, is given the catching rate for *A. culicifacies* at each Observation Station for each year that observations were made. At certain stations fairly high annual catching rates have been recorded. These stations are Alawwa, where the catching rates in the epidemic years of 1935, 1939 and 1943, were 1·82, 1·56 and 2·16 respectively; Giriulla where a catching rate of 2·06 per hour was recorded in 1935; Makandura, at which a catching rate of 1·05 was recorded in 1939 and Rambukkana, at which the catching rate in 1939 was 1·47.

Epidemic years naturally yielded *A. culicifacies* more readily as will be gathered from Table 19, where the catching rates at Alawwa (1939 and 1943), Aranayake

TABLE 17

Annual variation in the prevalence of female Anopheles culicifacies *and the total of all other anopheline mosquitos caught in dwellings and in cattle-baited traps at Malaria Observation Stations for the years* 1935-1950.

Year	DWELLINGS						CATTLE-BAITED TRAPS				
	Number of house examinations	Number of catching hours	*A. culicifacies*		Other anopheline mosquitos		Number of trapping hours	*A. culicifacies*		Other anopheline mosquitos	
			Number caught	Catching rate per hour	Number caught	Catching rate per hour		Number caught	Catching rate per hour	Number caught	Catching rate per hour
1935	1659	292	224	0·77	58	0·20	525	72	0·14	67	0·13
1936	4820	492	138	0·28	194	0·39	1050	23	0·02	7553	7·19
1937	4716	626	129	0·20	403	0·64	1050	10	0·01	13310	12·67
1938	4364	590	66	0·11	317	0·53	1050	9	0·008	13602	12·95
1939	3792	609	536	0·88	440	0·72	1050	97	0·09	11614	11·06
1940	4101	666	159	0·23	564	0·84	1129	7	0·006	10270	9·09
1941	4047	646	10	0·01	276	0·42	1193	1	0·0008	10721	8·98
1942	4549	726	2	0·002	301	0·41	957	3	0·003	10581	11·06
1943	5831	927	237	0·25	412	0·44	797	7	0·008	7451	9·35
1944	6969	1337	3	0·001	338	0·25	767	1	0·001	6072	7·91
1945	7449	1342	335	0·24	1359	1·00	763	25	0·03	5655	8·41
1946	6585	1060	143	0·13	311	0·29	739	2	0·002	4589	6·21
1947	6641	999	4	0·004	41	0·04	657	0	0	4703	7·15
1948	7929	1153	9	0·007	26	0·02	368	0	0	1833	4·98
1949	12995	1995	0	0	4	0·002	—	—	—	—	—
1950	5484	928	0	0	13	0·01	356	3	0·008	1113	3·12

TABLE 18

Annual variation in catching rates per hour for female Anopheles culicifacies *caught in dwellings at Malaria Observation Stations for the period* 1935-1950.

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Alawwa	1·82	0·38	0·40	0·25	1·56	0·17	0·01	0·02	2·16	0	0·27	0·01	0	0	0	0
Aranayake	0	0·01	0·01	0·01	0·43	0·02	0	0	0	0	0·01	0·01				
Boyawalana													0	0·16	0	
Bujjomuwa													0	0	0	
Galigomuwa																0
Girana									0	0	0·09	0				
Giriulla	2·06	0·34	0·10	0·04	0·65	0·77	0	0	0·12	0·01	0·05	0·79				0
Katana																0
Kegalle	0	0·02	0·07	0	0·27	0	0·01	0	0	0	0·01	0	0	0		
Kondepaluwa													0	0·01		
Kosgollegedera													0	0	0	
Kudagammana									0	0·01	0·93	0·80	0	0		
Maharachimulla													0	0	0	
Makandura			0·06	0·08	1·05	0·16										0
Mawanella	0·11	0·06	0	0·07	0·39	0·19	0	0	0	0	0·11	0·05	0·01	0		0
Meddapola									0	0	0·21	0·13				
Mirigama						0	0	0	0	0	0·04	0				

A blank space indicates that the station was not worked in that particular year.

TABLE 18 (*Contd.*)

Annual variation in catching rates per hour for female Anopheles culicifacies *caught in dwellings at Malaria Observation Stations for the period* 1935-1950.

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Nakalagamuwa														0		
Narammala						0·25	0·06	0	0	0·01	0·05	0·01	0	0		
Pannala													0	0	0	
Pattanduwa													0	0		
Pittawela													0	0		
Polgahawela													0	0	0	0
Rambukkana	0·25	0·30	0·82	0·32	1·47	0·13	0·03	0	0·03	0	0·80	0·28	0·04	0		0
Warakapola	0·07	0·07														

A blank space indicates that the station was not worked in that particular year.

TABLE 19

Catching rate per hour for female Anopheles culicifacies *caught in dwellings at monthly examinations of certain Malaria Observation Stations in the epidemic years of* 1939 *and* 1943.

Station	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alawwa	1939	0·12	0	0·28	8·44	8·22	0·22	0·44	0	0·11	0	0	0
	1943	0	0·12	13·23	1·25	2·25	0	0	0	0	0	0	0
Aranayake	1939	0	0	4·67	3·83	0·50	0·50	0	0	0	0	0	0
Giriulla	1939	0	1·66	2·11	2·55	1·00	0·33	0	0	0	0	0	0
	1943	0	0	0	1·00	1·38	0	0	0	0	0	0	0
Kegalle	1939	0	0·17	0·67	1·00	0·67	0·17	0	0	0	0	0	1·67
Mawanella	1939	0·17	0·17	0·50	0·50	2·50	2·67	0·17	0	0	0·17	0	0
Makandura	1939	0·22	8·22	0·88	1·88	0·77	0	0	0	0	0·11	0	0
Rambukkana	1939	0·50	1·00	5·00	8·83	1·16	0·50	0	0	0	0	0	0·66

(1939), Giriulla (1939 and 1943) and Kegalle, Mawanella, Makandura and Rambukkana in 1939 are given. These monthly catching rates are most interesting as the adult has been found more frequently in dwellings in the first half of the year than in the second half. Some of the catching rates recorded are also comparatively high. Thus the highest rate of 13·23 was at Alawwa in 1943. In 1939 at Giriulla rates of 8·44 and 8·22 were obtained in May and June. Other high rates recorded have been 8·22 at Makandura in February 1939 and 8·83 at Rambukkana in April 1939.

2. *Prevalence in Cattle-baited Traps.*—Adults of *A. culicifacies* are not caught in any great numbers in cattle-traps. The annual variation in the mean catching rate per hour at all Observation Stations is given in Table 17. Other species of anophelines, notably *A. hyrcanus*, are caught quite frequently and in comparatively large numbers. In Table 20, is given the annual catching rate for *A. culicifacies* caught in cattle-traps at each Observation Station. The highest catching rates of 0·58 at Giriulla and 0·33 at Alawwa were recorded in 1935. Thereafter the only relatively high catching rates were recorded in 1939, 1940 and 1945 as follows. At Giriulla, Makandura and Rambukkana in 1939 the catching rates were 0·22, 0·13 and 0·12 respectively. In 1940 at Alawwa and Giriulla the rates were 0·20 and 0·16 respectively, and at Mawanella in 1945 a catching rate of 0·55 was recorded.

The catching rates at monthly examinations at Alawwa, Giriulla, Makandura and Rambukkana in 1939 are given in Table 21. Here once again adults are found to be more prevalent in the first half of the year, and a catching rate of 2·40 at Giriulla in February and 1·44 at Makandura in April are the only high rates recorded.

3. *Prevalence in Human-baited Traps.*—Human-baited traps, set in verandahs of dwellings with a man sleeping inside, were operated only from 1935-41, and the results are given in Table 22. Whether the exceedingly poor catches recorded were due to the fact that the trapping was done from 6 p.m. to 8-30 p.m. one cannot say. Only at Mawanella and Rambukkana in 1939, when catching rates of 0·43 and 0·32 were recorded, were moderately high catches obtained. The catching rates at each monthly examination for these two stations are given in Table 23.

(c) **Natural Infections.** Table 24 summarises the total infections, gut infections and gland infections found in *A. culicifacies* from 1935-50. These rates were naturally highest in epidemic years. Thus infection rates of 8·82, 5·32 and 5·44 were recorded in 1935, 1939 and 1943. During the epidemic of 1945-46, the infection rate was 1·24 and 1·25 respectively. Gut and gland infections were also highest in these years. In 1935, 1939 and 1943 oocyst rates of 4·70, 3·08 and 3·40 were recorded, while the sporozoite rates in these years were 5·29, 2·52 and 3·40 respectively. Details with regard to the infections recorded in *A. culicifacies* caught in cattle-traps are given in Table 25. They have been found only at seven Observation Stations, the last at Mawanella in 1945. A complete record of all dissections of *A. culicifacies* caught in dwellings, whether found infected or not, is given in Table 26, and finally in Table 27 is a list of all those Observation Stations at which no

TABLE 20

Catching rates per hour for female Anopheles culicifacies *caught in cattle-traps at Malaria Observation Stations during the period* 1935-1950.

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Alawwa	0·33	0·03	0·01	0·02	0·09	0·20	0	0	0·02	0	0	0	0	0		0
Aranayake	0·01	0·01	0·02	0·01	0·04	0·01	0·01	0·01	0·02	0	0	0				
Boyawalana													0	0		
Bujjomuwa													0	0		
Galigomuwa																0
Girana									0	0	0·08	0				
Giriulla	0·58	0·03	0·01	0·01	0·22	0·16	0	0	0·01	0	0·02	0				0
Katana																
Kegalle	0	0	0		0	0	0	0	0	0	0	0	0	0		
Kondepaluwa													0	0		
Kosgollegedera													0	0		
Kudagammana									0	0·02	0	0	0	0		
Maharachimulla													0	0		
Makandura			0·02	0	0·13	0·11										0
Mawanella	0	0·01	0·01		0·03	0·01	0	0	0	0	0·55	0·02	0	0		0·06
Meddapola									0	0	0·17	0				
Mirigama						0	0	0	0	0	0	0				
Nakalagamuwa													0	0		

A blank space indicates that the station was not worked in that year.

TABLE 20 (*Contd.*)

Catching rates per hour for female Anopheles culicifacies *caught in cattle-traps at Malaria Observation Stations during the period* 1935-1950.

Station	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Narammala						0	0	0	0	0	0	0	0	0		
Pannala														0		
Pattanduwa													0	0·02		
Pittawela													0	0		
Polgahawela													0	0		0
Rambukkana	0·01	0·04	0	0·01	0·12	0·02	0	0·01	0·01	0	0·11	0	0	0		0
Warakapola	0·01	0·02														

A blank space indicates that the station was not worked in that year.

TABLE 21

Catching rate per hour for female Anopheles culicifacies *caught in cattle-traps at monthly examinations of four Malaria Observation Stations in* 1939.

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alawwa.	0	0	0	0·80	0·16	0·08	0·08	0	0	0	0	0
Giriulla	0·08	2·40	0	0·08	0	0	0	0	0	0	0	0
Makandura	0·08	0·08	0	1·44	0	0	0	0	0	0	0	0
Rambukkana	0	0·40	0·80	0·08	0·16	0	0	0	0	0	0	0

TABLE 22

Anopheles culicifacies *females caught per hour in human-baited traps during the period* 1936-1941.

Station	1936	1937	1938	1939	1940	1941
Alawwa	0·02	0·02	0·03	0·03	0	0
Aranayake	0	0·01	0	0·01	0·01	0
Giriulla	0·03	0·01	0	0·04	0·05	0
Kegalle	0·02	0	0	0	0	0
Makandura		0·02	0	0	0	
Mawanella	0	0·01	0	0·43	0·10	0
Mirigama					0	0
Narammala					0·01	0
Rambukkana	0·01	0·02	0·02	0·32	0·01	0
Warakapola	0			—		

A blank space indicates that the station was not worked in that year.

TABLE 23

Catching rate per hour for female Anopheles culicifacies *caught in human-baited traps at monthly examinations of Malaria Observation Stations at Mawanella and Rambukkana in* 1939.

