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AN APPROACH TO THE MALARIAL PROBLEM  
IN BRITISH GUIANA

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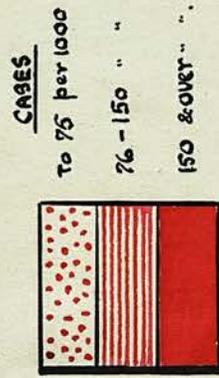
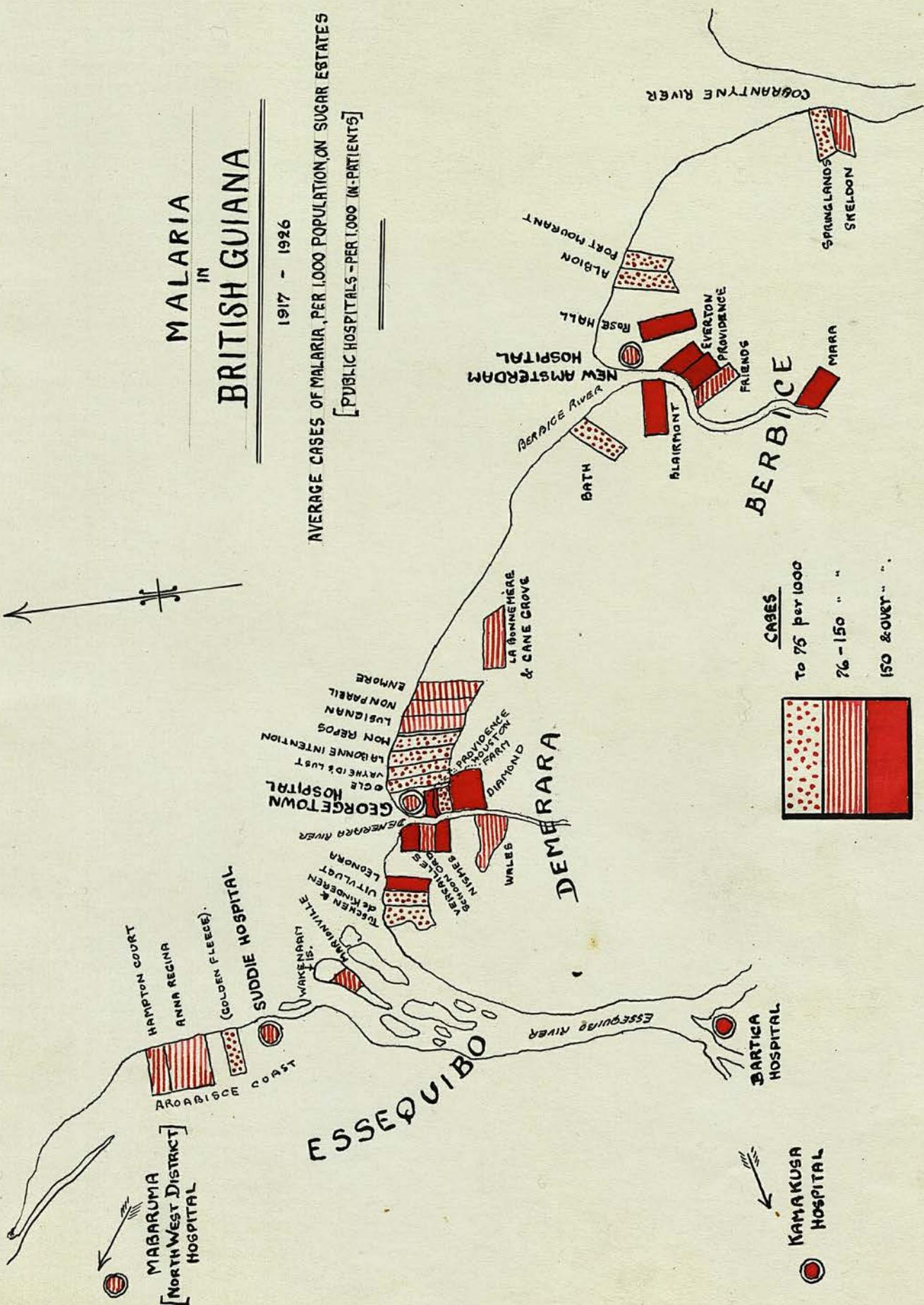
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# MALARIA IN BRITISH GUIANA

1917 - 1926

AVERAGE CASES OF MALARIA, PER 1,000 POPULATION, ON SUGAR ESTATES  
[PUBLIC HOSPITALS - PER 1,000 (IN-PATIENTS)]



MABARUMA  
[North West District]  
HOSPITAL

ARUA-BISSIE COAST  
SUDDIE HOSPITAL  
(GOLDEN FLEECE)

WAKENABLY  
MARIANVILLE  
TUSKEN & KINDEREN  
VIT VLUGT  
LEONORA  
VERSCHEDE  
NIEFES  
WALLES  
DIAMOND

GEORGETOWN  
DIE HOSPITAL  
L'AYNE DE LUST  
L'ARONNE INTENTION  
LUSIGNAN  
NON PAREIL  
EMORE

LA BONNE MÈRE  
& CANE GROVE

BATH  
BLAIRMONT  
NEW AMSTERDAM  
ROSE HALL  
ALBION  
FORT MOURANT  
BERBICE RIVER  
EVERTON  
PROVIDENCE  
FAIGENDS  
MARR

KAMAKUSA  
HOSPITAL

BARTICA  
HOSPITAL

SPRINGLANDS  
SKELDON  
CORRANTYNE RIVER

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A. INTRODUCTORY

The study of Malaria in British Guiana presents difficulties which at first appear insurmountable. Indeed, it is doubtful whether any other Colony is faced with problems so varied and so formidable as those involved in such a research. In text-books on the subject, almost without exception, we find reference to the abundant mosquitoes, the ideal conditions for breeding, the high incidence of the disease and the intensity of infections. In malarial distribution maps the brush sweeps without interruption across the Colony from border to border. Malaria is endemic: uniquely so, and to a degree hardly equalled by any other country.

2. It has been truly said that Demerara is overburdened with Nature; she is certainly overburdened with the essential requirements of anopheline breeding. Though lying between parallels  $1^{\circ}$  to  $8^{\circ}$  North, her climate rather approaches sub-tropical than tropical, the heat being tempered by fresh sea breezes which blow almost steadily throughout the year during the day and for the first three months of the year at night also, resulting in an average temperature of about  $81^{\circ}$  F. With a night temperature of  $73^{\circ}$  or  $74^{\circ}$  and a diurnal variation of  $12^{\circ}$  there is little for the human being to grumble at, and less for the mosquito. The rainfall varies between eighty-five inches on the coastlands and a little under sixty inches on the savannahs, there being two wet and two dry seasons in the former regions.

3. It is along these coastal areas with a seaboard of nearly two hundred and seventy miles, a depth of ten to forty miles and a flat alluvial soil, that we find a major part of the population of the Colony, the chief agricultural pursuits, and the Malaria. Four and one half feet below spring tide level, swampy, canalised and half covered with "bush", with a warm and moist atmosphere, sheltered areas and unhygienic conditions, it is no surprise that malaria is rife.

4. The country is broadly divisible into three main belts, the most northern of which has been discussed above. Southward of this is a wide, slightly elevated area of undulating country rising considerably to the south-west and traversed by the branches of the Essequibo River and the higher reaches of the Demerara and Berbice Rivers. Often, the low-lying banks are marshy and anopheline infested. To the west especially, this is important as being within the auriferous and diamondiferous areas of the Colony.

5. Still further south come the three great mountain ranges, the extensive grassy savannahs and plateaux, and to the eastward vast stretches of almost uninhabited and unexplored forest. Of the three belts this last is by far the healthiest, even in the cattle areas the mosquitoes being comparatively few. But the lack of a hinterland railway or of adequate roads - there is merely a cattle trail - and the difficulties of river navigation owing to the many rapids have collectively combined to prevent the opening up of the land for commerce and population.

To the north-west of British Guiana lies Venezuela, Brazil to the west and south, and on the east the Dutch and French Guianas: all countries in which, perhaps of all diseases, malaria stands pre-eminent.

6. As the rivers of the Colony play no small part in the malarial problem both as regards the mosquito which haunts their marshy banks and the inhabitants segregated along them, a word here will be appropriate.

Starting from the west, the Barima River by means of which the gold bearing districts in the vicinity are opened up to the coast, has its outflow on the eastern side of the mouth of the great Orinoco River of Venezuela. It might conceivably act as a connecting source of malaria from one country to the other, or at least as the line of spread of new species of mosquito. Further up there is a Government Hospital at Mabaruma and a settlement of some five hundred aborigines, besides numerous smaller occupied areas up the branches of the river. The gold diggings used, however, to be on a much more extensive scale than at present prevails.

This district has great potentialities and is likely in the near future to be opened up to the agriculturist: largely because of the general healthiness of this part of the Colony.

7. The low alluvial lands adjoining the Pomeroon River are extremely fertile and most of the farms thereon are well drained and flourishing.

8. The Essequibo River is the largest in the Colony and stretches to a length of over six hundred miles. Its tributaries drain more than half the country. Though fourteen miles across at its mouth, a distance certainly effective in preventing the transference of mosquitoes from one bank to the other, there are numerous small and three or four large islands which may unfortunately provide, as it were, stepping stones or stages of such transmission. Indeed, the island of Wakenaam, with a population of over six thousand, and at one time possessed of seventeen sugar estates, though now there is but one, contains villages which rank with the most malarious in the Colony.

In the Mazaruni district are the majority of the diamondiferous areas providing for a seasonal population varying between three to nine thousand. It is here that a particularly severe form of Sub-tertiary malaria is manifested. In fact, those who are accustomed to malaria in other tropical countries confess to an entirely different picture from the clinical standpoint. This is probably referable to the gastric symptoms which are exceptionally marked. The Mazaruni River joins the Essequibo at Bartica, which may be considered as the base for the diamond fields where the workers or "pork-knockers" as they are called replenish their stores. Malaria, as will be shown later, ranks high in the list of diseases at the Government Hospital there, and in importance comes only, perhaps, second to the venereal diseases.

9. The Demerara River, though much smaller than the Essequibo and but a third its length, is of considerable importance not only commercially as having at its mouth the capital of the Colony, but from the malarial viewpoint as many of the larger sugar estates are situated along its banks, as well as numerous villages. The Georgetown Hospital, the largest by far in the Colony with its five hundred and twenty beds, receives patients from all over the country, and as such must not be overlooked as a possible factor in the dissemination of malaria.

10. The Berbice River, about sixty miles east of the Demerara, and navigable for over a hundred miles, and with the town of New Amsterdam at its mouth, constitutes also a potent source of the anopheline population. The muddy banks and low-lying, marshy, bush-bestrewn land extending for many miles on either

side and for fifty miles southward provide ideal breeding places. This is reflected in the records for malaria in the Colonial Hospital at New Amsterdam.

11. Finally, the Courantyne River, the second largest and separating British from Dutch Guiana, has along its banks Indian Reserves and Mission stations and many small farms owned by the East Indians; but the incidence and mortality of malaria amongst other diseases must for long remain conjectural, as with other of the remoter parts of the Colony, with the exception of occasional figures determined from short trips at long intervals of time.

12. The POPULATION of British Guiana is remarkably cosmopolitan in character, a fact which adds not a little to the complexity of statistical deductions in relation to disease.

Of the three hundred and eight thousand inhabitants nearly half are Indians - or East Indians as they are called - immigrants from India and the descendants of those who chose to remain; while the blacks, whose ancestors were originally imported from West Africa during the fifth, sixth and seventh decades of the last century, constitute over two-thirds of the remainder. Many families of the ten thousand Portuguese originated from Madeira. The majority of these, with the Chinese who form about one per cent of the population, hold much of the retail trade of the Colony. Of the "Mixed" races, comprising some thirty to forty thousand, the majority are Black, with White or Portuguese admixture. Northern Europeans number a little short of five thousand.

The real natives of Demerara, the Aboriginal or "Buck" Indians, computed at nine thousand, largely inhabit the hinterland either in the Indian reservations of which there are ten covering an area of approximately thirteen hundred square miles, or are scattered in isolated village settlements along the banks of the upper reaches of the rivers.

13. The population at the census of 1921 was 297,691, showing that there has been a slight increase. It will be found that this is largely occasioned by the question of immigration and emigration than by natural increase. During the decade 1911 to 1921, for example, the births only exceeded the deaths by thirty-four.

Georgetown, the capital, on the east bank of the Demerara River, has a population of sixty thousand, being a fifth of the total inhabitants of the Colony. In the second largest town, New Amsterdam, some eight thousand persons reside.

At the last census a third of the population were returned as of no occupation, while of those occupied nearly fifty per cent were classed as agricultural, a little over a quarter as industrial and the remainder divided between domestic (17%), commercial (4%), and professional (1%).

14. Of the INDUSTRIES of the Colony, those which particularly concern us in the study of malaria are the production of cane sugar and of rice along the coastal lands and the lower reaches of the rivers, with the minor occupations of the cocoanut, coffee, cacao and fruit industries: and the mining pursuits chiefly of diamonds and gold, with the lesser industries of timber and forest production and cattle breeding, in the hinterland. The hard times through which the sugar industry, with its accompanying manufacture of rum, has recently been passing, has materially affected the general wealth of the Colony, with its inevitable effect on the resistance of the community to disease.



## B. STATISTICAL (a) Public Hospitals-

1. Of the statistical records available in the Colony the Hospital Returns are probably the most accurate as portraying the incidence of malaria, although these still leave much to be desired in the differential classification of malarial types. The Returns from the sugar estates are much less reliable but will be used extensively in comparative analysis.

There are six Government Hospitals of which those of Georgetown, New Amsterdam and Suddie are the chief, representing the counties of Demerara, Berbice and Essequibo respectively. The hospital at Bartica at the junction of the river Mazaruni with the Essequibo is much smaller comprising some twenty-five to thirty beds, and deals largely with cases from the diamond fields and to a smaller extent with the town of Bartica itself. The hospital at Mabaruma, in the North West District, is concerned with cases from up the rivers and from the group of aborigines settled in the neighbourhood.

Finally, in the Mazaruni district in the centre of the diamond industry there is a small hospital dealing mostly with out-patients and with but one of two available beds. Until recently a Medical Officer was resident there for varying periods throughout the year, but for the sake of economy a Dispenser has now been substituted.

2. Previous work on the study of malaria appears to have been restricted rather to special aspects of the subject, and these mostly with reference to entomological, larvicidal and general preventive measures. Records as to incidence and etiological problems are scanty to a degree, while epidemiological and endemiological research is practically absent. Much of this present study therefore must be purely mathematical, supplemented by necessarily limited practical work and statements rather of experience and observation than of actual proof. Some confusion results from a different division of the districts by the medical and Registrar's reports respectively, but in the present paper the former have been followed, with the exception of the figures for the populations of the various sugar estates which were drawn from the reports of the Immigration Agent General. Here, the figures were half-yearly only, and under the headings for male and female separately, but not collectively, necessitating considerable additional labour to

determine the annual totals of both sexes.

3. An earlier study of malarial incidence, by a former Surgeon General, gave only the total number of cases on each estate, but took no account of the varying number of coolies employed at each. To rectify this, and to gain an insight into the real comparative frequency of malaria the figures have all been corrected to a hypothetical estate of a thousand inhabitants, resulting, for the thirty estates over the ten year period chosen a no mean mathematical task. But the results appear to have justified it. The possibility of the effect of density of population on the incidence of infection has, of course, not been forgotten. In the case of hospitals, also, the malarial rate per thousand in-patients has been calculated, though here again, the actual number of cases of this disease is very important in determining re-infection and the mosquito rate.

4. It is not supposed for a moment that the figures in the Reports accurately represent the true incidence of malaria in the Colony. Not only are relapses disregarded in the returns, as also re-admissions, but it is common knowledge that a large number of cases that arrive in hospital with "Fever", are treated with quinine and ultimately discharged with the chart diagnosis of "Malaria" because the fever happens to have dropped during the administration of that drug, are in reality not cases of malaria at all; similarly others with atypical symptoms are not signed up as malaria when a thorough examination of the patient's blood might have revealed parasites. With, frequently, an over-crowded hospital and a limited staff, this is not only possible, but highly probable. The term "Febricula", formerly in common use, has now been given up in hospital diagnoses, though it is still employed on many of the estates.

5. Granted, therefore, a considerable error on this account - only a fraction of the cases are ever tested microscopically - the figures may yet be of considerable value from the comparative standpoint. And the main purpose of this initial study has been to determine, if possible, whether malaria - or at least "Fever" - is more frequent in certain parts of the Colony than others, and whether there is any evidence pointing to focal areas of spread on which concentrative effort in the direction of prevention might profitably be spent, in a Colony financially burdened.

TABLE I. SHOWING CASES OF MALARIA IN THE SIX HOSPITALS OF T

IN-P In-Patients.

C.M Cases of Malaria.

CR Malaria per 1000 In-Patients.

YEAR	GEORGETOWN			NEW AMSTERDAM			SUDDIE		
	IN-P	C.M	CR	IN-P	C.M	CR	IN-P	C.M	CR
1917	9370	787	84	2128	310	146	1666	264	159
1918	11047	756	69	2522	273	108	2186	194*	90
1919	10343	841	81	2766	279	101	1803	169	93
1920	10254	854	83	2402	236	98	1568	204*	130
1921	10911	1128	103	2724	274	101	1737	199	114
1922	11041	984	89	2471	405	164	1527	164	107
1923	13009	1124	87	2206	198	90	2158	287	133
1924	12509	1198	97	1990	222	112	2351	290	124
1925	13209	1141	87	2419	360	149	2627	105	40
1926	13209	670	51	2350	204	87	1879	190	101
	114,902	9,483	83	23,968	2,761	116	19,502	2,066	109

Note:- Figures marked \* include  
a few cases of FEBRICULA &  
BLACKWATER FEVER.

COLONY, TOTAL & CORRECTED TO 1000 IN-PATIENTS.

<u>BARTICA</u>			<u>N.W.D.</u>			<u>KAMAKUSA</u>			
IN-P	C.M	CR	IN-P	C.M	CR	IN-P	C.M	CR	
122	20	164	370	71	190	.	.	.	1917
113	16	141	422	57	125	.	.	.	1918
173	57	329	560	91	163	.	.	.	1919
139	15	108	443	58	130	.	.	.	1920
159	29	182	404	36	89	.	.	.	1921
227	31	137	339	25	74	.	.	.	1922
406	90	221	419	?	?	.	.	.	1923
317	67	211	398	36	90	.	.	.	1924
246	32	130	397	32	80	127	25	196	1925
354	60	170	522	133	255	167	21	130	1926
2256	417	179	4274	539	132	294	46	163	

Note:- The 1923 figures for the North West District were missing from the Annual Report studied. Hospital Records for Kamakusa first added to the Annual Report in 1925.

6. This Table (I) presents many points of interest, though it is remembered that the value lies not in the totals themselves but the comparisons between the totals in the different hospitals and years concerned, it being assumed for present purposes that the percentage of error in diagnosis and classification is maintained at the same level throughout the hospitals.

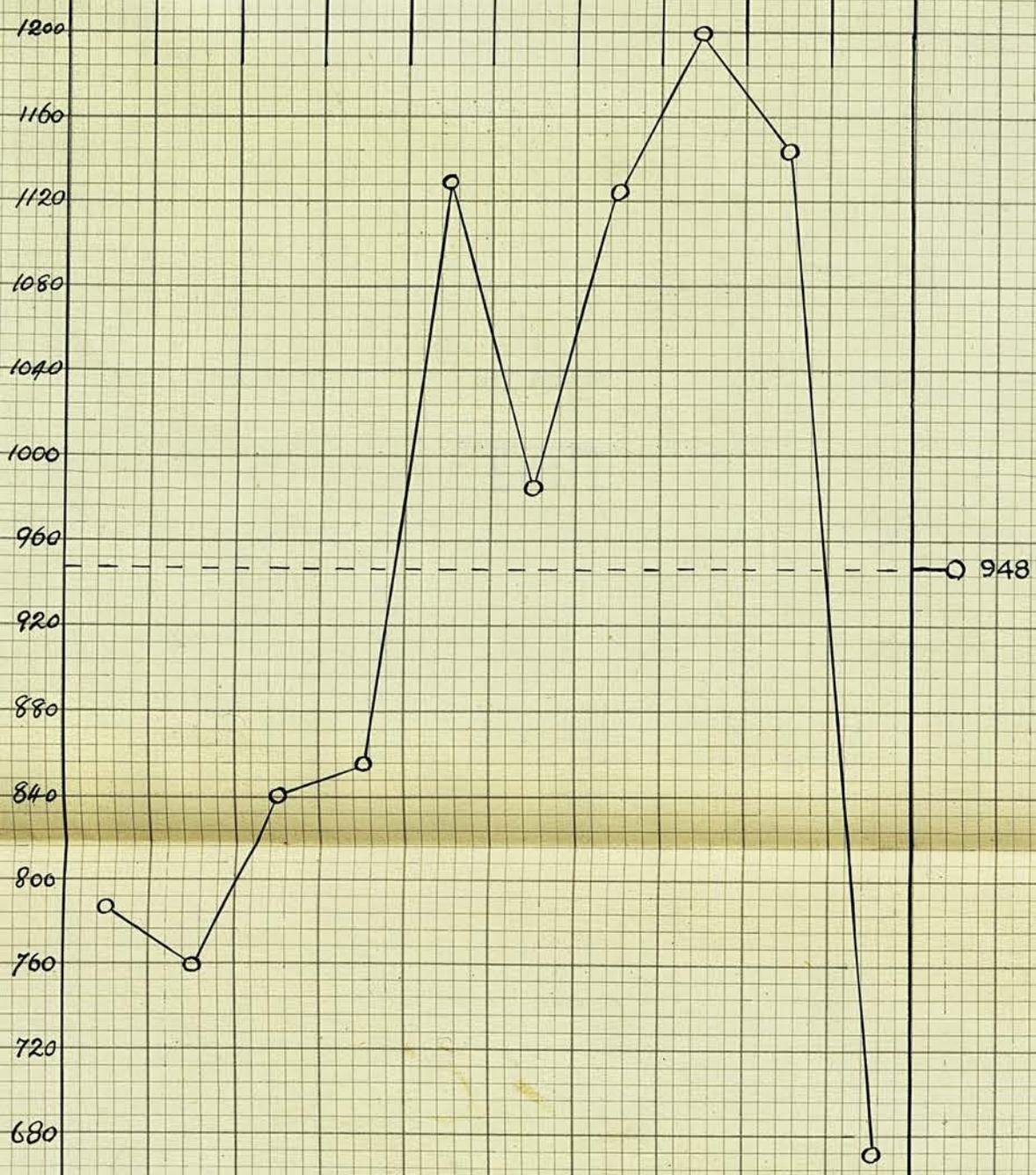
The wide variation in the number of in-patients treated each year at the Georgetown Hospital is probably accounted for as the practice of permitting or forbidding "floor-beds" has been given effect to, in a hospital generally filled to its limits, rather than to a sole change in the incidence of disease generally. Where such beds are forbidden there is in consequence the earlier discharge of patients to make room for others with more acute illness. The result is not only more admissions but in all probability more frequent relapses and re-admissions.

7. It was not thought of much value to compare the death-rates of malaria, so many cases being signed up as malaria because of a history of fever, and so many cases where malaria was undoubtedly the primary cause of death that were recorded as dying from some inter-current disease, that the figures would be of little real value. And until and unless correct differentiation into the several types of the disease is undertaken nonpreventive deductions can be drawn.

8. The percentage of in-patients diagnosed as malaria in the six hospitals of the Colony amounts to the high figure of 13.03 (including the two year average of Kamakusa): and this total of in-patients includes all those of surgical origin, of midwifery diseases and ophthalmic troubles: of purely medical cases therefore, the figures would easily be doubled.

9. The figures for Georgetown show the lowest number of malarial cases per thousand in-patients, and this is not unnatural when the facts are considered, (8.3% of total admissions and 4.7% below the average). Georgetown, so far as malaria goes, is certainly fairly healthy. The municipality has its own Medical Officer of Health and sanitary assistants. The mosquito prevention laws are moderately firmly adhered to, as a capital town it is the most up-to-date and hygienic, and the cleaning and trimming of the banks of canals and waterways is maintained. Not only so, but the adjacent lands in the immediate

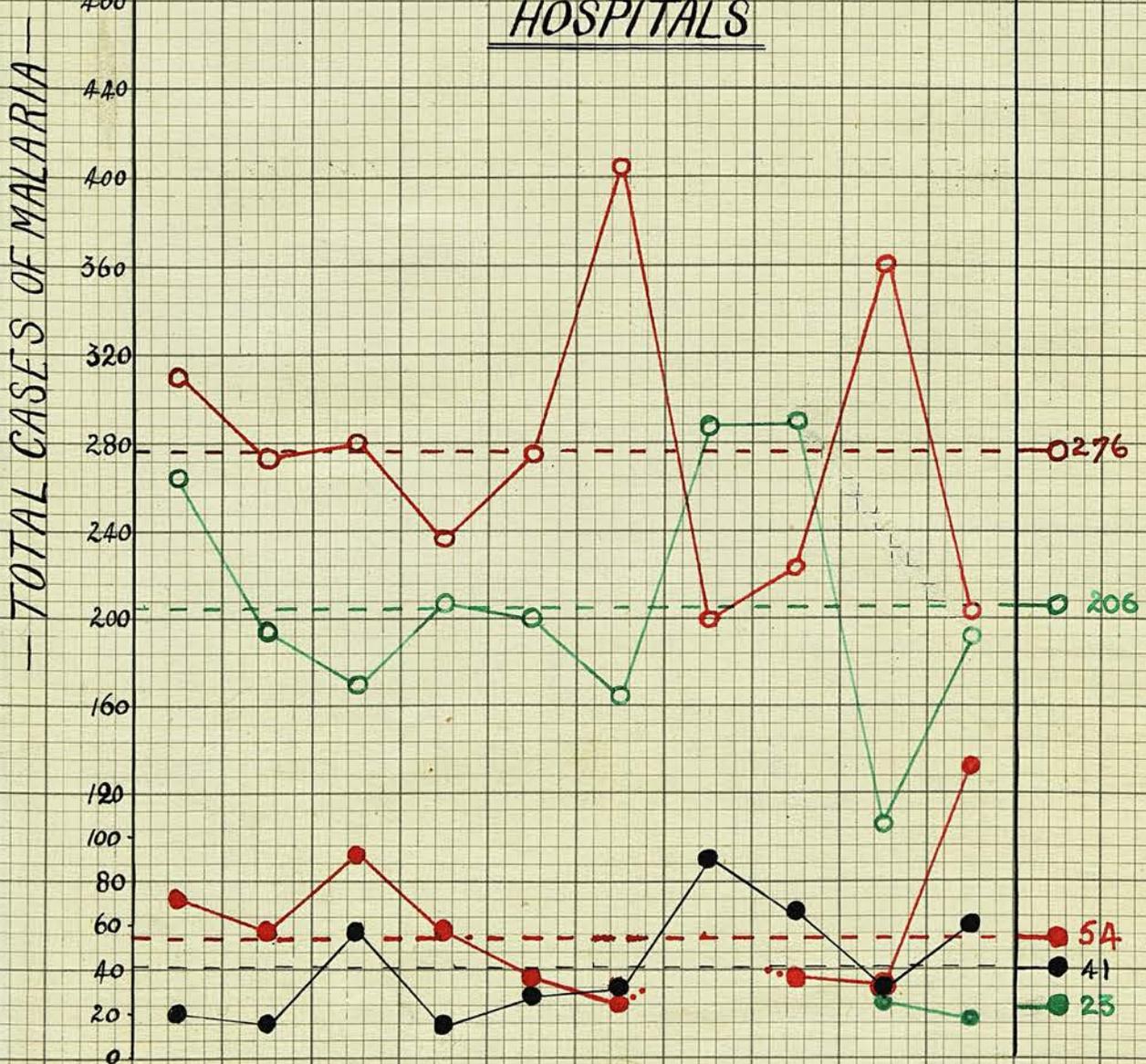
1917 1918 1919 1920 1921 1922 1923 1924 1925 1926



- GEORGETOWN = ○ — ○
- NEW AMSTERDAM = ○ — ○
- SUDDIE = ○ — ○
- BARTICA = ● — ●
- NORTH WEST DISTRICT = ● — ●
- KAMAKUSA = ● — ●

FIG: I

HOSPITALS



Shewing number of Malarial Cases in Hospitals

environs of the town being Crown land and so under the control of the Government Medical Officer of Health, have in recent years been practically cleared of mosquito breeding by filling-in and levelling; while inspection is maintained over all such ground given over to Clubs for the purposes of recreation. If Anopheline breeding has been reduced to a minimum it is not yet the case with the *Stegomyia* and the *Culex*. In this respect gutters, water-barrels and the like require stricter supervision.