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mawanella	0	0	0·56	0·80	1·92	1·68	0·24	0	0	0	0	0
Rambukkana	0·08	0·88	1·28	1·52	0·08	0	0·08	0	0	0	0	0

TABLE 24

Natural infections in Anopheles culicifacies *caught in dwellings at all Malaria Observation Stations for the years* 1935-1948.

Year	Number dissected	Total Infections		Gut Infections		Gland Infections	
		Number	Infection rate	Number	Oocyst rate	Number	Sporozoite rate
1935	170	15	8·82	8	4·70	9	5·29
1936	118	2	1·69	2	1·69	0	0
1937	116	3	2·58	2	1·72	1	0·86
1938	63	1	1·58	1	1·58	0	0
1939	357	19	5·32	11	3·08	9	2·52
1940	119	2	1·68	1	0·84	1	0·84
1941	8	0	0	0	0	0	0
1942	1	0	0	0	0	0	0
1943	147	8	5·44	5	3·40	5	3·40
1944	3	0	0	0	0	0	0
1945	241	3	1·24	2	0·83	2	0·83
1946	80	1	1·25	0	0	1	1·25
1947	—	—	—	—	—	—	—
1948	3	0	0	0	0	0	0

In 1947 only four *A. culicifacies* were caught but were received dry.
In 1949 and 1950 none were caught.

TABLE 25

Natural infections in A. culicifacies *caught in cattle-traps at Malaria Observation Stations during the period* 1935-1950.

Year	Station	Dissections	Infections	Guts	Glands
1935	Alawwa	17	1	0	1
1935	Giriulla	39	4	3	2
1939	Makandura	19	1	1	0
1945	Mawanella	4	1	0	1
1935	Rambukkana	3	1	0	1
1936	Warakapola	1	1	0	1

TABLE 27

Malaria Observation Stations at which no natural infections in A. culicifacies *have been recorded.*

Station	Period of Observation
Boyawalana	1947-1948
Bujjomuwa	1947-1948
Galigomuwa	1950
Katana	1950
Kegalle	1935-1950
*Kondepaluwa	1947-1948
Kosgollegedera	1947-1948
Maharachimulla	1947-1948
Mirigama	1940-1946
*Nakalagamuwa	1947-1948
Pannala	1947-1948
*Pattanduwa	1947-1948
*Pittawela	1947-1948
Polgahawela	1947-1948
Warakapola	1935-1936

*Untreated control villages in a DDT experiment.

infections have ever been recorded. At ten of these stations observations were commenced in 1947 when DDT spraying of houses was being carried out.

MALARIA CONTROL MEASURES

An account of the history of malaria control in Ceylon may be found in our earlier paper (Rajendram and Jayewickreme, 1951a), and only a brief recapitulation is attempted here. Prior to the epidemic of 1934-35 no rural malaria control was ever attempted in Ceylon. During the epidemic oiling of rivers was carried out for the first time, and up to 1937 this was done as and when conditions demanded it, but never on a very large scale. In 1939, oiling was placed on a sounder basis and it was decided to commence Emergency River Oiling as a routine measure on March 1st and September 15th at Pannala, Narammala and Polgahawela each year. But the epidemic which broke out in April 1939, served to show how vast an area had

TABLE 26

Details of natural infections in A. culicifacies *caught in dwellings at Malaria Observation Stations*, 1935-1950.

Year	Alawwa				Aranayake				Boyawalana				Giriulla				Kegalle				Kudagammana				Makandura				Mawanella				Mirigama				Narammala				Rambukkana				Warakapola			
	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands	Dissections	Infections	Guts	Glands
1935	67	10	3	8	—	—	—	—					93	5	5	1	—	—	—	—									—	—	—	—									7	0	0	0	3	0	0	0
1936	50	2	2	0	—	—	—	—					35	0	0	0	2	0	0	0									3	0	0	0									19	0	0	0	9	0	0	0
1937	33	2	2	0	1	0	0	0					12	0	0	0	5	0	0	0					5	0	0	0	1	0	0	0									59	1	0	1				
1938	23	1	1	0	1	0	0	0					4	0	0	0	—	—	—	—					7	0	0	0	5	0	0	0									23	0	0	0				
1939	107	5	2	3	20	1	1	0					48	4	1	3	15	0	0	0					50	3	3	0	27	4	3	1									90	2	1	2				
1940	17	0	0	0	2	0	0	0					43	1	1	0	—	—	—	—					13	0	0	0	12	0	0	0	—	—	—	—	23	1	0	1	9	0	0	0				
1941	1	0	0	0	—	—	—	—					—	—	—	—	1	0	0	0									—	—	—	—	—	—	—	—	6	0	0	0	—	—	—	—				
1942	1	0	0	0	—	—	—	—					—	—	—	—	—	—	—	—									—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				
1943	131	7	4	5	—	—	—	—					13	1	1	0	—	—	—	—									—	—	—	—	—	—	—	—	—	—	—	—	3	0	0	0				
1944	—	—	—	—	—	—	—	—					2	0	0	0	—	—	—	—									—	—	—	—	—	—	—	—	1	0	0	0	—	—	—	—				
1945	27	0	0	0	1	0	0	0					23	1	1	0	1	0	0	0	64	1	0	1					7	1	1	1	5	0	0	0	9	0	0	0	104	0	0	0				
1946	—	—	—	—	2	0	0	0					29	1	0	1	—	—	—	—	7	0	0	0					6	0	0	0	—	—	—	—	1	0	0	0	35	0	0	0				
1947	—	—	—	—					—	—	—	—					—	—	—	—									—	—	—	—					—	—	—	—	—	—	—	—				
1948	—	—	—	—					3	0	0	0					—	—	—	—									—	—	—	—					—	—	—	—	—	—	—	—				
1949	—	—	—	—					—	—	—	—																																					
1950	—	—	—	—																																					—	—	—	—				

A dash indicates that no *A. culicifacies* were dissected although the station was worked.

A blank shows that the station was not worked in that particular year.

to be covered by the river oiling organisation, before it could cope successfully with another outbreak. Money was not spared in attempting this and there was no lack of Shell Malariol, the proprietary mineral oil larvicide used, throughout the war period. Four Oaks (Ross Pattern) hand operated knapsack sprayers were used throughout, and as time went on more and more of these were made available. Actual costs of spraying are very difficult to obtain now, but in 1945, when oiling was carried out almost uninterruptedly for nine months, the inclusive cost could not have been far short of Rs. 1,500,000.

In 1940 examination of rivers, other than at Malaria Observation Stations, was first commenced at places called Subsidiary Observation Sites. These examinations along a half-mile stretch of river were carried out fortnightly by Sanitary Inspectors or weekly when conditions were deemed dangerous. By 1945 a network of about 350 such sites covered the Wet and Intermediate Zones. Oiling of all rivers and streams was carried out within a three-mile radius of a Subsidiary Observation Site, whenever *A. culicifacies* was found breeding at any of them. Later whole areas were oiled in times of drought when pooling of rivers was widespread, even though larvae had not actually been reported from some parts of them. Such action was considered justifiable in view of the prolific breeding of the vector in pools.

Spray-killing of adult mosquitos with pyrethrum sprays was also carried out but never on the same scale as river oiling. This was chiefly due to the great difficulty of obtaining adequate supplies of pyrethrum during the war. But whenever supplies were available, as during the 1943 epidemic, spray-killing was actively carried out.

DDT spraying of dwellings as a residual spray against adult mosquitos was begun in the first quarter of 1946, when a single round of spraying was carried out in the Narammala, Pannala, Polgahawela, Kegalle and Rambukkana areas. By the end of 1947 DDT spraying had become well organised, and five Truck Units were being operated from Rambukkana, Polgahawela, Narammala, Mirigama and Negombo. Each of these Truck Units consisted of fifteen labourers and two overseers with a Sanitary Inspector in charge. Range Sanitary Inspectors assisted in the supervision of their respective areas.

When DDT spraying first commenced in 1946 a 5 per cent. solution of technical DDT in kerosene was used at a dosage of 120 mg. per square foot. In 1947 the kerosene solution was replaced by a 40 per cent. emulsion concentrate of DDT in xylene, with an emulsifier (Formula of emulsion—188 lb. technical DDT ; 30 gallons xylene ; 2·4 gallons emulsifier—Triton X-100 or Craft). The concentrate was diluted in the field to make up a 5 per cent. emulsion. From the end of 1948 the emulsion was abandoned, and a 50 per cent. water-wettable DDT suspension powder was used instead, at a reduced dosage of 100 mg. per square foot. The dosage was still further reduced in October 1949 to 50 mg. per square foot.

The interval between successive sprayings has been kept at six weeks, except in the health area of Polgahawela, where spraying has been carried out once in eight weeks from 1947 as an experiment. This experiment, which involved intensive entomological observations in this health area, has been reported in our earlier paper.

Discussion

The study of malaria and its control in this important river basin falls naturally into two periods. The first period may be said to have commenced in 1935 and ended in 1945, and the second period has lasted from 1946 to the present day. Malaria has long been known to exist in the Maha Oya catchment, and the first authentic record of an epidemic dates back to 1877. Since then epidemics have been known to occur every three to six years, more commonly every four or five years. Thus prior to the spring epidemic of 1939 three epidemics preceded it. They occurred at intervals of five, six and five years respectively in 1934, 1928 and 1923. After 1939, epidemics occurred in 1943 and 1945, and climatic conditions during the north-east monsoon period of 1947-48 were such that in normal circumstances a spring epidemic would have been quite likely in 1948. If this epidemic had materialised, the intervals between epidemics after 1939 would have been four, two and three years respectively. Thus in the decade 1939-48 climatic conditions appear to have deteriorated more frequently than in the period 1923-39. The important subject of climate in relation to malaria has yet to be dealt with satisfactorily and offers a wide field for research. K. J. Rustomjee has made many observations, mainly in departmental reports, publication of which would have enhanced our knowledge of this aspect of the malaria problem, which is of such great importance in the Intermediate Zone.

Prior to 1946, epidemics in this basin occurred at intervals whenever climatic conditions were suitable. Such conditions arose whenever a monsoon failed. Failure of a monsoon resulted in pooling of the rivers in the catchment, with a consequent increase in the incidence of *A. culicifacies*. The incidence of malaria then rose suddenly about three weeks after the first appreciable rains had broken the prolonged drought. This sequence of events has been described earlier for the epidemics of 1939-40, 1943 and 1945-46, and need not be recapitulated again. The spring and autumnal seasonal rises of malaria have also followed the same pattern, the rises following the intermonsoonal rains which end each dry spell.

The annual morbidity rate, inclusive of first and subsequent visits of patients, at all hospitals and dispensaries in the Maha Oya Basin in 1939 was as high as 1,032·9; in 1940 it was 623·5. In 1943 the rate was 454·7, while in the epidemic years of 1945-46 it was 870·2 and 821·8 respectively. The lowest rate in a non-epidemic year was 233·4 in 1944.

Spleen and parasite surveys carried out in 1938 and 1939 have been described by Sivalingam and Rustomjee (loc. cit.); Sivalingam (1943) has also described a survey carried out in 1940. The truth of Sivalingam and Rustomjee's observation that spleen rates tend to be higher immediately after an epidemic and then diminished progressively until the next, is borne out by a study of the March surveys from 1936 to 1941 (Table 3). The 1936 spleen rates are very high because of the 1934-35 epidemic; they came down from 70·0 in 1936 to 18·1 in 1939 just before the epidemic broke out in April. In 1940, after the spring epidemic of the previous year, the spleen rates went up again to 25·1 and came down to 22·1 in 1941, when the surveys were abandoned because of the war.

No study of species prevalence of malaria parasites has been attempted in this paper. Sivalingam and Rustomjee (loc. cit.), Sivalingam (loc. cit.) and D'Abrera (1945) all have at various times made contributions to this subject after 1935. For earlier studies reference may be made to Carter (1927). It is, however, evident from the figures given in Table 5, that even in non-epidemic years such as 1938, 1939 (survey carried out before the epidemic) and 1944, there is a high proportion of parasite carriers in the population, and that active transmission is only hampered by the low incidence of *A. culicifacies* in non-epidemic years.