10. Figure I shows the total number of malarial cases for each year between 1917 and 1926, inclusive, for the six hospitals.

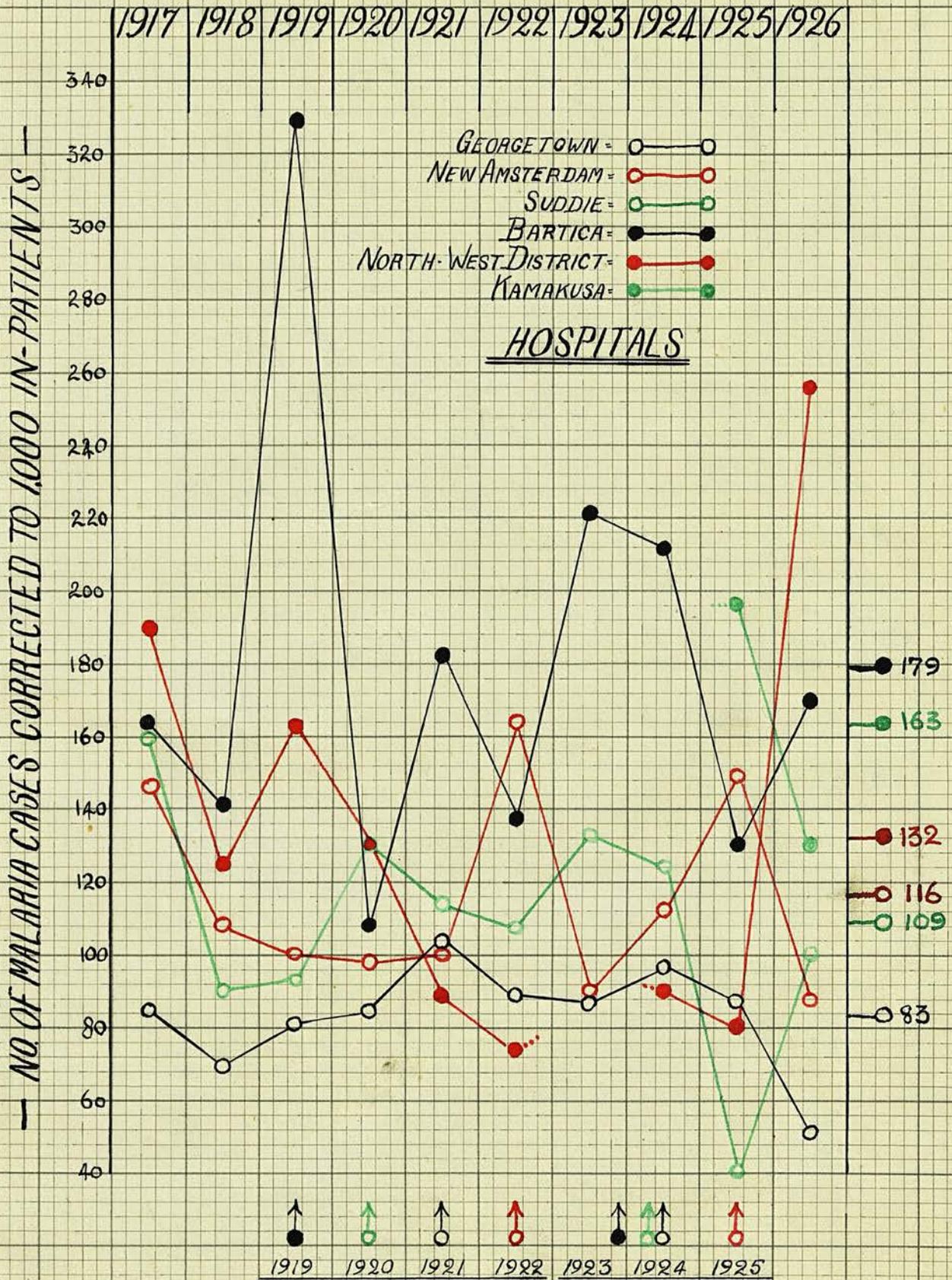
Figure II shows these figures corrected to 1000 in-patients.

In comparing the two figures it will at once be noticed that the corrected figures for malaria tend to vary inversely as the total number of cases: thus, whilst Georgetown easily tops the list in the total number of cases - naturally, being as large as all the other hospitals put together - the number of cases per thousand in-patients is less than any of the other hospitals.

Similarly, while Bartica shows the lowest number of cases (excluding Kamakusa for which figures are only forthcoming for two years) it appears highest on the corrected graph as the hospital receiving the largest number of malarial cases compared with total admissions.

The inference is important. Assuming for the present that diseases other than Malaria are equally frequent throughout the Colony, it will appear that the larger the town - or at least the area served by the hospital - the healthier. This is admittedly a very general statement, and takes no account of varying density in proportion to size of area, and other factors.

11. With New Amsterdam and Suddie this does not appear to hold good. But this is probably accounted for in two ways - (1) Suddie is known as a healthier place than New Amsterdam, is far freer of "bush", and areas of suitable water for breeding are less; and (2) The graph for New Amsterdam reveals two marked rises in the number of cases during 1922 and 1925, which are equally reflected in the corrected curve. These highly suggest epidemics. Although two such peaks occur in the graph for Suddie during 1920-1921 and 1923-1924 and are reflected in the corrected curve, they are not nearly so marked, while a decided drop is apparent in 1925. Collectively these result in a higher average for the larger hospital.



Malaria Cases, corrected to 1,000 In-Patients. 1917-1926.  
suggesting two "waves" of malaria across the colony.



In this connection also it is noteworthy that the corrected curve for Georgetown shows comparatively slight variation throughout the ten years - 1926 excepted, and to which reference will be made below - while the total figures show wide variation every year.

One explanation of this appears to rest on the fact that (para 6) there is also a wide variation in the number of in-patients yearly as compared with the other hospitals; and secondly, that in the case of this hospital patients are received from all parts of the Colony, whereas the in-patients are largely restricted to their respective districts in the case of the other hospitals. A levelling effect would thus be produced.

12. A further examination of Fig: 1 will show that, with the possible exception of the North West District (Mabaruma) hospital, where the figures are not complete, there are two distinct rises in the curve for each hospital.

And not only so, but that with Bartica, Suddie and Georgetown the second peak is noticeably greater than the first. With New Amsterdam, on the other hand, the first peak is followed by a sharp fall to much below the average: it is probably this which has affected the intensity of the later peak in 1925.

Turning now to the corrected graph (Fig: 2) we find a double rise, similarly, in the course of the ten years, but less marked rises also occur during the intervening periods, especially in the case of Bartica. But (A, para 8) the varying number of "pork-knockers" passing to and from the diamond fields materially affects the Bartica figures.

This close approximation between the total malarial cases and the number of malarial cases per 1,000 in-patients reveals how important a bearing malaria has upon hospital records.

The five hospitals whose figures are charted for 1917 and 1918 show, without exception, a marked decline both in the total number and percentage of malarial cases indicating a small or large rise during the immediate preceding years.

13. It is remarkable that for no two hospitals alike are the first and second "peak" years the same: thus, in the case of Bartica (Fig: 2) the first sharp rise occurs in 1919; that for Suddie, in 1920; that for Georgetown, in 1921; and that for New Amsterdam, in 1922 - a regular sequence, it

would appear, extending across the Colony from West to East, from Essequibo through Demerara to Berbice. of an undue percentage of malarial cases such as might be occasioned by an epidemic wave, and taking four years in its progress across the country.

14. A second similar wave occurs between 1923 and 1925, of slightly less intensity and passing more rapidly from west to east - three years in lieu of four.

It is not necessarily suggested that the wave of infection has passed from Bartica, sixty miles up the Essequibo river, to Suddie somewhat westward of its mouth, and thence east to Georgetown. It is not impossible, however, that Georgetown and Suddie (these names are used widely to include the hospitals and immediate neighbourhood) may both have become victims of the malarial waves directly from Bartica, the spread taking longer to pass to the former than the latter.

There is a passenger boat service between Georgetown, Bartica, the islands in the Essequibo (in particular, Wakenaam), and Aurora and Supenaam, two small places somewhat nearer and at the mouth of the Essequibo river, and a few miles each from Suddie which is reached by passengers from the boat by road. On the return journey from Bartica these boats call at Wakenaam and the two stellingen or wharves near Suddie before proceeding to Georgetown, the latter part of this journey being exposed to the Atlantic breeze. Infected mosquitoes might in this way be left behind in the Suddie district, or at least blown away before Georgetown is reached.

15. The Mabaruma hospital, in the North West District shows a rise in the malarial curve in 1919, in the same year as that for Bartica. The district, however, is very far removed from Suddie, and probably has little or nothing to do with the spread of an epidemic eastwards.

16. It is unfortunate that figures were not available for 1927. The phenomenal changes seen during 1925 and 1926 in both the total cases and when corrected are almost certainly attributable to the excessive drought experienced for nine consecutive months during the latter half of 1925 and the first three months of 1926.

The short wet season during part of November, December and January was entirely missed out. This followed the usual long dry period between August and November, and was followed by the short dry season which usually extends till April.

The result of such a drought, affecting as it did two half years would have been more adequately manifested in a graph showing the monthly percentage of malarial cases in hospital; or at least one in which the years had been divided, not between January and December, but July to June.

As it is, while the figures for Georgetown and New Amsterdam show a marked decline in the total number and percentage of cases, those for Suddie, Bartica and the North West District (all three hospitals being in the county of Essequibo) show an increase.

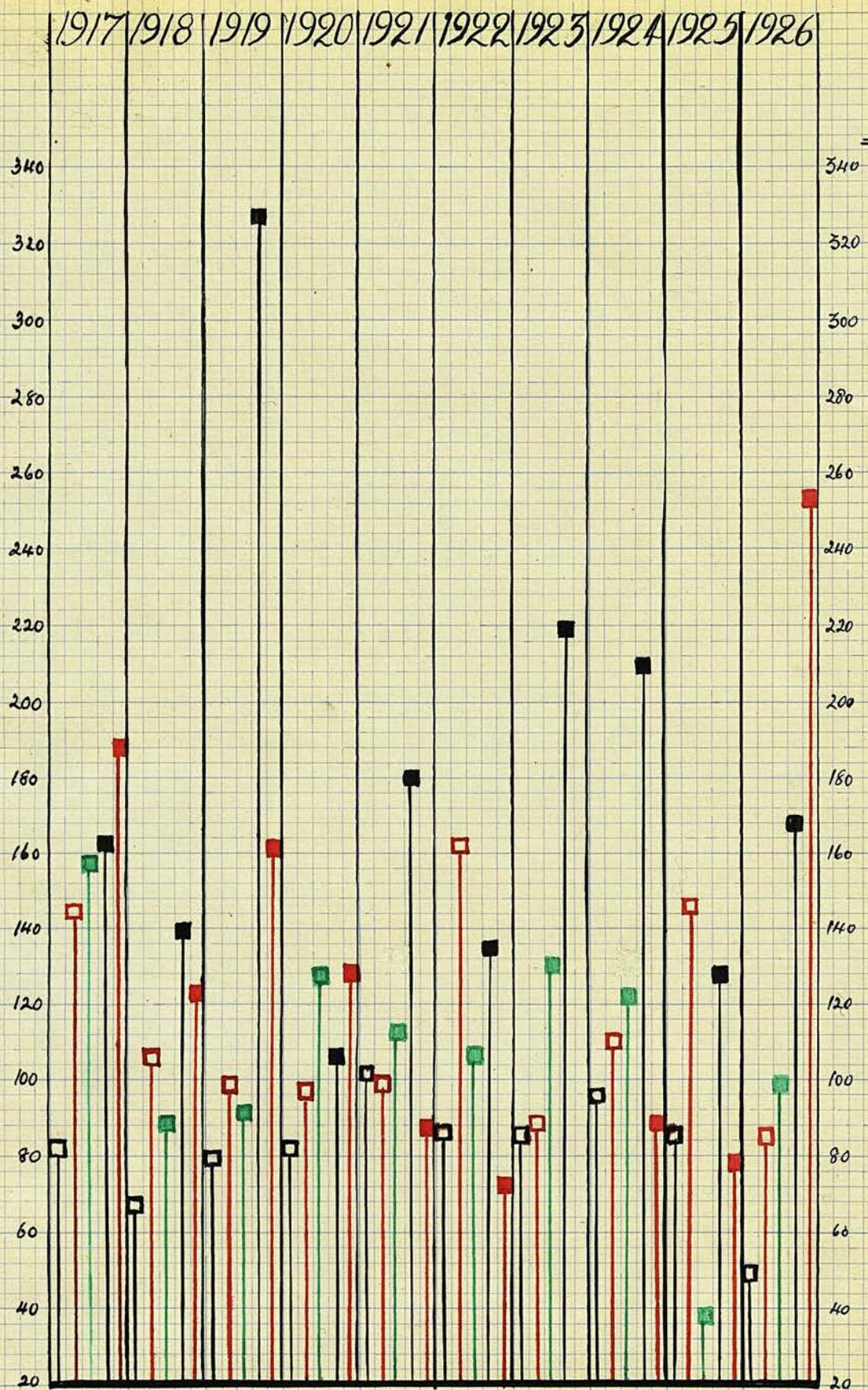
17. A tentative explanation may here be given, but more detailed study and later figures will be necessary before any conclusions are reached. The actual effect of the drought would not take place immediately, and the maximum effect would probably not be reached until late in 1925 or the beginning of 1926. The immediate effect would be on the breeding places of the Anophelines; and the later effect on the parasite and malarial rates. The actual entry of the patients into hospital would therefore depend primarily on how soon the drought took effect; and this, on the available water areas. Suffice it then for the moment, rather than anticipating a discussion on the comparison between the incidence of malaria and rainfall, that in the one case (Georgetown and New Amsterdam) the decline in 1926, and in the other case (Essequibo hospitals) the rise in 1926, depended upon whether the full effects were experienced at the end of 1925 or at the beginning of 1926: that is, whether the increase or decrease in the number of malaria cases were recorded in the Annual Reports of the hospitals for 1925 or 1926.

18. A line diagram (Fig: 3) has been added to show more graphically the malarial cases corrected to 1000 in-patients for the ten-year period.

A second line diagram (Fig: 4) shows clearly the suggested waves of malaria across the country from west to east.

FIG. 3

- MALARIA CASES CORRECTED TO 1,000 IN PATIENTS -



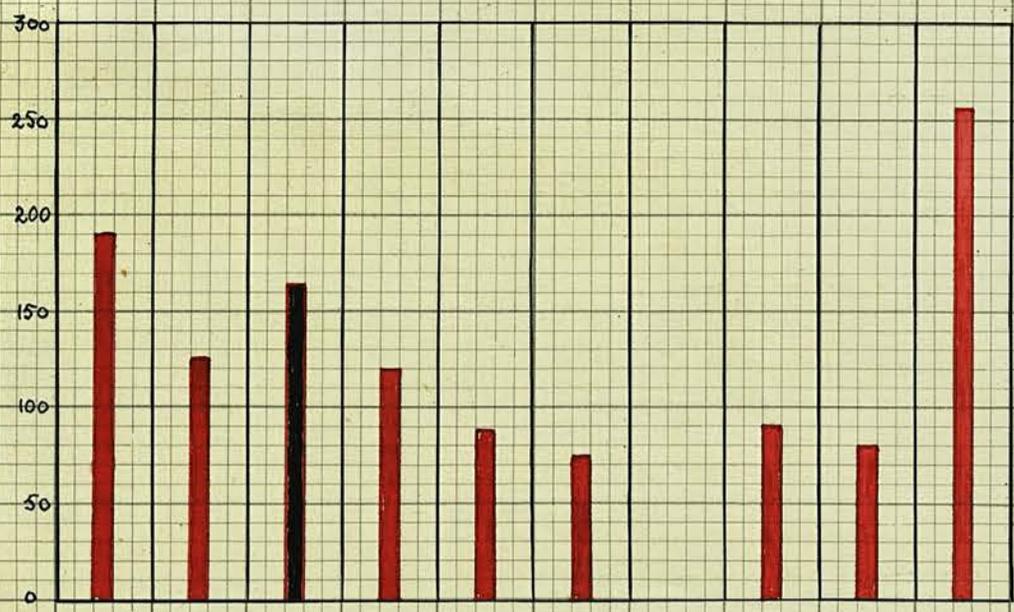
Public

Georgetown - □  
 New Amsterdam —  
 Suddie —  
 Bartica —  
 North West District —

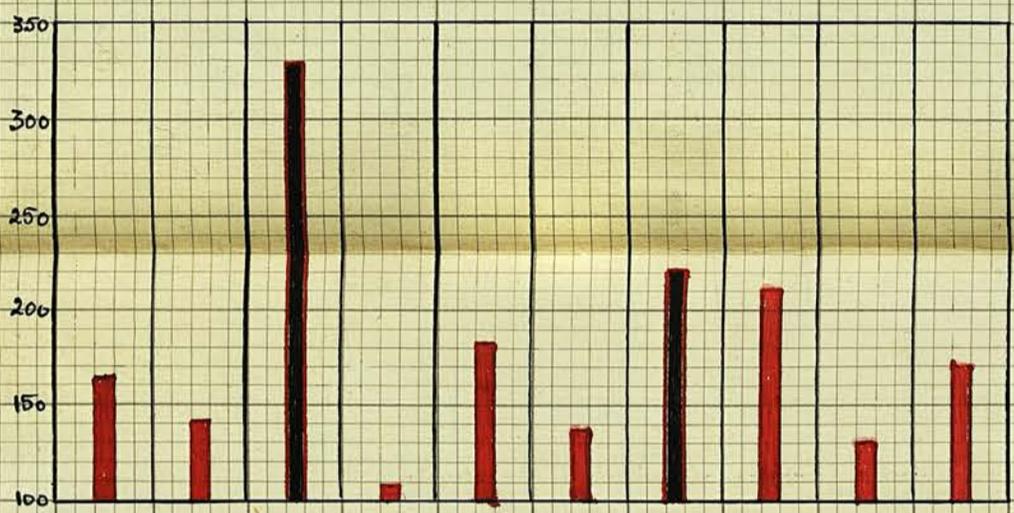
Hospitals

1917 · 1918 · 1919 · 1920 · 1921 · 1922 · 1923 · 1924 · 1925 · 1926

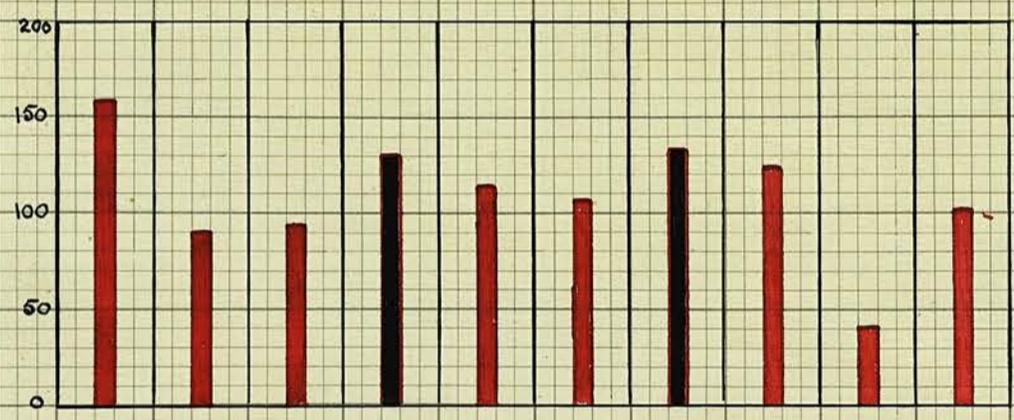
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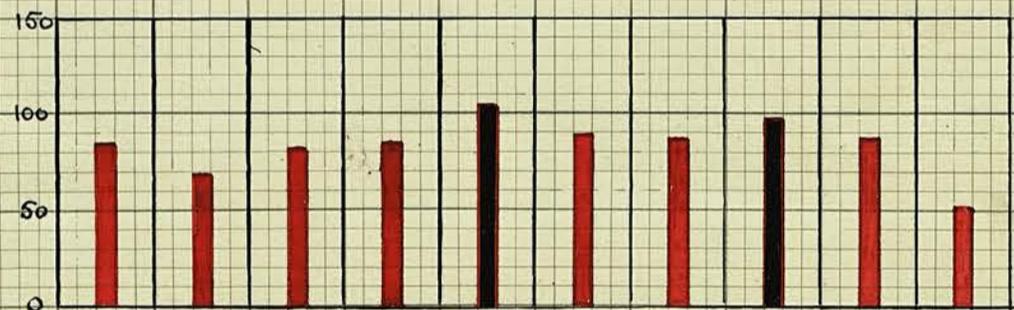
NORTH WEST DISTRICT



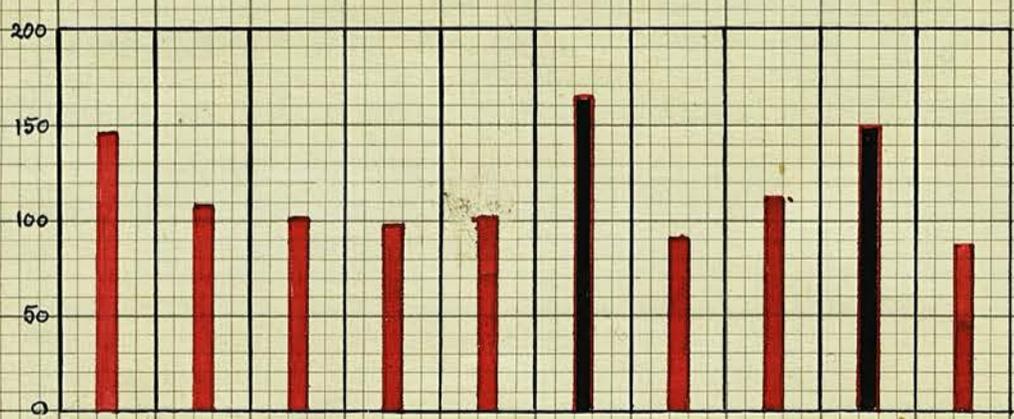
BARTICA



SUDDIE



GEORGETOWN



NEW AMSTERDAM

BERBICE ♦ DEMERARA ♦ F S S E Q U I B O

Showing "epidemic waves" across the colony  
from West to East.

1917 to 1926.

FIG: 4

B. STATISTICAL (b) Sugar Estates.

There are now thirty sugar estates in the Colony, each with its attached hospital (one recently, 1928, has closed down) distributed over the coastal lands and employing many thousands of East Indians. It is from the Reports from these hospitals, on the diagnosis of the visiting practitioner (Government Medical Officer) and the resident Dispenser, that the ensuing malarial figures are drawn. It cannot be too strongly stressed that the totals themselves are highly unreliable, despite the comparative clinical simplicity of diagnosis of the average malarial case: but with the collected figures of thirty, and more, estates over a ten year period much, from the comparative standpoint, of existing fallacies must be neutralised.

2. Each of these estates will ultimately require separate and detailed study before the various factors can be accounted for in their entirety, in relation to their several local peculiarities and conditions. It is doubtful if such a study has ever been undertaken, although individual estates have spent considerable sums of money in the endeavour to lessen the high sickness rate from malaria. For the present, therefore, a mere outline will be given of some of the more salient features which present themselves in relation to the sugar industry, the estate and its environment and the incidence of malaria thereon: and then, taking the figures as they stand attempt a tentative analysis.

3. Directly and indirectly nearly half of the working population of British Guiana is concerned in the sugar industry and its by-products. Quite one third are immediately employed in the actual production of cane sugar. The size of estates varies enormously - from those of a little more than a thousand acres to those of five, six and even seven thousand, with a total acreage under cultivation of something like fifty thousand.

4. The number of estates has changed rapidly within recent years. Thirty years ago there were about seventy-five estates: twenty years ago, but thirty to forty. Now a bare twenty-nine are active; many of these are but holding their own, while the few are on the verge of closing down. Throughout the history of the sugar industry one fact stands pre-eminent: those that have not included better sanitation in the estimates of necessary works to be carried through, are those which sooner or later have succumbed. And better sanitation has practically meant malarial

preventive measures.

5. A second change, and one that must soon rank prominently in any anti-malarial scheme, has been the cessation of sugar cultivation on the lands immediately adjacent to the sea, and their subsequent use as lands adapted to rice planting, or for cattle grazing, and "flood-lands" for the excess water from the sugar estates. It would seem that not only is new land being opened up "aback" of the estates, soon to be the haunt of the Anopheline, but the land left behind is quickly taken up by the mosquito. With the extension of rice cultivation matters are not likely to improve.

6. The canes are brought from the fields through a network of canals by means of barges to the factory. Too often these waterways, especially when not in use or following the opening up of new channels, become excellent breeding grounds. The mud banks gradually slip inwards and the vegetation spreads with it, leaving sheltered shady spots where larvae are soon abundant. This is all too apparent where derelict estates are concerned. But the solution is not easy to find. In a country where a mound cannot be made without digging a hollow for the earth to make it with, or a hollow filled in without creating another hollow, where almost every road has its two canals resulting from the building of it, estate owners cannot be expected to fill in every disused canal: the cost of keeping banks clean is heavy.