A correlation between the entomological observations carried out monthly at Malaria Observation Stations and the weekly dispensary attendances and meteorological data is not possible. Weekly entomological observations at Girulla or Polgahawela, both towns for which weekly morbidity and rainfall figures have been available for some considerable time would have proved invaluable prior to 1946. All that can be said now is that the incidence of both larval and adult *A. culicifacies* rose in epidemic years and fell in non-epidemic years and to that extent is correlated with the rise and fall in the morbidity and the spleen and parasite rates. For instance, in Table 9 it will be seen that the larval rate in sand pools was as high as 31·62 in 1939, an epidemic year, while it was only 0·02 in 1944, a non-epidemic year. From Table 10 it will be seen that there were seven Observation Stations in 1939 and that at all of them *A. culicifacies* larvae were found in that year. In 1944, on the other hand, only at one out of the nine Observation Stations was the vector species recorded.

After 1946 the malaria problem has undergone a vast change. The year 1950 was the fifth year after the 1945 epidemic, and not only has the Maha Oya Basin been free of epidemics, but also each year since 1946 there has been an appreciable decline in the morbidity rate. After the epidemic figure of 821·8 in 1946, the morbidity rate declined to 251·7 in 1947, 134·1 in 1948, 85·9 in 1949 and 85·0 in 1950. The 1950 rate is a little more than a third of the previous lowest non-epidemic figure registered in 1944. Sivalingam and Rustomjee (loc. cit.) were of opinion that the 1939 spleen rates would be the lowest that would be recorded in Ceylon at any time, when the rate for the Maha Oya Basin was 18·1. Yet in 1947 the March rate had declined to 6·7, after the September 1946 rate had been 12·9. Since then each year the spleen rate has declined progressively until in March, 1950 it had reached the record figure of 0·9. Similarly, the parasite rates, which prior to 1941 had always been high, have rapidly declined from 0·4 in 1947 to 0 in 1950.

The entomological data since 1947 is equally striking. From 1947 to 1950 the larval rate for *A. culicifacies* in sand pools has declined from 0·81 in 1947 to 0 in 1950, although no larvicidal control has been carried out in these years; a similar decline is seen in the prevalence of larvae in rock pools. But while the larval rate for *A. culicifacies* has been coming down the larval rate for the total of all other anopheline larvae has been going steadily up since 1946 (Graphs 2 and 3). That is, while the incidence of the domestic species, *A. culicifacies* has been gradually reduced, the effect on the non-domestic species has been quite the reverse.

The Maha Oya Basin since 1947 has become healthier each year, until in 1950 on the basis of the dearth of the vector, the spleen and parasite rates and the very low level to which morbidity has fallen it can be claimed that it is as healthy as such a

non-malarial district as Kalutara. This progressive improvement in the malarial endemicity of the Maha Oya Basin dates from the commencement of the residual spraying of houses with DDT, which began in 1946. By the end of 1947 the spraying had become well organised and has been regularly carried out up to the present day. This spraying has superseded all other forms of control, such as river oiling and the spray-killing of adult mosquitos. Its effect has been remarkable in reducing the incidence of malaria. But perhaps its most remarkable achievement has been that an almost certain spring epidemic, which on climatic grounds should have broken out in 1948, was completely averted. Such an event has never been possible before. From the time measures to combat rural malaria were put into operation after the epidemic of 1934-35, the most that could be hoped for was the reduction in the severity of epidemics. Thus although intensive river oiling failed to avert epidemics in 1943 and 1945, the first round of DDT spraying in 1946 so reduced the adult incidence of *A. culicifacies*, that a threatened spring epidemic in 1946 was brought to a summary conclusion. Since then, although there was a slight spring rise of malaria in 1948 (of considerably smaller magnitude than such rises prior to 1946), in 1949 and 1950 the small peaks seen in Graph 1 are the only evidence of any fever rise, and these are of such a small magnitude that they may well have been due to other causes.

Summary

Epidemiology:

1. There are two fever seasons in the Maha Oya Basin, beginning in April and November each year.

2. Epidemics have occurred generally every four or five years, but shorter periods such as two or three years or a longer period such as six years, have also been known to occur.

3. Epidemics, like the spring and autumnal fever seasons on a smaller scale, occur after appreciable rains have broken a spell of drought.

4. The spring epidemics of 1939 and 1945, described in this paper, commenced after a long spell of drought. But the spring epidemic of 1943 cannot so readily be explained on meteorological grounds.

5. The epidemic of 1945-46 was unusual because of the sequence, spring-autumn-spring. Also, the second wave of the epidemic was higher than the first, the reverse of the normal.

6. Since residual spraying of houses with DDT was begun in 1946 no epidemics have occurred in the Maha Oya Basin. Seasonal rises of malaria have been scarcely evident, particularly after 1948.

7. The morbidity rate per 1,000 population has come down from a non-epidemic figure of 336·3 in 1941 and 233·4 in 1944 to one of 85·0 in 1950.

8. In 1948 a spring epidemic, which on meteorological grounds should have broken out, was averted because of the successful control of the vector by residual spraying of houses with DDT.

9. In the period 1936-41 the lowest spleen rate of 18·2 was recorded in 1939. Since 1947 the mean spleen rate has been progressively lower each year, until in 1950 it was 0·9.

10. Parasite rates in the period 1938-41 were uniformly high, ranging from 3·3 to 6·1. Since 1947 the mean parasite rate has diminished rapidly and in 1949 and 1950 was 0.

Vital Statistics:

11. Birth-rates from 1939 to 1946 ranged from 27·3 to 34·9. From 1947 to 1950 the rate has ranged from 34·5 to 35·3.

12. Prior to 1947 the crude death-rate has been high in epidemic years, the highest being 17·7 in 1945 and the lowest 11·1 in the non-epidemic year of 1941. Since 1947 the rate has declined from 10·3 in 1947 to 9·6 in 1950.

13. Infant-mortality rates have also been highest in epidemic years, the highest being 170 in 1939 and the lowest 96 in the non-epidemic year of 1942. Since 1947 the rate has decreased each year and was 67 in 1950.

The Vector:

14. *Anopheles culicifacies* breeds prolifically in sand and rock pools in rivers and streams in times of drought. Its incidence, at all times, along the margins (banks) and in village breeding places is insignificant.

15. Prior to 1947 the incidence of the vector, whether larval or adult, was highest in epidemic years.

16. The catching rate for the adult does not reflect the true incidence of the mosquito in dwellings owing to its habit of secreting itself in the thatch of village houses.

17. *A. culicifacies* is caught in cattle-baited traps in negligible numbers.

18. Since the residual spraying of houses with DDT was begun in 1946 the catching rate for adult *A. culicifacies* has been negligible, while larval rates in sand and rock pools have been very low. In 1950 no larvae of the vector were caught at any Observation Station.

19. Although the larval rates for *A. culicifacies* in sand and rock pools have been very low from 1947 onwards, the larval rates for the total of all other anopheline species (non-domestic mosquitos) have increased each year.

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APPENDIX I A

Spleen rates among Children in Schools classified according to revenue divisions (March Surveys, 1936-1950).

Schools by revenue divisions	1936			1937			1938			1939			1940			1941			1947			1948			1949			1950		
	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.
TUMPANE—C.P.																														
Minigomuwa	—	—	—	78	35	44·9	71	30	42·3	85	14	16·5	84	15	17·9	83	19	22·9	56	9	16·1	60	2	3·3	96	4	4·2	79	1	1·3
Dedunupitiya	30	23	76·7	53	35	66·0	64	26	40·6	70	18	25·7	69	27	39·1	63	20	31·7	60	16	26·7	64	15	23·4	165	4	2·4	158	1	0·6
Hataraliyadde	174	147	84·5	177	113	63·8	177	67	37·9	180	43	23·9	149	50	33·6	112	45	40·2	60	15	25·0	—	—	—	162	0	0	157	0	0
Eramudaliyadde	84	84	100·0	105	57	54·3	128	63	49·2	82	18	22·0	97	17	17·5	78	19	24·4	44	8	18·2	60	1	1·7	49	0	0	54	0	0
Weliwita	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	2	3·3	—	—	—	156	2	1·3
Total	288	254	88·2	413	240	58·1	440	186	42·3	417	93	22·3	399	109	27·3	336	103	30·7	220	48	21·9	244	20	8·2	472	8	1·7	604	4	0·7
YATI NUWARA—C.P.																														
Balana	—	—	—	44	2	4·5	40	3	7·5	46	2	4·3	44	0	0	56	0	0	87	0	0	85	0	0	35	0	0	54	0	0
Pottupitiya	111	12	10·8	98	3	3·1	78	3	3·8	95	0	0	30	1	3·3	83	0	0	117	0	0	194	0	0	111	0	0	111	0	0
Udawela	—	—	—	53	0	0	83	1	1·2	101	1	1·0	117	0	0	99	1	1·0	125	0	0	172	0	0	77	0	0	76	0	0
Total	111	12	10·8	195	5	2·6	201	7	3·5	242	3	1·2	191	1	0·5	238	1	0·4	329	0	0	451	0	0	223	0	0	241	0	0
PARANAKURU KORALE—Sab.P.																														
Aranayake	127	87	68·5	205	50	24·4	201	42	20·9	214	20	9·3	179	25	14·0	164	7	4·3	226	1	0·4	188	3	1·6	212	0	0	118	1	0·8
Hakurugamana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	144	1	0·7	—	—	—	235	1	0·4
Randiligama	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	61	2	3·3	66	1	1·5	90	2	2·2
Hathgampola	156	25	16·0	113	19	16·8	131	4	3·1	142	3	2·1	139	0	0	129	0	0	113	3	2·7	133	1	0·8	104	0	0	150	0	0
Debatgama	117	24	20·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	92	1	1·1	98	0	0	114	1	0·9
Dippitiya	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41	1	2·4	97	0	0	63	2	3·2
Balawathgama	—	—	—	119	66	55·5	126	36	28·6	148	20	13·5	167	43	25·7	129	13	10·1	131	7	5·3	140	3	2·1	181	2	1·1	207	6	2·9
Hemmatagama	181	165	91·2	199	99	49·7	167	41	24·6	168	12	7·1	194	34	17·5	145	12	8·3	156	4	2·6	186	1	0·5	229	1	0·4	225	1	0·4
Wadiyatenne	88	83	94·3	103	43	41·7	101	37	36·6	85	15	17·6	93	17	18·3	76	11	14·5	126	3	2·4	84	1	1·2	151	4	2·7	151	1	0·7
Total	669	384	57·4	739	277	37·5	726	160	22·0	757	70	9·2	772	119	15·4	643	43	6·7	752	18	2·4	1069	14	1·3	1138	8	0·7	1353	15	1·1
GALBODA KORALE—Sab.P.																														
Mawanella	214	175	81·8	220	26	11·8	157	43	27·4	108	10	9·3	115	18	15·7	163	21	12·9	—	—	—	248	19	7·7	266	13	4·9	246	4	1·6
Ussapitiya	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	119	9	7·6	137	4	2·9	139	3	2·2
Beminiwatta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	146	7	4·8	158	1	0·6	161	1	0·6
Randiwela	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	112	7	6·3	111	4	3·6	130	3	2·3
Beddewela	200	182	91·0	225	109	48·4	177	69	39·0	160	15	9·4	172	29	16·9	150	24	16·0	—	—	—	251	23	9·2	265	10	3·8	285	5	1·8
Makehelwala	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	71	7	9·9	79	3	3·8	93	1	1·1
Ganetenne	139	117	84·2	116	94	81·0	120	34	28·3	142	21	14·8	114	16	14·0	114	15	13·2	—	—	—	194	11	5·7	234	4	1·7	231	2	0·9
Manikkawa	155	130	83·9	121	98	81·0	100	35	35·0	151	12	7·9	145	24	16·6	130	18	13·8	—	—	—	167	17	10·2	167	4	2·4	137	0	0
Uyanwatta	78	62	79·5	83	66	79·5	72	13	18·1	65	3	4·6	75	5	6·7	68	5	7·4	—	—	—	85	4	4·7	86	0	0	113	0	0
Wakerigala	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	96	5	5·2	99	1	1·0	67	0	0
Ambulugala	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	136	2	1·5	147	0	0	117	1	0·9
Asmadalla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72	1	1·4	75	1	1·3	74	0	0
Total	786	666	84·7	765	393	51·4	626	194	31·0	626	61	9·7	621	92	14·8	625	83	13·3	—	—	—	1697	112	6·6	1824	45	2·4	1793	20	1·1
KINIGODA KORALE—Sab.P.																														
Deliwela	176	176	100·0	142	95	66·9	148	79	53·4	137	39	28·5	132	55	41·7	125	56	44·8	133	23	17·3	161	6	3·7	302	9	3·0	313	8	2·6
Rambukkana	153	137	89·5	181	110	60·8	202	99	49·0	137	47	34·3	131	77	58·0	144	73	50·1	103	18	17·5	104	6	5·8	101	6	5·9	—	—	—
Hiriwadunna	88	75	85·2	92	38	41·3	95	53	55·8	100	45	45·0	98	53	54·1	108	38	35·2	87	21	24·1	101	6	5·9	141	8	5·7	159	5	3·1
Pitiyagama	101	90	89·1	106	59	55·7	118	57	48·3	140	35	25·0	145	79	54·5	111	45	40·5	125	16	12·8	147	6	4·1	116	3	2·6	128	2	1·6
Hewadiwela	59	56	94·9	71	42	59·2	67	28	41·8	65	26	40·0	68	34	50·0	87	29	33·3	68	5	7·4	73	2	2·7	65	4	6·2	68	0	0
Kudagama	71	66	93·0	89	80	89·9	95	46	48·4	73	17	23·3	98	35	35·7	92	30	32·6	47	6	12·8	102	2	2·0	96	7	7·3	113	1	0·9
Mollegoda	159	120	75·5	189	95	50·3	247	94	38·1	245	61	24·9	229	94	41·1	189	79	41·8	223	23	10·3	231	3	1·3	—	—	—	30	0	0
Total	807	720	89·2	870	519	59·7	972	456	46·9	897	270	30·1	901	426	47·3	856	350	40·9	786	112	14·2	919	31	3·4	821	37	4·5	811	16	2·0
BELIGAL KORALE—Sab.P.																														
Beligalla	110	59	53·6	158	31	19·6	110	50	45·5	40	14	35·0	105	75	71·4	102	55	53·9	144	6	4·2	135	7	5·2	102	0	0	168	0	0
Kahambiliyawela	80	43	53·8	92	30	32·6	82	38	46·3	66	38	57·6	83	59	71·1	97	57	58·8	100	8	8·0	108	1	0·9	104	0	0	110	0	0
Tulhiriya	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	78	0	0	67	0	0	107	0	0
Ambepussa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	95	3	3·2	116	1	0·9	108	0	0	97	0	0
Tholangamuwa	151	98	64·9	147	20	13·6	142	15	10·6	114	12	10·5	138	33	23·9	150	31	20·7	156	2	1·3	211	0	0	181	0	0	210	0	0
Etnalwela	28	11	39·3	41	17	41·5	34	2	5·9	85	1	1·2	56	4	7·1	45	1	2·2	56	0	0	75	0	0	80	0	0	69	0	0
Helamada	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	93	4	4·3	105	3	2·9	—	—	—	120	2	1·7
Total	369	211	57·2	438	98	22·4	368	105	28·5	305	65	21·3	382	171	44·8	394	144	36·5	644	23	3·6	828	12	1·4	642	0	0	881	2	0·2