7. Not much is to be gained by considering the thirty estates purely geographically: rather will it be better to group them into areas which have or are likely to have similar sets of conditions endemiologically; and thus we find two large groups centering round the Demerara and Berbice rivers respectively; three smaller groups one of which lies on the Atlantic seaboard west of the Essequibo river, one mid-way between that river and the Demerara, and a third on the west bank of the Courantyne river; finally, one single estate on the island of Wakenaam, and one again twenty-five miles up the Berbice river.

8. It is not proposed to describe these groups, and further to sub-divide them, until later, until they are dealt with in relation to malaria individually; but to proceed with the collected figures for all the estates over the ten year period.

TABLE II. SHOWING POPULATION, CASES OF MALARIA, AND MALARIA

CORRECTED TO POPULATION (1000) ON SUGAR ESTATES FROM 1917 to 1926.

ESTATE	1917			1918			1919			1920			1921			1922			1923			1924			1925			1926			ESTATES
	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	POP	MAL	CR	
<u>ESSEQUIBO</u>																															
Marionville	1180	76	65	1107	157	142	787	117	148	766	50	66	831	52	62	647	137	212	617	116	188	502	122	223	817	141	172	727	84	116	Marionville
Hampton Court	984	213	216	920	114	156	794	32	40	822	61	74	921	83	91	764	115	151	837	99	118	836	155	161	865	81	94	822	38	46	Hampton Court
Anna Regina	1369	16	12	1486	27	19	1405	65	46	1264	267	211	1139	219	192	909	135	148	858	61	71	857	56	65	792	44	56	779	70	90	Anna Regina
Golden Fleece	1826	99	54	2158	89	41	2208	81	36	2415	108	44	956	87	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Golden Fleece
<u>DEMERARA</u>																															
Tuschen & de Kinderen	2585	352	132	2249	203	90	1792	116	74	1741	142	82	2135	137	64	2117	128	60	2073	103	50	2107	-	-	2135	170	80	2171	75	34	Tuschen & de Kinderen
Uitvulgt	5398	327	60	5237	179	34	5361	78	15	5449	88	16	5238	210	40	4770	149	31	4317	190	44	4200	-	-	4335	333	77	4225	112	26	Uitvulgt
Leonora	3029	99	33	3572	643	280	3509	311	89	3310	298	90	2694	604	224	2641	735	278	2830	654	231	2828	668	236	2876	627	218	3118	302	97	Leonora
Versailles	644	318	493	593	238	401	475	159	335	468	62	133	468	40	85	485	21	43	527	43	82	565	70	124	590	95	161	615	25	41	Versailles
Schoon Ord	551	25	45	527	32	61	490	49	100	420	50	119	396	36	91	348	45	129	258	51	198	346	43	124	352	68	193	360	32	89	Schoon Ord
Nismes	303	57	188	291	38	131	231	58	251	164	-	-	132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Nismes
Wales	1885	220	117	1745	144	83	1689	143	84	1638	79	48	1558	77	67	1573	174	111	1588	184	116	1631	130	80	1615	163	101	1626	127	78	Wales
Diamond Farm	2818	727	258	2960	322	109	2957	300	102	2900	418	144	2691	244	91	2725	698	256	2808	717	255	2830	1076	380	2787	546	196	2720	760	280	Diamond Farm
Providence & Peter's Hall	1166	84	72	996	68	68	1075	42	39	1134	43	38	1222	21	17	1464	6	4	1404	155	110	1354	139	103	1428	198	137	1445	225	156	Providence & Peter's Hall
Houston	2565	590	230	2687	132	49	2804	416	113	2421	289	119	1967	241	123	2578	172	67	2454	601	245	2506	619	246	2540	587	231	2430	515	208	Houston
Ruimveldt	497	191	384	439	47	107	415	216	520	425	164	386	397	101	254	417	-	-	402	-	-	494	-	-	468	-	-	524	-	-	Ruimveldt
Ogle	388	-	-	401	-	-	302	-	-	311	-	-	334	-	-	386	-	-	407	-	-	409	-	-	377	-	-	432	-	-	Ogle
Vryheid's Lust	1240	93	75	1089	100	92	1755	76	43	1683	14	8	1774	1	0	1812	0	0	1786	37	21	1893	201	106	1821	272	149	1877	144	76	Vryheid's Lust
Success	1569	167	106	1941	59	30	1379	54	40	1404	16	11	1241	92	74	1147	90	78	1156	87	75	1160	121	91	1145	131	114	1158	75	65	Success
L.B. Intention	973	82	84	796	19	24	--	-	-	--	-	-	--	-	-	--	-	-	--	-	-	--	-	-	--	-	-	--	-	-	L.B. Intention
Mon Repos	1026	29	28	914	31	34	1371	8	6	1427	22	15	1750	4	2	1851	13	7	1916	136	71	2088	342	163	2026	251	126	1967	41	21	Mon Repos
Lusignan	853	22	26	841	43	52	590	28	47	582	18	31	694	0	0	683	1	2	645	24	37	641	112	175	639	77	105	633	25	40	Lusignan
Non Pareil	2616	302	115	3070	643	213	2999	302	101	2935	259	88	2638	683	281	2536	389	153	2546	302	119	2568	413	161	2596	250	96	2614	60	23	Non Pareil
Enmore	2996	1137	380	2897	536	185	3037	357	117	3122	171	55	3082	303	98	2998	159	53	3150	110	35	3184	236	74	2988	175	58	2822	86	31	Enmore
Cove & John	2246	475	211	2008	457	227	1941	331	171	2011	208	103	2267	275	121	2259	320		2021	320		2079	379		2003	308		2021	116		Cove & John
Hope	435	32	74	316	106	336	275	49	178	290	49	170	266	29	112	164	-	113	261	-	117	134	-	91	153	-	120	163	-	44	Hope
La Bonne Mère	860	216	251	806	84	104	790	113	143	635	79	124	475	121	254	398	-		439	-		440	-		411	-		430	-		La Bonne Mère
Cane Grove	256	-	110	255	-	63	183	-	150	173	-		190	-		78	-		125	-		67	-		83	-		83	-		Cane Grove
1633	209		1319	99		1161	205		150	1110	152		1065	213		1149	160		1224	111		1253	306		1239	281		1233	175		133
<u>BERBICE</u>																															
Bath	1642	236	144	1688	102	60	1784	66	17	1917	58	30	2046	91	44	2103	175	83	2131	64	30	2217	172	77	2047	282	137	1921	135	70	Bath
Blairmont	1709	740	433	1623	316	294	1482	145	98	1879	371	198	1856	351	189	1885	303	255	1903	213	112	1919	364	189	2051	304	148	1988	156	78	Blairmont
Mara	675	268	397	542	62	114	460	36	78	387	45	117	367	116	316	418	84	201	421	109	258	342	91	266	365	56	154	341	91	267	Mara
Friends	563	98	174	406	31	76	345	36	104	310	13	42	387	21	54	374	30	80	331	32	97	229	20	87	223	41	184	212	27	127	Friends
Providence	853	287	354	648	161	248	432	87	204	497	73	147	697	56	80	710	68	96	698	76	109	699	114	163	675	95	141	674	62	92	Providence
Rose Hall	2774	1165	456	2666	518	194	2490	331	133	2490	248	99	2593	166	64	2589	317	123	2639	378	144	2742	358	130	2902	379	130	3157	162	51	Rose Hall
Albion	3542	578	163	3782	416	109	4035	339	84	4046	241	59	4431	231	52	4580	280	61	4669	248	53	4909	269	55	4948	305	62	4948	182	37	Albion
Port Mourant	5287	575	109	5343	455	85	5279	99	19	5353	216	40	5338	162	30	5589	295	53	5632	251	45	5193	474	91	4764	304	64	4879	72	15	Port Mourant
Springlands	518	40	77	444	11	25	434	1	2	441	1	2	430	3	7	440	14	32	440	23	52	441	7	16	391	5	13	386	20	52	Springlands
Skeldon	1987	515	259	1975	225	114	1544	85	55	1617	38	24	1650	122	74	1522	283	185	1379	244	177	1302	206	157	1235	309	158	1363	98	72	Skeldon



9. Before further dividing up this table(II) a few points may be noted here.

By far the largest number of estates is in the county of Demerara: that is, to west and east of the river and for a short distance up its banks. Many factors have probably led to this. Although the capital of the Colony in the days of Dutch occupation was up the Essequibo river, since its removal to Georgetown it has had the effect of bringing with it much of the agricultural population. Navigation at the mouth of the Demerara river, too, though precarious, is more certain than amongst the islands of the Essequibo where the bed of the river is constantly changing. Once Georgetown became the chief port of the Colony, it was natural that its main industries should centre round it.

10. The gradually decreasing number of estates remaining active becomes very apparent on glancing at the table. Of the four in the Essequibo district in 1917 only three remained in 1926. Anna Regina has since closed down, together with its hospital. Of the twenty-seven (three of which were already combined with others) in Demerara in 1917, only seventeen were active in 1926; although the ten estates in Berbice continued active through the ten year period, the solitary estate up the Berbice river - Mara - no longer now maintains a resident physician, or at least a visiting physician, in the hospital. A Dispenser has been substituted.

11. With but few exceptions, it will be seen that the smaller the estate the larger the proportion of malarial cases. On the other hand one or two of the larger estates show an unusually high percentage of malaria with marked persistence. Of these, Plantations Diamond, and Lusignan in Demerara, and those of Blairmont and Rose Hall in Berbice are outstanding.

12. For the determination of the proportion of malaria on a few of the estates, groups of two and three have been bracketed. This was called for as in each case the smaller estate(s) had no hospital and it was assumed that such cases were sent to the nearest hospital. Arrangements for this existed between the several estates. Thus: though cases are only recorded at La Bonne Mère (Demerara) by being included in those for Cane Grove, this is not shown under the malarial figures, but is allowed for in the corrected count.

Similarly, the smaller estates of Cove & John and Hope are included with the figures for Enmore (Demerara) and the corrected malarial figures based on the population of all three.

In the case of Ruimveldt (Demerara) of which the population only is given, its proximity to Georgetown results in malarial cases being largely sent to the Public Hospital, by the resident Government Medical Officer, rather than to a neighbouring estate hospital.

13. Table III. SHOWING AVERAGE NUMBER OF MALARIAL CASES PER 1000 POPULATION ON SUGAR ESTATES (COUNTIES).  
(From Table II)

YEAR	ESSEQUIBO	DEMERARA	BERBICE	BRITISH GUIANA
1917	87	142	218	149
1918	90	131	132	118
1919	68	119	79	81
1920	99	95	76	90
1921	109	108	91	103
1922	170	89	117	125
1923	126	111	108	115
1924	150	150	123	141
1925	107	139	119	122
1926	84	85	100	90
<b>Averages:-</b>	<b>109</b>	<b>117</b>	<b>116</b>	<b>114</b>

14. On the basis of the sugar estate hospitals' reports, which include both out-patient and in-patient cases of malaria, over eleven per cent of those employed find it necessary to appear for treatment for this one condition. It is, however, admitted that no account is taken of re-admissions, or of those who began treatment as out-patients and then continued as in-patients (or vice versa), which, if allowed for, would certainly lessen these figures. On the other hand there are very many coolies who have attacks of malaria who do not bother to come for treatment. And this would more than counterbalance those counted twice.

15. Comparing these figures with those in Table I, it

will be noticed that although those for the sugar estates are corrected to populations and those for the Public Hospitals are corrected to in-patients, they are yet very similar, showing how very much greater must be the proportion of malaria to in-patients in estate hospitals, figures for which have not yet been attempted and which will have to be collected from individual estate reports. It may be stated with confidence, therefore, that malaria in country districts is vastly more prevalent than in the immediate neighbourhood of large towns - a fact common enough to all investigators, and to local practitioners alike.

16. However true the last sentence may be on the average, it does not by any means hold good *necessarily* when considering individual country districts - in this case, individual estates, and surrounding villages - as a criterion from which to start. The corrected figures for Springlands (Berbice) (Table II) is an example of this, there being only an average of 27.8 cases per thousand of the estate population for the ten year period: in fact, the healthiest estate in the Colony. It will be the concern of a later section, when dealing with rainfall, and when discussing individual estates or groups, to account for it.

17. Fig: 5 (over) shows the annual variation in the total number of cases of malaria for each county. (From Table II)

18. Fig: 6 shows the annual variation of the sugar estates of the whole Colony (total cases of malaria) as compared with the total number of malarial cases occurring as in-patients in the six Public Hospitals. (Obtained from Tables II and I respectively)

19. Fig: 7 shows the corrected figures as obtained from estate hospitals compared with the corrected figures from Public Hospitals.