DAMBADENI HATPATTU—N.W.P.																															
Wadakada	265	192	72·5	219	37	16·9	178	102	57·3	159	63	39·6	135	37	27·4	174	29	16·7	170	16	9·4	174	3	1·7	206	2	1·0	125	0	0
Handugala	107	104	97·2	85	42	49·4	118	19	16·1	78	25	32·1	98	7	7·6	84	6	7·1	135	8	5·9	110	0	0	153	0	0	115	0	0
Mahapitiya	118	116	98·3	135	80	59·3	108	51	47·2	112	38	33·9	72	13	18·1	108	10	9·3	135	7	5·2	147	4	2·7	124	0	0	189	1	0·5
Hondella	73	70	95·9	81	46	56·8	71	37	52·1	95	34	35·8	95	10	10·5	119	13	10·9	115	10	8·7	151	5	3·3	180	0	0	186	1	0·5
Ratmalgoda	141	136	96·5	156	121	77·6	86	41	47·7	137	85	62·0	112	32	28·6	112	16	14·3	113	3	2·7	146	3	2·1	135	1	0·7	169	1	0·6
Udapola	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	102	0	0	132	0	0	116	0	0
Denagamuwa	120	116	96·7	128	88	68·8	131	32	47·3	136	32	23·5	114	30	26·3	103	26	25·2	123	4	3·2	143	1	0·7	183	0	0	146	1	0·7
Aragoda	34	33	97·1	60	49	81·7	42	22	52·4	60	7	11·7	62	19	30·6	58	15	25·9	83	3	3·6	81	3	3·7	102	1	1·0	107	0	0
Polgahawela	56	49	87·5	46	28	60·9	63	30	47·6	66	19	28·8	69	18	26·1	68	14	20·6	100	3	3·0	106	5	4·7	235	0	0	157	0	0
Pannaleeya	46	19	41·3	47	8	17·0	48	26	54·2	56	26	46·4	62	21	33·9	55	16	24·6	58	1	1·7	64	1	1·6	195	0	0	58	0	0
Galbodagama	82	80	97·6	101	82	81·2	—	—	—	98	11	11·2	81	30	37·0	91	27	29·7	73	8	11·0	83	1	1·2	75	1	1·3	84	1	1·2
Galgamuwa	72	37	51·4	65	30	46·2	68	26	38·2	81	14	17·3	87	17	19·5	54	10	18·5	52	5	9·6	58	0	0	62	0	0	62	0	0
Boyawalana	143	135	94·4	134	14	10·4	139	73	52·5	142	70	49·3	154	33	21·4	152	30	19·7	182	15	8·2	201	5	2·5	210	0	0	136	1	0·7
Andiyadeniya	72	55	76·4	87	43	49·4	85	36	42·4	79	34	43·0	42	19	45·2	59	10	16·9	54	1	1·9	88	0	0	62	0	0	61	0	0
Kandegedara	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	53	0	0	117	1	0·9	116	0	0
Wettawe	103	76	73·8	90	45	50·0	113	44	39·0	99	8	8·1	77	19	24·7	49	6	12·2	85	2	2·4	105	0	0	77	0	0	56	4	7·1
Poramadala	188	177	94·1	181	62	34·3	185	64	34·6	197	11	5·6	179	46	25·7	169	25	14·8	128	3	2·3	152	1	0·7	162	1	0·6	175	3	1·7
Walakumbura	47	23	48·9	55	35	63·6	50	33	55·0	62	19	30·6	59	27	45·8	56	7	12·5	60	2	3·3	74	0	0	85	0	0	71	1	1·4
Alawwa	144	59	41·0	144	22	15·3	232	48	20·7	156	20	12·8	150	27	18·0	125	11	8·8	141	0	0	173	0	0	195	0	0	205	1	0·5
Humbuluwa	239	146	61·1	219	47	21·5	193	69	35·8	221	9	4·1	229	25	10·9	242	40	16·5	232	3	1·3	242	2	0·8	240	0	0	210	3	1·4
Dambadeniya	233	218	93·6	215	89	41·4	—	—	—	213	34	16·0	105	67	63·8	238	161	67·6	233	28	12·0	310	15	4·8	241	1	0·4	355	5	1·4
Narammala, G.C.S.	135	42	31·1	117	45	38·5	69	29	42·0	133	29	21·8	125	55	44·0	105	59	56·2	78	7	9·0	255	9	3·5	197	2	1·0	335	0	0
Narammala, Govt. Infants	77	38	49·4	98	41	41·8	97	28	28·9	66	15	22·7	81	46	56·8	154	75	48·7	76	6	7·9	145	2	1·4	147	1	0·7	193	11	5·7
Paranagama	120	113	94·2	95	45	47·4	113	20	17·7	122	39	32·0	54	38	70·4	79	55	69·6	81	12	14·8	75	3	4·0	112	0	0	151	0	0
Yakkawita	88	41	46·6	130	55	42·3	128	28	21·9	130	28	21·5	153	63	41·2	168	90	53·6	—	—	—	169	14	8·3	136	5	3·7	113	2	1·8
Mettiyagane	93	87	93·5	55	32	58·2	74	26	35·1	85	19	22·4	77	27	35·1	83	53	63·9	81	14	17·3	106	9	8·5	115	1	0·9	134	0	0
Etampola	112	64	57·1	103	43	41·7	—	—	—	106	26	24·5	79	41	51·9	124	69	55·6	—	—	—	—	—	—	—	—	—	83	0	0
Kiulgalla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	78	13	16·7	84	2	2·4	88	1	1·1	115	11	9·6
Talwatta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	2908	2226	76·5	2846	1219	42·8	2401	914	38·1	2889	715	24·7	2546	767	30·1	2839	873	30·8	2666	174	6·5	3577	88	2·4	3967	18	0·5	4023	47	1·2
WEUDAVILI HATPATTU—N.W.P.																															
Indulgodakanda	91	46	50·5	61	30	49·2	111	13	11·7	102	15	14·7	88	10	11·4	91	4	4·4	110	3	2·7	120	4	3·3	146	2	1·4	142	0	0
Kattupitiya	81	73	90·1	68	63	92·6	62	28	45·2	64	23	35·9	70	26	37·1	60	7	11·7	53	10	18·9	54	9	16·7	71	6	8·5	68	0	0
Watarakka	47	45	95·7	78	48	61·5	77	17	22·1	104	40	38·5	102	18	17·6	93	12	12·9	132	53	40·2	140	21	15·0	176	9	5·1	128	4	3·1
Total	219	164	74·9	207	141	68·1	250	58	23·2	270	78	28·9	260	54	20·8	244	23	9·4	295	66	22·4	314	34	10·8	393	17	4·3	338	4	1·2
KATUGAMPOLA HATPATTU—N.W.P.																															
Elibichchiya	120	98	81·7	151	53	35·1	144	36	25·0	126	10	7·9	141	23	16·3	142	11	7·7	108	8	7·4	141	10	7·1	132	4	3·0	146	4	2·7
Maholuwa	51	44	86·3	47	23	48·9	50	6	12·0	57	5	8·8	60	12	20·0	53	3	5·7	74	6	8·1	48	4	8·3	71	1	1·4	76	1	1·3
Narangamuwa	117	110	94·0	107	58	54·2	95	24	25·3	95	8	8·4	101	22	21·8	114	13	11·4	98	2	2·0	120	8	6·7	148	2	1·4	123	1	0·8
Makandura	82	14	17·1	94	24	25·5	74	10	13·5	83	7	8·4	88	13	14·8	125	6	4·8	54	11	20·4	87	2	2·3	89	1	1·1	79	0	0
Handalankawa	54	18	33·3	53	15	28·3	49	8	16·3	54	5	9·3	43	12	27·9	62	4	6·5	45	8	17·8	44	3	6·8	51	3	5·9	50	0	0
Hendiyagalla	89	11	12·4	114	16	14·0	128	10	7·8	107	5	4·7	115	11	9·6	99	6	6·1	92	6	6·5	97	2	2·1	106	3	2·8	146	0	0
Nelawalana	104	68	65·4	133	42	31·6	91	20	22·0	86	4	4·7	94	18	19·1	—	—	—	107	18	16·8	98	9	9·2	104	2	1·9	93	1	1·1
Pannala	188	156	83·0	167	36	21·6	170	37	21·8	172	11	6·4	221	40	18·1	158	10	6·3	140	9	6·4	330	24	7·3	329	6	1·8	329	4	1·2
Total	805	519	64·5	866	267	30·8	801	151	18·9	780	55	7·1	863	151	17·5	753	53	7·0	718	68	9·7	965	62	6·4	1030	22	2·1	1042	11	1·1
PITIGAL KORALE SOUTH—N.W.P.																															
Tambarawila	113	67	59·2	94	37	39·4	95	27	28·4	109	23	21·1	106	18	17·0	111	16	14·4	126	7	5·6	153	1	0·7	164	3	1·8	171	0	0
Etiyawala	104	64	61·5	111	46	41·4	—	—	—	129	12	9·3	125	17	13·6	140	16	11·4	121	9	7·4	160	3	1·9	152	2	1·3	161	1	0·6
Godella	66	41	62·1	69	20	29·0	77	9	11·7	93	8	8·6	91	10	10·9	109	8	7·3	112	4	3·6	145	3	2·1	127	0	0	117	0	0
Total	283	172	60·8	274	103	37·6	172	36	20·9	331	43	13·0	322	45	14·0	360	40	11·1	359	20	5·6	458	7	1·5	443	5	1·1	449	1	0·2
ALUTKURU KORALE NORTH A.—W.P.																															
Kochchikade	155	44	28·4	150	46	30·7	118	28	23·7	147	12	8·2	145	9	6·2	—	—	—	106	8	7·5	133	6	4·5	169	0	0	—	—	—
HAPITIGAM KORALE—W.P.																															
Banduragoda, Primary	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	151	0	0
Banduragoda, Govt. Junior	199	96	48·2	192	16	8·3	188	5	2·7	137	3	2·2	174	10	5·7	203	7	3·4	201	0	0	179	0	0	67	3	4·5	33	0	0
Kinadeniya	235	122	51·9	247	13	5·3	228	7	3·1	268	97	36·2	149	64	43·0	131	64	48·9	242	14	5·8	251	4	1·6	299	23	7·7	151	0	0
Weweldeniya	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	59	1	1·7
Muddaragama	—	—	—	—	—	—	185	3	1·6	174	2	1·1	172	12	7·0	140	14	10·0	150	0	0	132	0	0	170	7	4·1	173	0	0
Kotadeniyawa	130	63	48·5	95	20	21·1	105	27	25·7	92	1	1·1	63	9	14·3	78	17	21·8	133	7	5·3	113	4	3·5	149	10	6·7	137	0	0
Nawana	133	34	25·6	197	37	22·1	155	35	22·6	169	9	5·3	137	31	22·6	151	43	28·5	174	1	0·6	217	2	0·9	221	7	3·2	284	0	0
Ullalpola	—	—	—	59	3	5·1	79	8	10·1	86	4	4·7	79	14	17·7	77	7	9·1	103	1	1·0	83	0	0	103	5	4·9	66	0	0
Gaspe	38	11	28·9	—	—	—	47	1	2·1	54	0	0	54	7	13·0	63	3	4·8	90	2	2·2	94	2	2·1	99	5	5·1	108	0	0
Balagalla	—	—	—	—	—	—	33	7	21·2	29	0	0	36	9	25·0	51	4	7·8	62	3	4·8	57	0	0	76	8	10·5	69	0	0
Mirigama, G.M.S.	61	39	63·9	135	25	18·5	55	4	7·3	62	1	1·6	49	0	0	155	11	7·1	331	3	0·9	—	—	—	—	—	—	191	0	0
Mirigama, Primary	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	222	0	0
Halugama, Bapt. Mixed	—	—	—	26	2	7·7	19	1	5·3	—	—	—	16	2	12·5	19	3	15·8	52	0	0	—	—	—	—	—	—	—	—	—
Halugama, Bud. Mixed	—	—	—	60	12	20·0	69	6	8·7	22	0	0	85	10	11·8	91	8	8·8	89	1	1·1	—	—	—	—	—	—	111	0	0
Total	796	365	45·9	981	128	13·0	1163	104	8·9	1093	117	10·7	1014	168	16·6	1159	181	15·6	1627	32	1·9	1126	12	1·1	1184	68	5·7	1755	1	0·1

A dash indicates that no survey was carried out for the year.

Parasite rates among Children in Schools classified according to revenue divisions (March Surveys, 1938-1950).

Schools by revenue divisions	1938			1939			1940			1941			1948			1949			1950		
	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.
TUMPANE—C.P.																					
Minigomuwa	9	1	11·1	9	0	0	8	0	0	8	0	0	24	0	0	10	0	0	10	0	0
Dedunupitiya	10	1	10·0	10	0	0	7	1	14·3	6	0	0	22	0	0	7	0	0	15	0	0
Hataraliyadde	23	0	0	21	0	0	14	0	0	12	0	0	—	—	—	8	0	0	15	0	0
Eramudaliyadde	15	2	13·3	11	1	9·1	10	1	10·0	8	1	12·5	24	0	0	11	0	0	9	0	0
Weliwita	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	0	0
Total..	57	4	7·0	51	1	2·0	39	2	5·1	34	1	2·9	70	0	0	36	0	0	64	0	0
YATI NUWARA—C.P.																					
Balana	7	0	0	6	0	0	5	0	0	6	0	0	11	0	0	10	0	0	10	0	0
Pottupitiya	11	0	0	11	2	18·2	—	—	—	9	0	0	20	0	0	11	0	0	13	0	0
Udawela	13	0	0	11	0	0	12	0	0	11	0	0	17	0	0	14	0	0	10	0	0
Total..	31	0	0	28	2	7·1	17	0	0	26	0	0	48	0	0	35	0	0	33	0	0
PARANAKURU KORALE—Sab. P.																					
Aranayake	28	0	0	27	3	11·1	18	1	5·6	17	0	0	17	0	0	20	0	0	12	0	0
Hakurugamana	—	—	—	—	—	—	—	—	—	—	—	—	18	0	0	—	—	—	23	0	0
Randiliganna	—	—	—	—	—	—	—	—	—	—	—	—	10	0	0	10	0	0	10	0	0
Hathgampola	20	0	0	14	0	0	17	0	0	13	1	7·7	15	0	0	11	0	0	15	0	0
Debatgana	—	—	—	—	—	—	—	—	—	—	—	—	12	0	0	12	0	0	11	0	0
Dippitiya	—	—	—	—	—	—	—	—	—	—	—	—	11	0	0	11	0	0	8	0	0
Balawathgama	19	0	0	16	2	12·5	18	3	16·7	12	0	0	17	0	0	18	0	0	20	0	0
Hemmatagama	26	0	0	21	1	4·8	20	3	15·0	15	0	0	18	0	0	22	0	0	23	0	0
Wadiyatenne	13	0	0	14	2	14·3	10	0	0	8	0	0	12	0	0	16	0	0	15	0	0
Total..	106	0	0	92	8	8·7	83	7	18·4	65	1	1·5	130	0	0	120	0	0	137	0	0
GALBODA KORALE—Sab. P.																					
Mawanella	21	1	4·8	17	0	0	16	0	0	21	0	0	20	0	0	30	0	0	25	0	0
Ussapitiya	—	—	—	—	—	—	—	—	—	—	—	—	14	0	0	15	0	0	15	0	0
Beminiwatta	—	—	—	—	—	—	—	—	—	—	—	—	15	0	0	20	0	0	20	0	0
Randiwela	—	—	—	—	—	—	—	—	—	—	—	—	12	0	0	14	0	0	15	0	0
Beddewela	20	0	0	24	1	4·2	21	2	9·5	14	0	0	20	0	0	30	0	0	30	0	0
Makehelwala	—	—	—	—	—	—	—	—	—	—	—	—	10	0	0	10	0	0	10	0	0
Ganetenne	13	0	0	16	0	0	13	0	0	12	0	0	30	0	0	—	—	—	25	0	0
Manikkawa	11	0	0	16	1	6·3	15	0	0	15	0	0	—	—	—	20	0	0	15	0	0
Uyanwatta	10	0	0	9	0	0	8	0	0	9	0	0	10	0	0	10	0	0	12	0	0
Wakerigala	—	—	—	—	—	—	—	—	—	—	—	—	10	0	0	10	0	0	10	0	0
Ambulugala	—	—	—	—	—	—	—	—	—	—	—	—	14	0	0	—	—	—	12	0	0
Asmadalla	—	—	—	—	—	—	—	—	—	—	—	—	10	0	0	25	0	0	10	0	0
Total..	75	1	1·3	82	2	2·4	73	2	2·7	71	0	0	165	0	0	184	0	0	199	0	0
KINIGODA KORALE—Sab. P.																					
Deliwela	15	1	6·7	15	1	6·7	14	2	14·3	13	0	0	15	0	0	30	0	0	31	0	0
Rambukkana	20	2	10·0	17	2	11·8	14	1	7·1	16	0	0	11	0	0	10	0	0	—	—	—
Hiriwadunna	10	1	10·0	10	1	10·0	10	1	10·0	10	0	0	—	—	—	14	0	0	16	0	0
Pitiyagama	12	0	0	15	0	0	15	0	0	12	1	8·3	14	0	0	12	0	0	13	0	0
Hewadiwela	7	0	0	6	0	0	7	0	0	9	0	0	8	0	0	10	0	0	10	0	0
Kudagama	10	0	0	8	0	0	10	0	0	10	1	10·0	10	0	0	10	0	0	12	0	0
Mollegoda	23	0	0	25	0	0	23	2	8·7	20	0	0	24	0	0	—	—	—	30	0	0
Total..	97	4	4·1	96	4	4·2	93	6	6·5	90	2	2·2	82	0	0	86	0	0	112	0	0
BELIGAL KORALE—Sab. P.																					
Beligalla	13	1	7·7	5	0	0	10	3	30·0	36	0	0	13	0	0	11	0	0	35	0	0
Kahabiliyawela	9	0	0	6	1	16·7	9	0	0	22	0	0	10	0	0	11	0	0	11	0	0
Tulhiriya	—	—	—	—	—	—	12	1	8·3	—	—	—	10	0	0	7	0	0	11	0	0
Ambopussa	—	—	—	—	—	—	—	—	—	—	—	—	11	0	0	11	0	0	10	0	0
Tholangamuwa	20	0	0	15	0	0	14	0	0	15	1	6·7	21	0	0	18	0	0	21	0	0
Etnawela	5	0	0	10	0	0	7	1	14·3	6	1	16·7	10	0	0	8	0	0	10	0	0
Helamada	—	—	—	—	—	—	—	—	—	—	—	—	11	0	0	—	—	—	11	0	0
Total..	47	1	2·1	36	1	2·8	52	5	9·6	79	2	2·5	86	0	0	66	0	0	109	0	0
DAMBADENI HATPATTU—N.W.P.																					
Wadakada	25	0	0	16	1	6·3	15	0	0	20	0	0	18	0	0	15	0	0	16	0	0
Handugala	7	0	0	9	2	22·2	28	3	10·7	10	1	10·0	22	0	0	23	0	0	16	0	0
Mahapitiya	14	0	0	11	1	9·1	8	2	25·0	12	0	0	15	0	0	14	0	0	17	0	0
Hondella	7	0	0	10	0	0	12	0	0	14	0	0	12	0	0	17	0	0	16	0	0
Ratmalgoda	9	0	0	14	0	0	15	0	0	14	0	0	12	0	0	17	0	0	15	0	0
Udapola	—	—	—	—	—	—	—	—	—	—	—	—	9	0	0	—	—	—	10	0	0
Denagamuwa	14	0	0	14	3	21·4	15	0	0	12	0	0	14	0	0	18	0	0	15	0	0
Aragoda	5	0	0	6	0	0	8	1	12·5	8	0	0	15	0	0	10	0	0	13	0	0
Polgahawela	8	1	12·5	6	0	0	8	0	0	8	2	25·0	18	0	0	23	0	0	17	0	0
Pannalcoya	7	0	0	7	1	14·3	7	1	14·3	8	1	12·5	12	1	8·3	13	0	0	10	0	0
Galbodaguna	—	—	—	10	1	10·0	11	0	0	10	0	0	10	0	0	10	0	0	10	0	0
Galgamuwa	7	0	0	15	0	0	10	1	10·0	6	1	16·7	6	0	0	18	0	0	8	0	0
Boyawalana	18	1	5·6	16	1	6·3	16	1	6·3	20	1	5·0	20	0	0	21	0	0	16	0	0
Andiyadeniya	8	1	12·5	8	0	0	5	0	0	8	0	0	10	0	0	11	0	0	6	0	0
Kandegedara	—	—	—	—	—	—	—	—	—	—	—	—	11	0	0	10	0	0	12	0	0
Wettawe	13	0	0	10	0	0	10	0	0	5	0	0	10	0	0	10	0	0	12	0	0
Poramadala	23	0	0	20	0	0	—	—	—	20	1	5·0	15	0	0	20	0	0	18	0	0
Walakumbura	6	1	16·7	6	0	0	7	2	28·6	6	1	16·7	—	—	—	10	0	0	10	0	0
Alawwa	—	—	—	15	0	0	20	0	0	15	2	13·3	18	0	0	18	0	0	22	0	0
Humbuluwa	25	0	0	22	0	0	23	3	13·0	26	2	7·7	24	0	0	20	0	0	22	0	0
Dambadeniya	31	2	6·5	22	2	9·1	11	0	0	23	0	0	32	1	3·1	24	0	0	30	0	0
Narammala, G.C.S. ..	14	3	21·4	14	1	7·1	13	2	15·4	15	1	6·7	23	0	0	10	0	0	33	0	0
Narammala, Govt. Infants ..	19	0	0	10	0	0	8	0	0	11	2	18·2	15	0	0	24	0	0	18	0	0
Paranagama	17	3	17·6	13	5	38·5	5	1	20·0	8	0	0	7	0	0	10	0	0	15	0	0
Yakkawita	15	3	20·0	13	1	7·7	18	2	11·1	17	0	0	11	1	9·1	12	0	0	11	0	0
Mettiyagane	11	2	18·2	9	1	11·1	7	1	14·3	8	1	12·5	8	0	0	11	0	0	13	0	0
Etampola	—	—	—	11	3	27·3	8	0	0	12	4	33·3	—	—	—	—	—	—	8	0	0
Kiulgalla	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	0	0	12	0	0
Talwatta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total..	303	17	5·6	307	23	7·5	288	20	6·9	316	20	6·3	367	3	0·8	415	0	0	421	0	0
WEUDAVILI HATPATTU—N.W.P.																					
Indulgodakanda	15	1	6·7	11	0	0	9	0	0	10	0	0	15	0	0	15	0	0	10	0	0
Kattupitiya	11	2	18·2	7	0	0	7	0	0	6	0	0	10	0	0	10	0	0	10	0	0
Watarakka	14	0	0	11	1	9·1	10	0	0	10	0	0	15	0	0	18	0	0	14	0	0
Total..	40	3	7·5	29	1	3·4	26	0	0	26	0	0	40	0	0	43	0	0	34	0	0
KATUGAMPOLA HAT-PATTU—N.W.P.																					
Elibichchiya	14	0	0	13	1	7·7	14	0	0	14	1	7·1	14	0	0	18	0	0	21	0	0
Maholuwa	5	0	0	4	0	0	6	0	0	6	1	16·7	9	0	0	10	0	0	10	0	0
Narangamuwa	8	0	0	9	0	0	10	0	0	12	1	8·3	21	0	0	14	0	0	15	0	0
Makandura	7	0	0	8	1	12·5	9	0	0	12	0	0	11	0	0	10	0	0	10	0	0
Handalankawa	5	0	0	5	0	0	4	0	0	6	0	0	5	0	0	6	0	0	10	0	0
Hendiyagalla	12	1	8·3	11	2	18·2	12	0	0	10	0	0	9	0	0	14	0	0	16	0	0
Nelawalana	9	0	0	9	2	22·2	9	0	0	—	—	—	12	0	0	—	—	—	10	0	0
Pannala	17	0	0	17	1	5·9	23	1	4·3	15	4	26·7	39	0	0	38	0	0	53	0	0
Total..	77	1	1·3	76	7	9·2	87	1	1·1	75	7	9·3	120	0	0	110	0	0	145	0	0
PILIGAL KORALE SOUTH—N.W.P.																					
Tambarawila	9	0	0	13	0	0	11	0	0	11	1	9·1	15	0	0	19	0	0	17	0	0
Etiyawala	—	—	—	13	0	0	12	4	33·3	15	1	6·7	15	0	0	15	0	0	16	0	0
Godella	9	0	0	9	0	0	9	1	11·1	11	0	0	14	0	0	12	0	0	12	0	0
Total..	18	0	0	35	0	0	32	5	15·6	37	2	5·4	44	0	0	46	0	0	45	0	0
ALUTKURU KORALE NORTH A—W.P.																					
Kochchikade	11	0	0	14	0	0	15	0	0	—	—	—	13	0	0	10	0	0	8	0	0
HAPITIGAM KORALE—W.P.																					
Banduragoda, Primary ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	0	0
Banduragoda, Govt. Junior ..	16	0	0	14	0	0	20	0	0	20	0	0	20	0	0	10	0	0	3	0	0
Kinadeniya	23	0	0	35	0	0	24	6	25·0	23	0	0	26	0	0	31	0	0	16	0	0
Weweldeniya	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	0	0
Muddaragama	15	1	6·7	19	0	0	16	0	0	15	0	0	14	0	0	18	0	0	17	0	0
Kotadeniyawa	10	0	0	—	—	—	20	0	0	10	0	0	12	0	0	15	0	0	14	0	0
Nawana	16	0	0	20	0	0	14	1	7·1	16	0	0	20	0	0	24	0	0	29	0	0
Ullalpola	7	0	0	—	—	—	8	0	0	8	1	12·5	10	0	0	—	—	—	10	0	0
Gaspe	6	0	0	11	0	0	6	0	0	6	0	0	—	—	—	11	0	0	11	0	0
Balagalla	4	0	0	9	0	0	5	0	0	6	0	0	10	0	0	10	0	0	10	0	0
Mirigama, G.M.S. ..	6	0	0	13	2	15·4	8	0	0	16	0	0	—	—	—	—	—	—	21	0	0
Mirigama, Primary ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	23	0	0
Halugama, Bapt. Mixed ..	—	—	—	—	—	—	4	1	25·0	2	0	0	—	—	—	—	—	—	—	—	—
Halugama, Bud. Mixed ..	8	0	0	6	0	0	10	2	20·0	9	0	0	—	—	—	—	—	—	11	0	0
Total..	111	1	0·9	127	2	1·6	135	10	7·4	131	1	0·8	112	0	0	119	0	0	190	0	0