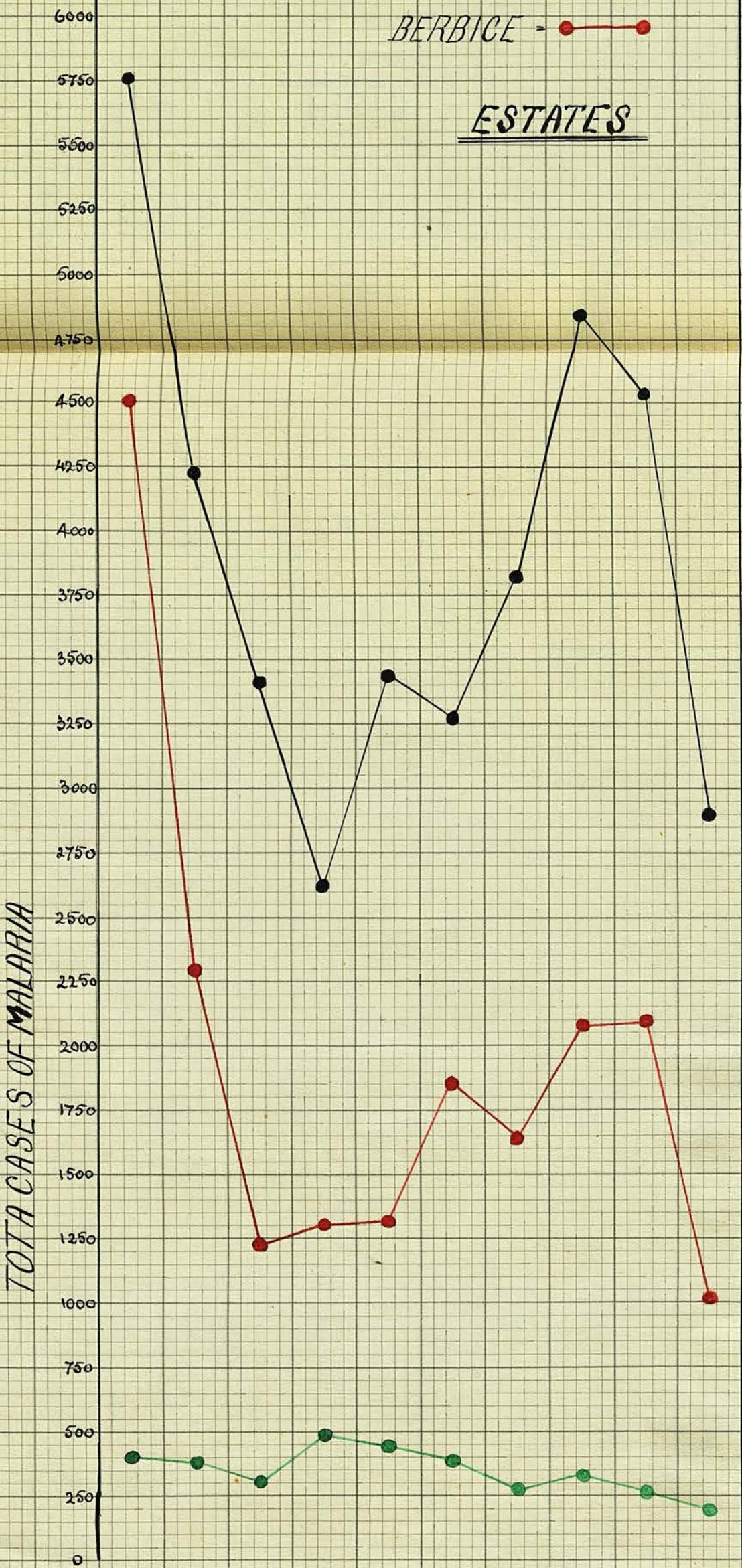
20. The object of these comparisons is to see whether a higher or lower proportional intake of malarial patients into the Public Hospitals accompanies a higher sickness rate from malaria on the estates.

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

ESSEQUIBO - ● -

DEMERARA - ● -

BERBICE - ● -



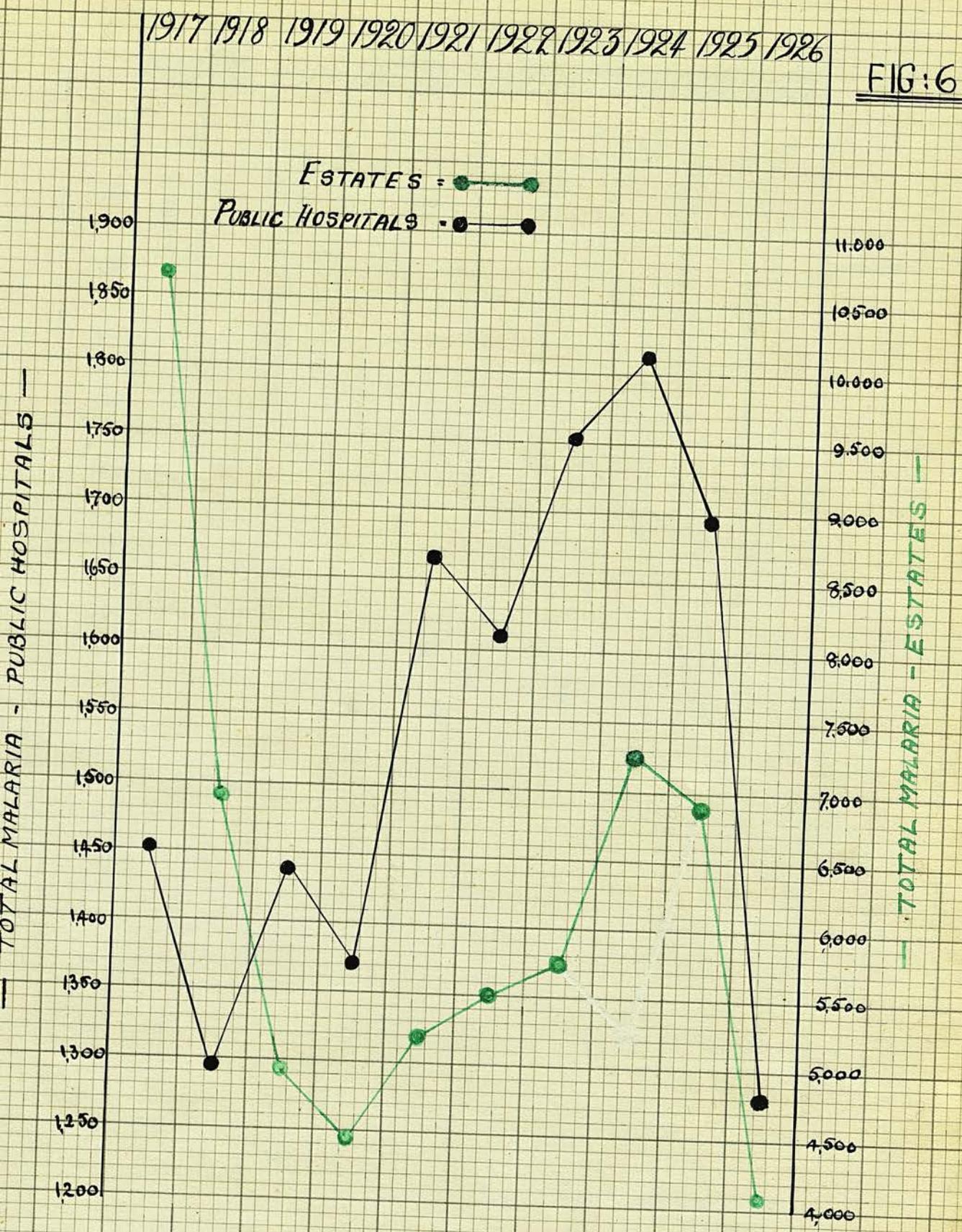
ESTATES

FIG:5

TOTAL CASES OF MALARIA

Showing total cases of Malaria in each County on Sugar Estates.

FIG: 6

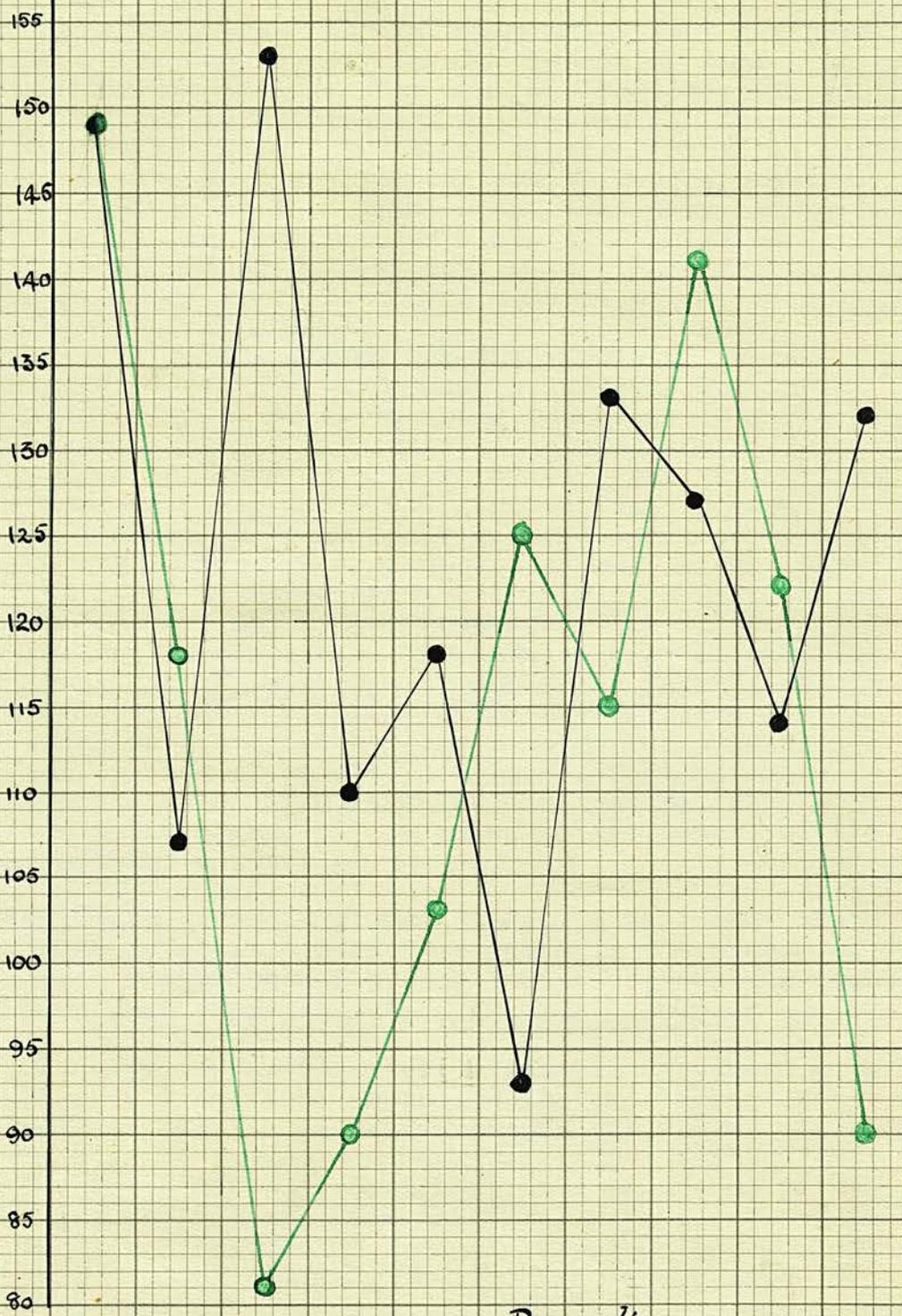


Showing Number of bases of Malaria  
at Public & Estate  
Hospitals

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG: 7

MALARIA CASES PER 1,000



PUBLIC HOSPITALS = ● — ●  
ESTATES = ● — ●

Showing Cases of Malaria, corrected to 1,000.  
Public Hospitals & Estates

21. With regard to Fig. 5, no adjustment has been made for each county for the lessening number of active estates over the ten year period: thus, in and after 1922 there are no figures for Plantation Golden Fleece, and the total figures for three estates have been charted instead of four without averaging for this plantation. Similarly, in the case of Demerara, the hospitals of Plantations Nismes, Houston, Success, Cove & John, Hope and La Bonne Mere were all closed down at some period between 1917 and 1926.

To give averages for the remaining years would not only be questionable in itself, but in point of fact would be quite incorrect. For assuming that a proportion of the existing population on these estates remained - and the figures show that they did - and granting that a quota of them still found their malaria sufficiently severe to require treatment, they must either have journeyed to the nearest estate with a hospital, as in the vast majority of cases, or else to one of the Public Hospitals. The total number of malarial cases therefore, though augmented as regards certain estates, must still remain the actual total of cases occurring in any one county. Put otherwise, the closing of an estate hospital does not mean the cessation of malaria on that estate; simply the transference of its cases to the totals of the remaining estates.

22. And indeed, a glance at Fig. 5 will show that there is still a marked increase in the number of cases rather than a proportionate decrease as might have been expected, with a smaller number of estates.

23. Fig. 5 further shows a general agreement with Figures 2 and 4 as depicting the two "waves" of malaria passing eastwards across the Colony. In this graph there is no equivalent for Barbica and the North West District hospitals in the matter of sugar estates, and thus the first wave commences in 1920 in Essequibo in lieu of 1919, and the second in 1923 instead of 1922. The shorter second wave is also recorded.

24. Turning to Fig. 6, while there is a general similarity, with minor exceptions, between the curves for the Public Hospitals and Estates, showing some common factor to be influencing the malarial incidence throughout the Colony, not much stress must be laid on the actual shape or intensity of the curves either of which may be considerably modified, and the

general truth hidden, by some outstanding individual Hospital or estate figure: as, for example, in the case of Bartica Hospital for 1919 (329 cases per 1000 in-patients), and the Berbice estates for 1917 (218 per 1000 population).

25. So, with Fig. 7 which while showing the corrected figures for Public Hospitals in comparison with those for estates, might be expected roughly to agree and yet which bear little or no, if not an inverse, relation to each other. Further analysis of Fig. 7 does not therefore appear of value until the estates have been sub-divided into groups, and these compared with the Hospital figures.

26. These three graphs agree, however, in portraying - (1) The marked reduction in the number and proportion of malarial cases from 1917 to 1918; (2) The definite and outstanding, if slightly interrupted, rise to a crest in 1924; and (3) a marked variation from the normal, to say the least, in 1926.

And in these three points the estate figures compare very closely with those for the Public Hospitals. This at any rate serves to show firstly that though the figures are questionable individually, they have an appreciable comparative value; and secondly, that some one or more factors, apart from population alone, must be playing a profound part in determining the annual incidence. Commonplace as these points may appear, it would have been unwise to assume them in a country of which the study of malaria has hardly yet been attempted.

27. ESTATE POPULATION & MALARIA. Table IV (from Table II) gives the number of people employed on estates for each county and for each of the ten years, together with the corrected malarial figure for that year (from Table III). (see over).

28. It will be seen that there is a progressive reduction in the number of labourers employed from sixty-three thousand in 1917 to fifty-six and one half thousand in 1926, and that this diminution occurs entirely in the Essequibo and Demerara Counties, and in the former more than the latter; while in Berbice the number has remained much the same with a tendency, if anything, to increase. It is not proposed to discuss the economic aspect of this here, but it does show that certain companies seem to be more successful than others on their estates. There has certainly been much more malarial preventive activity in Berbice than in the other counties.



TABLE IV. SHOWING POPULATION OF SUGAR ESTATES FOR EACH COUNTY, 1917 to 1926, TOGETHER WITH MALARIAL CASES (CORRECTED TO 1,000 POP:). (From Tables II & III).

(CR = Cases malaria corrected to 1000 population).

YEAR	ESSEQUIBO		DEMERARA		BERBICE		COLONY	
	POP	CR	POP	CR	POP	CR	POP	CR
1917	5,359	87	38,144	142	19,551	218	63,054	149
1918	5,671	90	37,548	131	19,117	132	62,336	118
1919	5,194	68	36,279	119	18,285	79	59,758	81
1920	5,267	99	35,442	95	18,937	76	59,646	90
1921	3,847	109	34,340	108	19,795	91	57,982	103
1922	2,320	170	34,193	89	20,210	117	56,723	125
1923	2,312	126	33,930	111	20,243	108	56,485	115
1924	2,195	150	34,368	150	19,993	123	56,556	141
1925	2,474	107	34,230	139	19,601	119	56,305	122
1926	2,328	84	34,275	85	19,869	100	56,472	90
10yrs-36,	967	109	352,749	117	195,601	116	585,317	114

29. This generalised reduction in employees is not reflected in a proportionate reduction in malaria: there is, rather, a decided increase, as the corrected figures show. The reasons for this are probably spread over many factors. Lessened employment follows worse trade balances; and more economy causes lower general resistance, and less money spent on estate upkeep - especially drainage, cleanliness of waterways and bush clearance. Fewer people means more infected Anophelines per person at the moment of reduction, the higher parasite rate probably balancing what would otherwise have been a larger number of infected persons with a lower parasite rate. The fight is unequal, and more malaria results.

30. With the closure of Plantation Golden Fleece (Essequibo) the labourers appear to have left the district, rather than to have been grafted on to the other estates (as frequently happens in Demerara),

namely, Hampton Court and Anna Regina. (Marionville, being separated from the others, on the island of Wakenaam, would not be affected). But the marked reduction in population has not reflected advantageously on the remaining estates whose percentage of malaria seems to have risen *pari passu* with the reduction in, and final cessation of employment at Golden Fleece. This, however, is largely apparent than real. The corrected malarial figures for Golden Fleece, so far as they go (1917 to 1921) are much lower on the average than those for Hampton Court or Anna Regina, as well as Marionville. Once removed (1922 et seq.) the figures for these three estates show up in their true light.

Owing to the distances involved it is less likely that the infected Anopheline factor (para 29 above) obtains to any appreciable extent.

31. SIZE OF POPULATION & MALARIA. As was mentioned in para 11. of this section, it was noticed from Table II that the smaller estates seemed to show a higher proportion of malaria; while a few of the larger estates also showed exceptional figures. To determine more accurately the relation between the size of the estate and the malaria per 1000 of its population, a Table has been compiled (from Table II) showing the estates divided into five groups according to size (population), giving in their respective groups the corrected malarial figures. It was thought advisable not to take the average population of any one estate for the whole ten year period and then allocate it to its appropriate group, owing to the closing of some of them during that period, but rather to take each year separately, classify them into the groups, and then take the average for that group: finally to collect the figures for each group for each of the ten years and average them. One example (TABLE V.) will suffice to make this clear. A similar Table was prepared for each of the remaining nine years, the final figures for the ten Tables being collected into TABLE VI. (See over).

32. It will be noticed that while certain estates remain in the same group year by year, others change from one to another above or below it according as its population increases or decreases for the year in question. At times, where the difference is very slight, and yet enough to transfer it to an adjacent group, the difference to the average which it makes is not justified. This weakness is minimised, however, over the ten year period taken.

TABLE V. SHOWING ESTATES DIVIDED INTO FIVE GROUPS ACCORDING TO SIZE, TOGETHER WITH CORRECTED FIGURES FOR MALARIA FOR EACH ESTATE. (Being one year (1917) as an example of ten similar Tables to illustrate method adopted).

(CR = Cases-Malaria per 1000 population).

GROUP I		GROUP II		GROUP III		GROUP IV		GROUP V	
To 499		500 to 999		1000 to 1999		2000 to 2999		3000 upw.	
ESTATE	CR	ESTATE	CR	ESTATE	CR	ESTATE	CR	ESTATE	CR
				<u>ESSEQUIBO</u>					
		Hampt.Ct.	216	Marionvil.	65				
				Anna Reg.	12				
				Golden F.	54				
				<u>DEMERARA</u>					
Nismes	188	Versaill.	493	Wales	117	T. & de Ki.	132	Uitvlugt	60
Houston	384	Schoon O.	45	Farm	72	Diamond	258	Leonora	33
Cov. & J.	74	Success	84	Ogle	75	Providen.	230		
		Mon Repos	26	Vryheids	106	Lusignan	115		
		Hope	251	L.B.Int.	28	Non Par.	380		
				Cane Gr.	110	Enmore	211		
				<u>BERBICE</u>					
		Mara	397	Bath	144	Rose Hall	456	Albion	163
		Friends	174	Blairmont	43			Pt.Mour.	109
		Providen.	354	Skeldon	259				
		Springla.	77						
(3)	215	(10)	212	(12)	90	(7)	255	(4)	91

33. In 1917, therefore, it will be seen that most of the estates come under Groups II & III. But this is very far from being the case in other years. The figures in brackets (that is, the number of estates in that group for the year in question) in Table VI (over) show that Group I steadily increases up to 1921 at the expense of Group II which similarly declines. The smaller estates tend to become still smaller. There are a less number of estates in the first two groups after 1921, showing some to have closed down altogether. Similarly in other estates,

in higher groups. Berbice estates tend to be transferred to the right, showing an increase in the population. The varying number of employees on any one estate gives a fair idea of the rise and fall in prosperity of that estate year by year. This will be further discussed when individual estates and groups will be dealt with.

TABLE VI. SHOWING GROUP AVERAGES FOR TABLE V, AND NINE OTHER SIMILAR TABLES FOR THE YEARS 1918 TO 1926 INCLUSIVE. DETERMINATION OF RELATION BETWEEN ESTATE POPULATION & PROPORTION OF MALARIA(per 1000 of population).

Note:- Numbers in brackets refer to number of estates in that group for which the average malarial (CR) cases for that year are taken.

<u>GROUP I</u>		<u>GROUP II</u>		<u>GROUP III</u>		<u>GROUP IV</u>		<u>GROUP V</u>	
To 499		500 - 999		1000-1999		2000-2999		3000 upw.	
<u>YEAR</u>	<u>CR</u>		<u>CR</u>		<u>CR</u>		<u>CR</u>		<u>CR</u>
1917	(3) 215	(10)	212	(12)	90	(7)	255	(4)	91
1918	(5) 135	(10)	126	(9)	100	(7)	128	(5)	144
1919	(9) 141	(4)	117	(12)	69	(5)	97	(5)	65
1920	(8) 124	(4)	74	(11)	70	(6)	99	(5)	52
1921	(8) 147	(5)	65	(10)	91	(7)	127	(4)	55
1922	(5) 97	(5)	122	(7)	110	(8)	132	(4)	48
1923	(4) 151	(6)	101	(8)	96	(8)	149	(4)	44
1924	(4) 123	(6)	152	(7)	135	(8)	186	(3)	73
1925	(4) 136	(6)	122	(6)	145	(11)	140	(3)	59
1926	(4) 134	(6)	71	(9)	83	(6)	103	(5)	45
	(54) 140	(62)	116	(91)	99	(73)	142	(42)	68

34. Estates with a population varying between two and three thousand actually top the list as being on the average the most malarious in the Colony. Apart from this group it holds good that the smaller the estate

the greater the percentage of malaria among its workers. From the economic point of view it is not unnatural that the smallest estates should show a high malarial proportion. There is evidently a struggle to keep in existence at all. There is not the capital available to maintain the estates at the same level of repair in bad years as in prosperous years. The status of the employees must be on a lower grade and general poverty more manifest. Estates of a fair size, as in Group III, on the other hand do not suffer from these difficulties, with the result that the workers are more adequately looked after, overseers are more numerous and better paid, and conditions generally are on a higher level: malaria is less rife.

35. This argument would appear to fail, however, when considering Group IV. With the largest and most flourishing estates, it again seems to apply. It may be that the estates in Group IV just so happen to be situated in particularly bad malarious areas, or a few of them to an exceptional degree giving a high final average to the whole.

A list of those estates classed in Group IV one or more times during the ten years is given below; together with the number of times they are so included:-

Golden Fleece	- (4)	Leonora	- (5)
Tuschen & de Kinderen	- (7)	L.B.Intent.	(2)
Diamond	- (10)	Enmore	- (9)
Providence & Peter's Hall	- (8)	Bath	- (5)
Lusignan	- (9)	Blairmont	- (1)
Non Pareil	- (5)	Rose Hall	(8)

It will be seen that Diamond, Lusignan, Enmore and Providence (& Peter's Hall) and Tuschen & de Kinderen belong most consistently to this group. The average corrected figures for the ten years for each of these is - Diamond, 207; Lusignan, 135; Enmore, 132; Providence, 163; Tuschen & de Kinderen, 74. All except the last, that is to say, have a high percentage of malarial cases year by year. And yet these estates are scattered over a wide area of country. The suggestion follows that estates with a population of between two and three thousand may possibly be run on lines similar to those in the lower Group III, but with more economy and less strict control in proportion to size, with, consequently, more disastrous results - in fact, a false economy.

36. Whereas, with the largest estates, more elaborate methods of control are necessary owing to the much wider field covered. Further, a reserve of capital is always at hand to maintain the upkeep of the estate. And this upkeep includes the proper maintenance of the estate hospital and equipment - the cost of which, in the smaller hospitals, is almost always the first item to be reduced, though it should be the last. So, in Group V, we find the lowest of all the Groups as to the number of cases of malaria per thousand of the population.

37. The statements in the above two paragraphs may, when more detailed analysis is made of the estates concerned, be found too sweeping, or at least hardly justified on the strength of Table VI alone. These deductions must therefore be considered only temporary and await confirmation or otherwise when a more exacting study is made.

B. STATISTICAL(contd.) - (c) Rainfall -

Simply to take the crude annual rainfall and compare it with the malaria figures can hardly be expected to provide much data of permanent value: but a start has to be made somewhere. In a part of the Colony where there are normally two wet and two dry seasons the obvious need is to compare monthly rainfall with monthly malarial returns. This, if carried over a number of years in British Guiana will be a considerable undertaking, and will mean a detailed reference to a large number of stored away files and Reports, besides attention to the local books of the estates. Though this is intended as soon as practicable, it has been so far wholly impossible. Meanwhile, over the ten year period chosen, together with a brief comparison with a somewhat similar work on total malaria on estates by a former Surgeon General, more especially between 1906 and 1911, some general measure of the effect of rainfall on the incidence of malaria may be gauged.

2. It is true that rainfall *per se* has probably less direct bearing on the breeding and infection of mosquitoes than the combined consideration of rainfall with temperature, and relative and absolute humidity, but the time involved in collecting the present data, together with correcting the malarial figures has so far precluded the possibility of more complete research in this direction. While a small diurnal variation in the temperature ( $12^{\circ}$ ) would not suggest much effect on the Anopheline, the humidity which varies markedly during the year most certainly would.

3. In this sub-section only the Colony estates as a whole, together with each county separately, will be dealt with, leaving consideration of environment and local distribution to the next sub-section where the estates are sub-divided into local groups.

4. TABLE VII(over) shows the rainfall on each estate for each of the ten years together with the corrected malarial figures. The rainfall has been recorded to the nearest whole number, except for the averages.

Where estates have closed down early in the decade the average rainfall recorded as for the ten years will not bear the same value as in the case of estates where the average is based on the full ten years.

TABLE VII. SHOWING ANNUAL RAINFALL ON SUGAR ESTATES (to nearest whole number) FROM 1917 to 1926, TOGETHER WITH MALARIA, CORRECTED TO POPULATION.  
(R = Rainfall. M = Cases Malaria per 1000 pop.)