APPENDIX 1B

Spleen rates among Children in Schools classified according to revenue divisions (September Surveys, 1946-1949).

Schools by revenue divisions	1946			1947			1948			1949		
	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.	No. exd.	No. pos.	S.R.
TUMPANE—C.P.												
Minigomuwa	44	9	20·5	60	5	8·3	90	5	5·6	105	1	1·0
Dedunupitiya	63	11	17·5	76	4	5·3	90	4	4·4	157	2	1·3
Hataraliyadde	63	8	12·7	52	9	17·3	71	5	7·0	157	1	0·6
Eramudaliyadde	—	—	—	56	4	7·1	69	2	2·9	64	0	0
Weliwita	—	—	—	49	3	6·1	—	—	—	188	1	0·5
Total..	170	28	16·5	293	25	8·5	320	16	5·0	671	5	0·7
YATI NUWARA—C.P.												
Balana	38	0	0	112	0	0	98	0	0	23	0	0
Pottupitiya	120	0	0	186	0	0	230	0	0	116	0	0
Udawela	51	0	0	128	0	0	178	0	0	93	0	0
Total..	209	0	0	426	0	0	506	0	0	232	0	0
PARANAKURU KORALE—Sab.P.												
Aranayake	180	0	0	172	3	1·7	207	1	0·5	220	1	0·5
Hakurugamana	—	—	—	142	0	0	194	3	1·5	214	1	0·5
Randiligama	—	—	—	55	1	1·8	62	0	0	74	1	1·4
Hathgampola	88	0	0	110	1	0·9	127	0	0	105	0	0
Debatgama	—	—	—	81	1	1·2	106	2	1·9	102	0	0
Dippitiya	—	—	—	95	3	3·2	15	0	0	106	1	0·9
Balawathgama	155	5	3·2	169	7	4·1	189	2	1·1	240	1	0·4
Hemmatagama	109	8	7·3	211	4	1·9	190	4	2·1	178	0	0
Wadiyatenne	98	14	14·3	118	2	1·7	87	0	0	197	2	1·0
Total..	630	27	4·3	1153	22	1·9	1177	12	1·0	1436	7	0·5
GALBODA KORALE—Sab.P.												
Mawanella	183	24	13·1	195	20	10·3	209	18	8·6	259	6	2·3
Ussapitiya	—	—	—	118	20	16·9	—	—	—	141	1	0·7
Beminiwatta	—	—	—	145	9	6·2	171	4	2·3	161	0	0
Randiwela	—	—	—	104	16	15·4	120	12	10·0	126	2	1·6
Baddewela	229	16	7·0	233	28	12·0	248	26	10·5	293	4	1·4
Makehelwala	—	—	—	63	7	11·1	70	4	5·7	81	2	2·5
Ganetenne	149	12	8·1	191	29	15·3	228	8	3·5	231	1	0·4
Manikkawa	107	10	9·3	157	24	15·3	162	8	4·9	161	2	1·2
Uyanwatta	53	8	15·1	68	6	8·8	89	4	4·5	114	0	0
Wakerigala	—	—	—	103	3	2·9	91	1	1·1	98	2	2·0
Ambulugala	—	—	—	129	10	7·8	133	1	0·8	138	0	0
Asmadalla	—	—	—	88	3	3·4	86	1	1·2	70	0	0
Total..	721	70	9·7	1594	175	11·0	1607	87	5·4	1873	20	1·1
KINIGODA KORALE—Sab.P.												
Deliwela	86	9	10·5	136	5	3·7	298	3	1·0	270	5	1·9
Rambukkana	81	11	13·6	97	6	6·2	108	2	1·9	97	2	2·1
Hiriwadunna	85	31	36·5	94	15	16·0	133	8	6·0	139	6	4·3
Pitiyagama	98	26	26·5	123	2	1·6	104	0	0	129	1	0·8
Hewadiwela	52	6	11·5	52	0	0	52	0	0	63	1	1·6
Kudagama	82	20	24·4	84	4	4·8	99	0	0	88	3	3·4
Mollegoda	193	33	17·1	225	6	2·7	29	3	10·3	235	5	2·1
Total..	677	136	20·1	811	38	4·7	823	16	1·9	1021	23	2·3
BELIGAL KORALE—Sab.P.												
Beligalla	102	22	21·6	169	4	2·4	160	0	0	151	0	0
Kahambiliyawela	89	32	36·0	104	0	0	127	0	0	127	0	0
Tulhiriya	—	—	—	81	0	0	102	0	0	98	0	0
Ambepussa	—	—	—	94	2	2·1	57	0	0	103	0	0
Tholangamuwa	165	12	7·3	206	0	0	228	0	0	195	0	0
Etnawela	66	8	12·1	62	0	0	61	0	0	70	0	0
Helamada	89	16	18·0	32	3	9·4	100	2	2·0	112	3	2·7
Total..	511	90	17·6	748	9	1·2	835	2	0·2	856	3	0·4
DAMBADENI HATPATTU—N.W.P.												
Wadakada	164	23	14·0	162	4	2·5	186	3	1·6	201	0	0
Handugala	129	19	14·7	69	2	2·9	135	0	0	152	0	0
Mahapitiya	107	33	30·8	69	0	0	147	2	1·4	187	0	0
Hondella	119	15	12·6	69	5	7·2	180	0	0	195	0	0
Ratmalgoda	126	42	33·3	88	4	4·5	159	1	0·6	174	0	0
Udapola	—	—	—	94	1	1·1	112	1	0·9	122	0	0
Denagamuwa	126	6	4·8	141	0	0	170	1	0·6	—	—	—
Aragoda	94	5	5·3	96	2	2·1	84	2	2·4	—	—	—
Polgahawela	157	23	14·6	122	2	1·6	136	1	0·7	147	1	0·7
Pannaleeya	32	1	3·1	57	0	0	73	0	0	96	0	0
Galbodagama	52	10	19·2	39	0	0	101	2	2·0	104	0	0
Galgamuwa	53	13	24·5	52	2	3·8	62	0	0	—	—	—
Boyawalana	157	23	14·0	102	4	3·9	198	3	1·5	197	0	0
Andiyadeniya	46	4	8·7	58	2	3·4	57	0	0	71	0	0
Kandegedara	—	—	—	124	0	0	95	0	0	170	0	0
Wettawe	76	14	18·4	91	1	1·1	107	0	0	114	0	0
Poramadala	122	19	15·6	175	2	1·1	170	1	0·6	187	0	0
Walakumbura	42	5	11·9	58	0	0	86	0	0	84	0	0
Alawwa	151	26	17·2	167	2	1·2	217	0	0	212	0	0
Humbuluwa	236	13	5·5	48	0	0	267	1	0·4	255	0	0
Dambadeniya	242	62	25·6	179	12	6·7	—	—	—	—	—	—
Narammala, G.C.S.	88	15	17·0	121	7	5·8	251	1	0·4	177	0	0
Narammala, Govt. Infants ..	—	—	—	30	2	6·7	134	4	3·0	199	1	0·5
Paranagama	76	16	21·1	43	2	4·7	—	—	—	134	0	0
Yakkawita	126	31	24·7	105	5	4·8	127	6	4·7	109	3	2·8
Mettiyagane	76	30	39·5	105	5	4·8	87	5	5·7	—	—	—
Etampola	—	—	—	—	—	—	80	4	5·0	—	—	—
Kiulgalla	—	—	—	—	—	—	61	5	8·2	95	1	1·1
Talwatta	—	—	—	—	—	—	—	—	—	—	—	—
Total..	2597	448	17·3	2464	66	2·7	3482	43	1·2	3382	6	0·2
WEUDAVILI HATPATTU—N.W.P.												
Indulgodakanda	80	4	5·0	109	7	6·4	139	3	2·2	134	1	0·7
Kattupitiya	51	12	23·5	68	7	10·3	85	9	10·5	81	6	7·4
Watarakka	115	60	52·2	149	36	24·2	160	9	5·6	162	5	3·1
Total..	246	76	30·9	326	50	15·3	384	21	5·5	377	12	3·2
KATUGAMPOLA HATPATTU—N.W.P.												
Elibichchiya	116	7	6·0	132	14	10·6	152	9	5·9	162	7	4·3
Moholuwa	70	4	5·7	87	9	10·3	84	1	1·2	78	3	3·8
Narangamuwa	93	2	2·2	100	10	10·0	120	4	3·3	101	5	5·0
Makandura	51	10	19·6	84	4	4·8	92	0	0	89	2	2·2
Handalankawa	38	4	10·5	30	3	10·0	55	5	9·1	50	1	2·0
Hendiyagalla	92	3	3·3	114	4	3·5	108	2	1·9	134	1	0·7
Nelawalana	102	13	12·7	103	11	10·7	103	2	1·9	100	2	2·0
Pannala	137	12	8·8	306	25	8·2	329	10	3·0	383	5	1·3
Total..	699	55	7·9	956	80	8·4	1043	33	3·2	1097	26	2·4
PITIGAL KORALE SOUTH—N.W.P.												
Tambarawila	142	29	20·4	136	4	2·9	153	2	1·3	161	2	1·2
Etiyawala	111	14	12·6	141	5	3·5	150	0	0	153	0	0
Godella	109	9	8·3	107	2	1·9	111	0	0	138	0	0
Total..	362	52	14·4	384	11	2·9	414	2	0·5	452	2	0·4
ALUTKURU KORALE NORTH—W.P.												
Kochchikade	93	2	2·2	122	8	6·6	153	0	0	122	0	0
HAPITIGAM KORALE—W.P.												
Banduragoda, Primary ..	—	—	—	—	—	—	81	2	2·5	94	0	0
Banduragoda, Govt. Junior ..	193	3	1·6	124	0	0	41	1	2·4	40	0	0
Kinadeniya	—	—	—	299	12	4·0	254	26	10·2	352	0	0
Weweldeniya	—	—	—	—	—	—	44	3	6·8	—	—	—
Muddaragama	90	1	1·1	164	0	0	143	5	3·5	192	0	0
Kotadeniyawa	141	11	7·8	105	0	0	130	1	0·8	147	1	0·7
Nawana	177	6	3·4	172	0	0	236	6	2·5	246	0	0
Ullalpola	99	1	1·0	94	0	0	102	2	2·0	95	0	0
Gaspe	81	2	2·5	73	0	0	115	1	0·9	115	0	0
Balagall	—	—	—	61	0	0	76	2	2·6	87	0	0
Mirigama, G.M.S.	92	4	4·3	450	3	0·7	210	10	4·8	—	—	—
Mirigama, Primary	—	—	—	—	—	—	337	42	12·5	—	—	—
Halugama, Bapt. Mixed ..	33	1	3·0	55	0	0	58	0	0	—	—	—
Halugama, Bud. Mixed ..	81	8	9·9	80	0	0	87	2	2·3	—	—	—
Total..	987	37	3·7	1677	15	0·9	1914	103	5·4	1368	1	0·1

Parasite rates among Children in Schools classified according to revenue divisions (September Surveys, 1946-1950).

Schools by revenue divisions	1946			1947			1948			1949		
	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.	No. exd.	No. pos.	P.R.
TUMPANE—C.P.												
Minigomuwa	—	—	—	22	0	0	27	0	0	11	0	0
Dedunupitiya	21	0	0	16	0	0	29	0	0	15	0	0
Hataraliyadde	—	—	—	32	0	0	40	2	5·0	18	0	0
Eramudaliyadde	—	—	—	23	0	0	22	0	0	11	0	0
Weliwita	—	—	—	22	0	0	—	—	—	17	0	0
Total..	21	0	0	115	0	0	118	2	1·7	72	0	0
YATI NUWARA—C.P.												
Balana	5	0	0	11	0	0	11	0	0	10	0	0
Pottupitiya	13	0	0	18	0	0	23	0	0	12	0	0
Udawela	6	0	0	13	0	0	26	0	0	10	0	0
Total..	24	0	0	42	0	0	60	0	0	32	0	0
PARANAKURU KORALE—Sab. P.												
Aranayake	20	0	0	12	1	8·3	23	0	0	22	0	0
Hakurugamana	—	—	—	16	0	0	20	0	0	25	0	0
Randiligama	—	—	—	7	0	0	10	1	10·0	8	0	0
Hathgampola	—	—	—	17	0	0	11	0	0	10	0	0
Dobatgama	—	—	—	10	0	0	10	0	0	10	0	0
Dippitiya	—	—	—	10	1	10·0	10	0	0	10	0	0
Balawathgama	16	0	0	21	0	0	20	0	0	24	0	0
Hemmatagama	9	0	0	18	0	0	22	0	0	18	0	0
Wadiyatenne	12	1	8·3	14	0	0	15	0	0	15	0	0
Total..	57	1	1·8	125	2	1·6	141	1	0·7	142	0	0
GALBODA KORALE—Sab. P.												
Mawanella	21	0	0	20	0	0	20	0	0	30	0	0
Ussapitiya	—	—	—	10	0	0	20	0	0	20	0	0
Beminiwatta	—	—	—	20	0	0	20	0	0	20	0	0
Randiwela	—	—	—	13	1	7·7	15	0	0	15	0	0
Baddewela	20	0	0	25	0	0	30	1	3·3	30	0	0
Makehelwala	—	—	—	10	0	0	10	0	0	10	0	0
Ganetenne	14	0	0	20	0	0	25	0	0	24	0	0
Manikkawa	20	4	20·0	20	1	5·0	20	0	0	20	0	0
Uyanwatta	9	0	0	10	0	0	10	0	0	10	0	0
Wakerigala	—	—	—	14	0	0	—	—	—	10	0	0
Ambulugala	—	—	—	15	0	0	15	0	0	20	0	0
Asmadalla	—	—	—	10	0	0	10	0	0	10	0	0
Total..	84	4	4·8	187	1	0·5	195	1	0·5	219	0	0
KINIGODA KORALE—Sab. P.												
Deliwela	9	1	11·1	14	0	0	34	0	0	27	0	0
Rambukkana	9	1	11·1	10	0	0	12	0	0	—	—	—
Hiriwadunne	8	0	0	9	0	0	14	0	0	13	0	0
Pitiyagama	10	0	0	13	0	0	15	0	0	13	0	0
Hewadiwela	5	0	0	5	0	0	5	0	0	10	0	0
Kudagama	7	2	28·6	11	0	0	8	0	0	10	0	0
Mollegoda	—	—	—	23	0	0	28	0	0	23	0	0
Total..	48	4	8·3	85	0	0	116	0	0	96	0	0
BELIGAL KORALE—Sab. P.												
Beligalla	11	3	27·3	16	0	0	15	0	0	15	0	0
Kahambiliyawela	10	0	0	10	0	0	—	—	—	10	0	0
Tulhiriya	—	—	—	8	0	0	12	0	0	13	0	0
Ambepussa	12	0	0	10	0	0	8	0	0	10	0	0
Tholangamuwa	17	0	0	18	0	0	23	0	0	21	0	0
Etnawela	7	0	0	10	0	0	10	0	0	10	0	0
Holamada	9	0	0	10	0	0	13	0	0	12	0	0
Total..	66	3	4·5	82	0	0	81	0	0	91	0	0
DAMBADENI HATPATTU—N.W.P.												
Wadakada	17	4	23·5	17	0	0	17	0	0	20	0	0
Handugala	13	2	15·4	10	0	0	16	0	0	16	0	0
Mahapitiya	10	1	10·0	11	0	0	10	0	0	—	—	—
Hondella	13	1	7·7	10	0	0	16	0	0	20	0	0
Ratmalgoda	13	2	15·4	9	0	0	16	0	0	18	0	0
Udapola	—	—	—	10	0	0	14	0	0	13	0	0
Denagamuwa	12	1	8·3	15	0	0	18	0	0	—	—	—
Aragoda	9	0	0	10	0	0	9	0	0	—	—	—
Polgahawela	11	2	18·2	12	0	0	15	0	0	25	0	0
Pannaleeya	4	0	0	10	0	0	10	0	0	10	0	0
Galbodagama	6	0	0	10	0	0	10	0	0	10	0	0
Galgamuwa	6	0	0	10	0	0	10	0	0	—	—	—
Boyawalana	15	1	6·7	10	0	0	19	0	0	14	0	0
Andiyadeniya	5	0	0	10	0	0	10	0	0	8	0	0
Kandegedara	—	—	—	13	0	0	12	0	0	10	0	0
Wettawe	8	1	12·5	10	0	0	12	0	0	13	0	0
Poramadala	13	0	0	18	0	0	12	0	0	16	0	0
Walakumbura	4	0	0	9	0	0	12	0	0	11	0	0
Alawwa	15	3	20·0	14	0	0	15	0	0	22	0	0
Humbuluwa	24	0	0	13	0	0	17	0	0	24	0	0
Dambadeniya	78	13	16·7	17	1	5·9	—	—	—	13	0	0
Narammala, G.C.S.	30	1	3·3	11	0	0	24	1	4·2	—	—	—
Narammala, Govt. Infants ..	28	4	14·3	5	0	0	11	0	0	37	0	0
Paranagama	25	3	12·0	6	0	0	—	—	—	10	0	0
Yakkawita	48	6	12·5	12	0	0	10	0	0	11	0	0
Mettiyagane ..	27	5	18·5	—	—	—	8	0	0	—	—	—
Etampola	—	—	—	—	—	—	7	0	0	—	—	—
Kiulgalla	—	—	—	—	—	—	5	0	0	11	0	0
Talwatta	—	—	—	—	—	—	—	—	—	16	0	0
Total..	434	50	11·5	282	1	0·4	335	1	0·3	348	0	0
WEUDAVILI HATPATTU—N.W.P.												
Indulgodakanda	8	0	0	10	0	0	14	0	0	14	0	0
Kattupitiya	6	1	16·7	10	1	10·0	10	0	0	10	0	0
Watarakka	14	6	42·9	17	0	0	17	0	0	18	0	0
Total..	28	7	25·0	37	1	2·7	41	0	0	42	0	0
KATUGAMPOLA HATPATTU—N.W.P.												
Elibichchiya	—	—	—	16	0	0	18	1	5·6	22	0	0
Maholuwa	8	1	12·5	—	—	—	10	0	0	10	0	0
Narangamuwa	—	—	—	6	0	0	12	0	0	15	0	0
Makandura	6	0	0	9	0	0	10	0	0	10	0	0
Handalankawa	4	0	0	6	0	0	10	1	10·0	10	0	0
Hendiyagalla	10	2	20·0	8	0	0	12	0	0	15	0	0
Nelawalana	11	1	9·1	10	0	0	12	0	0	12	0	0
Pannala	14	2	14·3	32	0	0	30	0	0	48	0	0
Total..	53	6	11·3	87	0	0	114	2	1·8	142	0	0
PITIGAL KORALE SOUTH—N.W.P.												
Tambarawila	—	—	—	13	0	0	14	0	0	16	0	0
Etiyawala	11	1	9·1	—	—	—	15	0	0	15	0	0
Godella	11	1	9·1	11	0	0	11	0	0	14	0	0
Total..	22	2	9·1	24	0	0	40	0	0	45	0	0
ALUTKURU KORALE NORTH A—W.P.												
Kochchikade	22	2	9·1	14	0	0	5	0	0	—	—	—
HAPITIGAM KORALE—W.P.												
Banduragoda, Primary ..	—	—	—	—	—	—	—	—	—	19	0	0
Banduragoda, Govt. Junior ..	15	0	0	16	0	0	22	0	0	—	—	—
Kinadeniya	—	—	—	—	—	—	24	0	0	35	0	0
Woweldeniya	—	—	—	—	—	—	—	—	—	—	—	—
Muddaragama	9	0	0	8	0	0	15	0	0	19	0	0
Kotadeniyawa	15	0	0	12	0	0	—	—	—	14	0	0
Nawana	18	0	0	18	0	0	28	0	0	22	0	0
Ullalpola	10	0	0	12	0	0	10	0	0	9	0	0
Gaspe	8	0	0	11	0	0	11	0	0	11	0	0
Balagalla	4	0	0	4	0	0	30	0	0	8	0	0
Mirigama, G.M.S.	11	0	0	10	0	0	71	0	0	—	—	—
Mirigama, Primary	—	—	—	—	—	—	—	—	—	—	—	—
Halugama, Bapt. Mixed ..	—	—	—	5	0	0	8	0	0	—	—	—
Halugama, Bud. Mixed ..	12	0	0	10	0	0	—	—	—	—	—	—
Total..	102	0	0	106	0	0	219	0	0	137	0	0

APPENDIX III

Vital Statistics by Health Areas, 1939-1950.

Year	Population	Number of births	Birth rate	Number of deaths	Crude death rate	Number of infant deaths	Infant mortality rate	Malaria attendance	Malaria morbidity rate
				(*a*). *KEGALLE*					
1939	64060	2300	35·9	1053	16·4	319	139	43484	679
1940	65324	2239	34·3	827	12·6	251	112	25455	390
1941	67905	2540	37·4	691	10·2	228	90	14915	220
1942	69615	2522	36·2	811	11·6	231	92	14602	210
1943	72590	2809	38·7	990	13·6	281	100	12339	170
1944	69583	2705	38·8	1208	17·3	300	111	13192	190
1945	70217	2806	40·4	1433	20·4	316	113	46292	659
1946	68259	2697	39·5	1281	18·7	345	128	50143	735
1947	70602	3119	44·2	946	13·4	283	91	13606	193
1948	72501	2748	37·9	881	11·9	235	86	7924	109
1949	73259	2892	39·5	797	10·9	223	77	6180	84
1950	74565	2928	39·3	903	12·1	179	66	5427	73
				(*b*). *MAWANELLA*					
1939	40065	1409	35·2	695	17·3	220	156	19167	478
1940	41509	1286	31·0	521	12·2	149	116	10551	254
1941	41564	1448	34·8	422	10·1	135	93	6963	168
1942	37533	1504	40·1	537	16·4	157	104	5080	135
1943	38500	1587	41·2	680	17·6	164	103	6224	162
1944	38500	1666	43·2	719	18·7	143	86	5194	135
1945	38500	1681	43·6	1102	28·6	191	114	22581	587
1946	46885	1344	28·6	705	15·0	160	119	17144	366
1947	46885	1858	39·6	511	10·9	151	81	1511	32
1948	49223	1674	34·0	510	10·3	129	77	3424	70
1949	50461	1797	35·6	447	8·8	133	74	733	15
1950	51287	1708	33·4	498	9·7	95	56	890	17
				(*c*). *RAMBUKKANA*					
1939	27024	949	35·1	829	30·7	240	253	32729	1211
1940	27887	736	28·4	409	14·6	98	133	18999	681
1941	29650	1090	36·7	348	11·7	101	93	7508	253
1942	31378	1196	38·1	364	11·6	120	100	7109	227
1943	32210	1259	39·1	498	15·4	129	103	15958	495
1944	32971	1220	37·0	509	15·4	130	107	9905	300
1945	33682	1198	35·6	951	28·2	230	192	39618	1176
1946	36698	838	22·8	648	17·6	145	173	48114	1311
1947	35227	1472	41·8	317	9·0	103	70	11926	339
1948	36241	1220	33·7	319	8·8	90	74	6117	169
1949	37630	1302	34·6	286	7·6	91	70	4629	123
1950	40401	1324	32·7	330	8·2	72	54	2271	56
				(*d*). *WARAKAPOLA*					
1939	—	—	—	—	—	—	—	—	—
1940	42180	1246	29·5	477	11·3	127	102	48082	1140
1941	42785	1475	34·5	455	10·6	132	90	15428	361
1942	43390	1597	36·8	549	12·6	150	94	13996	323
1943	43954	1737	39·5	711	16·1	265	153	20530	467
1944	45686	1588	34·7	735	16·1	163	103	6719	147
1945	45267	1588	35·1	1002	22·1	195	128	14735	326
1946	46903	1398	29·8	748	15·9	197	141	15899	339
1947	48257	1858	38·5	484	10·3	138	74	8924	185
1948	54678	1631	29·8	402	7·3	96	59	2962	54
1949	54878	1691	30·8	455	8·3	132	78	2857	52
1950	54212	1505	27·7	395	7·2	121	80	2448	45
				(*e*). *POLGAHAWELA*					
1939	46238	1408	30·4	1028	22·3	451	321	93969	2032
1940	47360	1224	25·8	872	18·4	283	231	62861	1327
1941	47360	1437	30·3	609	12·9	225	157	22452	474
1942	48043	1688	35·0	647	13·3	224	133	25697	535
1943	49047	2014	40·7	1113	22·5	396	197	51691	1054
1944	49047	1667	33·7	871	17·6	248	149	23151	472
1945	49047	1724	34·8	1339	27·1	363	211	124913	2547
1946	49647	1218	24·5	911	18·3	153	126	95623	1926
1947	51903	1953	37·6	632	12·1	247	127	23332	450
1948	56896	1800	31·6	517	9·1	199	111	14948	263
1949	56896	1971	34·6	518	9·1	182	92	11790	207
1950	56896	1878	33·0	504	8·8	169	90	9318	164

A dash indicates that no figures were available.

Year	Population	Number of births	Birth rate	Number of deaths	Crude death rate	Number of infant deaths	Infant mortality rate	Malaria attendance	Malaria morbidity rate
				(*f*). *NARAMMALA*					
1939	33735	1423	42·2	1098	32·6	357	251	87515	2594
1940	34028	1296	38·1	1064	32·2	309	238	66567	1368
1941	34322	1760	51·3	697	20·3	209	119	60544	1764
1942	34616	1816	52·5	663	19·2	174	96	39892	1152
1943	34910	1998	57·2	1049	30·1	326	163	54319	1556
1944	35859	1677	46·7	751	20·9	226	135	23394	652
1945	36579	1878	51·3	1166	32·0	324	113	74303	2031
1946	37200	1275	34·2	1339	35·9	386	303	135989	3656
1947	37821	2112	55·9	576	15·2	195	92	44736	1183
1948	40543	2449	60·4	529	13·1	204	83	10943	270
1949	36991	1389	37·5	299	8·1	124	89	7233	196
1950	37330	1403	37·6	339	9·1	116	83	7800	209
				(*g*). *PANNALA*					
1939	46467	1340	28·8	903	19·4	263	196	31784	684
1940	46467	1184	25·5	1087	23·4	211	178	17193	370
1941	—	—	—	—	—	—	—	—	—
1942	—	—	—	—	—	—	—	—	—
1943	45539	1639	35·9	724	15·9	206	126	27161	596
1944	45995	1359	29·5	559	12·1	150	110	12664	275
1945	46451	1525	32·8	796	17·1	199	131	47747	1028
1946	47363	995	20·9	997	21·0	271	272	37500	792
1947	47363	1449	30·6	444	9·4	110	76	17209	363
1948	51516	1456	28·3	316	6·1	59	41	20238	393
1949	51516	1820	35·3	308	5·9	115	63	6771	131
1950	51516	1654	32·1	340	6·6	83	50	6722	130
				(*h*). *DANKOTUWA*					
1939	44268	1033	23·3	527	11·9	132	128	53744	1214
1940	44902	1191	26·5	491	11·0	115	97	38898	866
1941	45536	1092	24·0	458	10·0	86	79	29208	641
1942	46130	1302	28·2	491	10·6	118	91	25289	548
1943	46804	1422	30·4	624	13·4	139	98	34750	742
1944	46804	1333	28·5	590	12·6	117	88	16306	348
1945	47547	1494	31·4	764	16·1	151	101	35468	746
1946	48803	1356	27·8	699	14·3	166	103	32605	668
1947	49354	1934	39·2	413	8·4	148	77	12830	260
1948	50059	2001	39·9	495	9·9	134	66	8765	175
1949	56029	2019	36·0	483	8·6	109	54	4865	87
1950	58141	1960	33·7	463	7·9	109	56	934	17
				(*i*). *NEGOMBO*					
1939	180497	3862	21·4	2364	13·1	540	140	89270	495
1940	181490	4911	27·1	2863	15·8	617	126	117187	646
1941	180000	4665	25·9	2343	13·0	531	114	55781	310
1942	182000	5503	30·2	2585	14·2	585	106	43666	240
1943	185144	6069	32·8	3065	16·5	653	108	128594	695
1944	177919	4355	24·4	2644	14·8	462	106	43609	245
1945	188392	5186	27·5	2760	14·6	680	131	82439	438
1946	184323	5171	28·1	2865	15·5	670	129	34214	186
1947	184323	6304	34·2	2043	11·1	564	90	21512	117
1948	184458	6924	37·5	2387	12·9	625	90	14218	77
1949	186140	5837	31·4	1890	10·1	498	85	10485	56
1950	191426	5450	28·5	2055	10·7	479	88	6774	35
				(*j*). *YAKKALA*					
1939	263230	7024	26·7	3478	13·2	1004	143	98449	374
1940	307731	7324	23·8	3680	11·9	858	117	55091	179
1941	307201	7465	24·3	2818	9·1	704	94	23107	75
1942	306996	9031	29·4	3862	12·6	764	85	55690	181
1943	306996	9180	29·9	4463	14·5	953	104	119692	390
1944	307025	8028	26·1	4721	15·3	903	112	41844	136
1945	319538	6683	20·9	4205	13·1	829	124	118564	371
1946	323578	8070	24·9	4083	12·6	910	113	49808	154
1947	323578	9591	29·6	2919	9·0	780	81	50975	158
1948	296996	9466	31·8	2819	9·5	702	74	33862	114
1949	289755	10673	36·8	3209	11·1	812	76	10205	35
1950	289755	11491	39·7	2868	9·9	657	57	9029	31

A dash indicates tha no figures were available.