ESTATES	1917		1918		1919		1920		1921		1922		1923		1924		1925		1926		AVERAGE ESTATES	
	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M
<b>ESSEQUIBO</b>																						
Marionville	94	65	96	142	102	148	137	66	142	62	83	212	83	188	71	223	66	172	73	116	94.7	139
Hampton Court	94	216	74	156	73	40	103	74	107	91	92	151	81	118	57	161	103	94	71	46	85.5	115
Anna Regina	84	12	72	19	80	46	130	211	117	192	89	148	109	71	78	65	91	56	69	90	91.9	91
Golden Fleece	90	54	78	41	89	36	118	44	-	91	-	-	-	-	-	-	-	-	-	-	90.8	53
	90.5	87	80	90	86	68	122	99	122	109	88	170	91	126	68.6	150	86.6	107	71	84	90.7	109
<b>DEMERARA</b>																						
(Tuschen &) de Kinderen	104	132	86	90	85	74	116	82	126	64	79	60	86	50	61	-	88	80	75	34	90.6	74
Uitvlugt	102	60	79	34	86	15	112	16	125	40	81	31	85	44	76	-	68	77	72	26	88.6	38
Leonora	102	33	79	280	69	89	109	90	118	224	132	278	82	231	61	236	77	218	67	97	89.6	178
Versailles	75	493	91	401	82	33	117	133	98	85	88	43	89	82	63	70	74	161	74	41	85.1	154
Schoon Ord	97	45	101	61	87	100	128	119	121	91	89	129	97	198	70	43	82	193	85	89	95.7	107
Nismes	87	188	96	131	92	251	-	-	-	-	-	-	-	-	-	-	-	-	-	-	88.7	190
Wales	110	117	105	83	90	84	114	48	129	67	94	111	87	116	65	80	81	101	87	78	96.2	89
Houston	85	38	93	107	82	520	111	386	-	254	-	-	-	-	-	-	-	-	-	-	89.0	261
Providence Farm	106	230	102	49	78	113	121	119	114	123	92	67	96	245	71	246	87	231	79	208	94.6	163
Diamond	99	72	103	68	84	39	117	38	101	17	87	4	94	110	68	103	66	137	79	156	89.8	74
Ogle	102	258	107	109	96	102	126	144	115	91	91	256	94	255	77	380	92	196	92	280	99.2	207
Vryheid's Inst	81	85	85	92	76	43	98	8	100	0	77	0	75	21	63	106	75	149	57	76	78.7	57
Success	77	106	86	30	79	40	141	11	104	74	77	78	65	75	59	91	72	114	68	65	82.8	68
L.B.Intention	86	84	86	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	86.0	54
Mon Repos	88	28	86	34	108	6	104	15	98	2	78	7	76	71	63	163	73	126	112	21	88.6	47
Lusignan	79	26	87	52	81	47	97	31	95	0	77	2	124	37	67	175	116	105	70	40	83.6	52
Non Pareil	71	115	79	213	79	101	100	88	97	281	78	153	76	119	58	161	69	96	71	23	77.8	135
Enmore	88	380	78	185	82	117	94	55	106	98	89	53	88	35	76	74	77	58	64	31	84.2	109
Hope	72	211	77	227	75	171	105	103	99	121	83	113	74	117	58	91	60	120	64	44	76.7	132
Cane Grove (& La B.Mere)	76	251	69	104	70	143	79	124	-	254	-	-	-	-	-	-	-	-	64	-	71.6	175
	70	110	69	63	62	150	100	111	91	169	83	130	83	82	54	231	67	212	52	133	73.1	139
<b>BERBICE</b>																						
Bath	88	142	87	131	82	119	109	95	102	108	87	89	87	111	65	150	78	139	73	85	85.8	117
Blairmont	82	144	68	60	72	17	73	30	80	44	72	83	74	30	52	77	54	137	54	70	68.1	69
Mara	90	433	70	294	68	98	87	198	114	189	88	255	83	112	60	189	68	148	55	78	78.3	160
Friends	97	397	86	114	100	78	91	117	78	316	67	201	94	258	68	266	75	154	73	267	82.9	217
Providence (& Everton)	94	174	79	76	64	104	95	42	140	54	68	80	75	97	58	87	75	184	57	127	73.5	103
Rose Hall	88	354	85	248	88	204	91	147	100	80	79	96	82	109	53	163	64	141	63	92	79.3	163
Albion	82	456	74	194	69	133	84	99	92	64	84	123	75	144	49	130	56	130	41	51	70.6	152
Port Mourant	82	163	64	109	65	84	76	59	83	61	64	61	70	53	47	55	51	62	42	37	63.5	74
Springlands	73	109	59	85	53	19	63	40	76	30	57	53	58	45	42	91	43	64	32	150	55.3	69
Skeldon	70	77	73	25	66	2	51	2	75	7	76	32	72	52	54	16	63	13	52	52	66.4	28
	81	259	60	114	54	55	72	24	75	74	74	185	87	177	54	157	64	158	50	72	67.1	128
	83.9	218	71.8	132	69.9	79	78.3	76	91.3	91	72.9	117	77.0	108	53.7	123	61.3	119	51.9	100	70.5	116
<b>COLONY</b>																						
	87.5	149	79.6	118	79.3	89	103.1	90	105.1	103	82.6	125	85.0	115	62.4	141	75.3	122	65.3	90	82.3	114



5. The average rainfall for the ten years for the whole Colony is 82.3 inches, or roughly that for the wettest village in England (Seatoller, Cumberland). With a flat coastland heavily planted with "bush", cabbage and coconut palms, it is not to be wondered at that Culicines are so numerous. But if the Colony average is 82", it would be much higher were it not for the lower rainfall in Berbice (70.5") as compared with the other two counties (Essequibo, 90.7"; and Demerara, 85.8").

6. It has generally been assumed, in works on Malaria, that the more the rainfall the higher the malaria in any country because of more Anophelines. It is hoped to show, though only tentatively with the available data, that in the case of British Guiana this is not the case - or at least, that if it may be true in extremes it is very often the reverse where small increases or decreases are concerned. This will be weighed more fully in the discussion at the end, but meanwhile some of the figures pointing to this aspect will be analysed.

7. Essequibo county figures show a high rainfall with a comparatively low malarial rate; Berbice figures reveal a low rainfall with a high malarial percentage; while those for Demerara give a rainfall slightly above the average for the Colony, and yet a high malarial figure. But the Demerara average is hardly a fair one; for this reason. Four estates closed down early in the decade, and three of these (Nismes, Houston & Hope) with only fifteen out of thirty series of figures recorded, show the cases of malaria per thousand respectively as 190, 261 & 175 as averages - that is, three out of five highest averages for the county. Further, all three show figures recorded for 1917, a year which has already been mentioned as an exceptionally bad one for malaria, and indeed, as the malaria for the Colony shows, a higher figure than any of the others. If therefore these estates which did not remain active throughout were excluded from the average, the malarial figure for Demerara would be reduced from that of 117 to 107. ~~More accurately,~~ Were they more accurately averaged - that is, each year averaged on the average of the Colony for the year, good and bad included, the malarial figure for Demerara would be found to be in the neighbourhood of 110 to 112: that is, with a rainfall slightly higher than the average for the Colony, and a malarial figure slightly lower: thus agreeing closely, with the two

other counties, with the suggestion in para 6 above.

8. Figure 8 (over) shows the rainfall for the county of Essequibo for the ten year period, as recorded on the sugar estates, together with the curves for the total and corrected malaria.

9. The total malaria curve bears only a superficial resemblance to that of the rainfall, except perhaps in the years 1920 and 1921: this is not borne out, however, in the corrected curve. A reference to Table II shows that in 1920 there was a general rise in the amount of malaria along the Aroabisce Coast (that is, the coast west of the Essequibo River), particularly at Plantation Anna Regina, the population being little altered from that of the previous year: the corrected curve thus agrees with the total curve. But in 1921 the population of Golden Fleece was reduced by nearly fifteen hundred persons, or nearly a third of the estate population of Essequibo for 1920. Instead of a proportionate fall in the malaria there is an actual increase, the corrected curve not agreeing with the total curve, without any change in the rainfall.

10. Further, while there was an appreciable rise in the rainfall in 1919 there is a marked drop in the malaria. And again, in 1922, there is a notable drop in the rainfall with a heavy rise in the malaria (corrected curve) - despite the closing down of Golden Fleece in that year, and a reduced population in each of the other three estates. This inverse ratio is again evident in 1923, in 1924 and in 1925, during which years there was little change in the number of employed.

11. 1921 and 1922 are interesting years from another point of view. Hampton Court and Marionville were each roughly one-fifth smaller in the latter year, and yet the malarial figures rose considerably. It would almost seem that estate managers are hit both ways: economy demands a reduction in the number of employees: up goes the sickness rate of those that remain, owing to the resulting higher Anopheline rate - a smaller number of persons per infected insect.

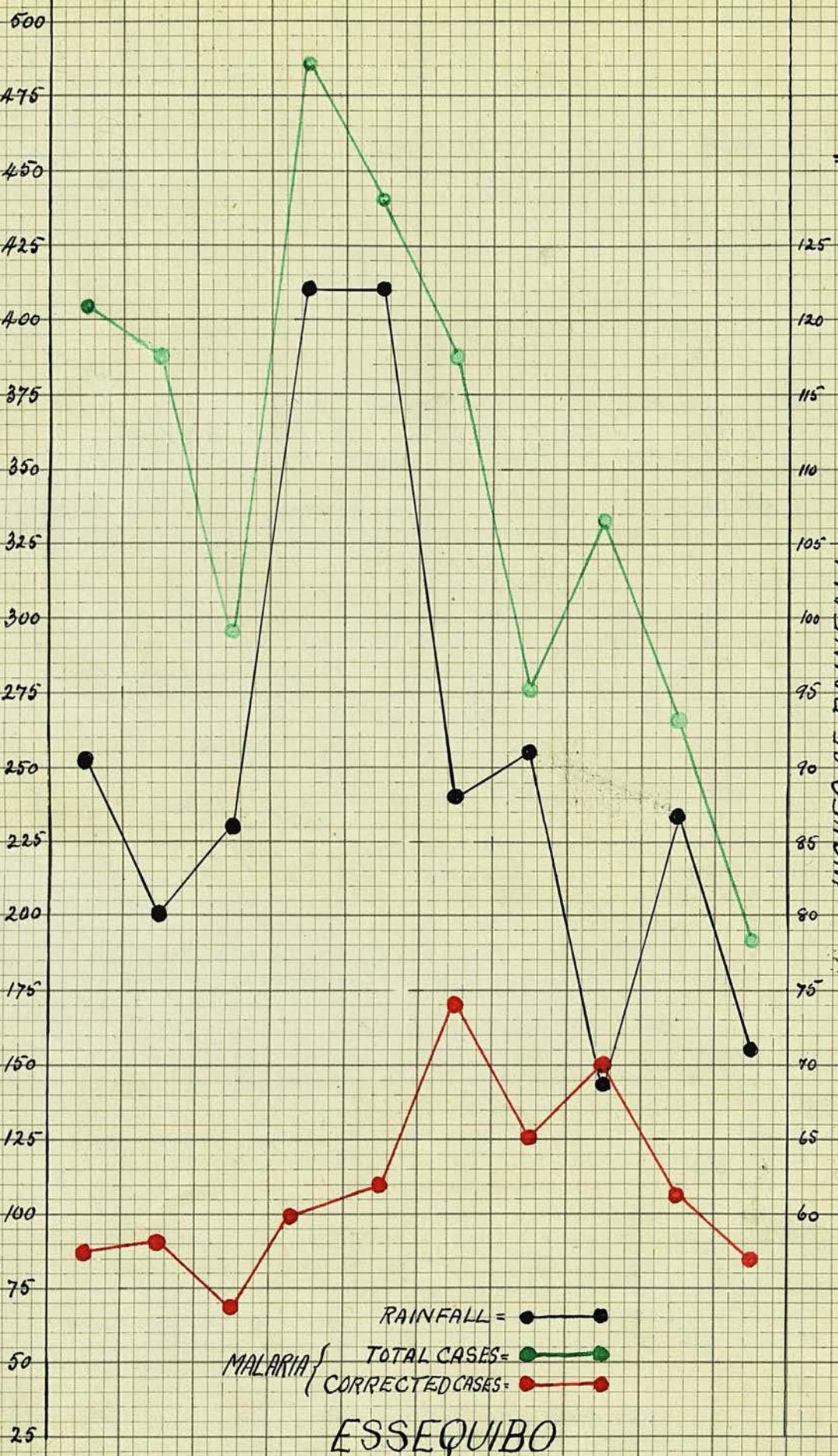
12. The years 1917 and 1926 will be discussed when the graph for the Colony is discussed as a whole.

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG: 8

- CASES OF MALARIA -

- INCHES OF RAINFALL -



RAINFALL = ● — ●  
MALARIA { TOTAL CASES = ● — ●  
CORRECTED CASES = ● — ●

ESSEQUIBO

13. Turning now to the similar graph for Demerara (FIG. 9, over), this inverse ratio between rainfall and malaria is still more obviously manifested, more especially in 1920 and 1924: the higher the rainfall in 1920, the lower appears to be the malaria. Conversely, in 1924, the lower the rainfall the higher the malaria. The same holds good in the years immediately following these two years (1921 and 1925).

14. The corrected curve follows very closely the rise and fall of the total curve (though here it must be noted the scale for each is separate and distinct and drawn thus, merely for the convenience of the graph representation).; and this despite the general lessening of the population and the closing down of a few estates. In the case of Demerara the estates are comparatively close together quite unlike the three on the Aroabisce coast of Essequibo and the fourth on the island of Wakenaam, resulting probably in a less marked effect on individual estates of a gradually reducing population. This will be referred to again when considering the sub-groups.

15. Figure 10 gives a parallel graph for the county of Berbice.

From 1919 to 1925 the inverse ratio between the rainfall and the corrected curve is consistently observed, and markedly so in 1922 and 1924. The outstanding reduction in the malaria between 1917 and 1919, due probably to more local factors, seems to have overcome the slight rainfall variation.

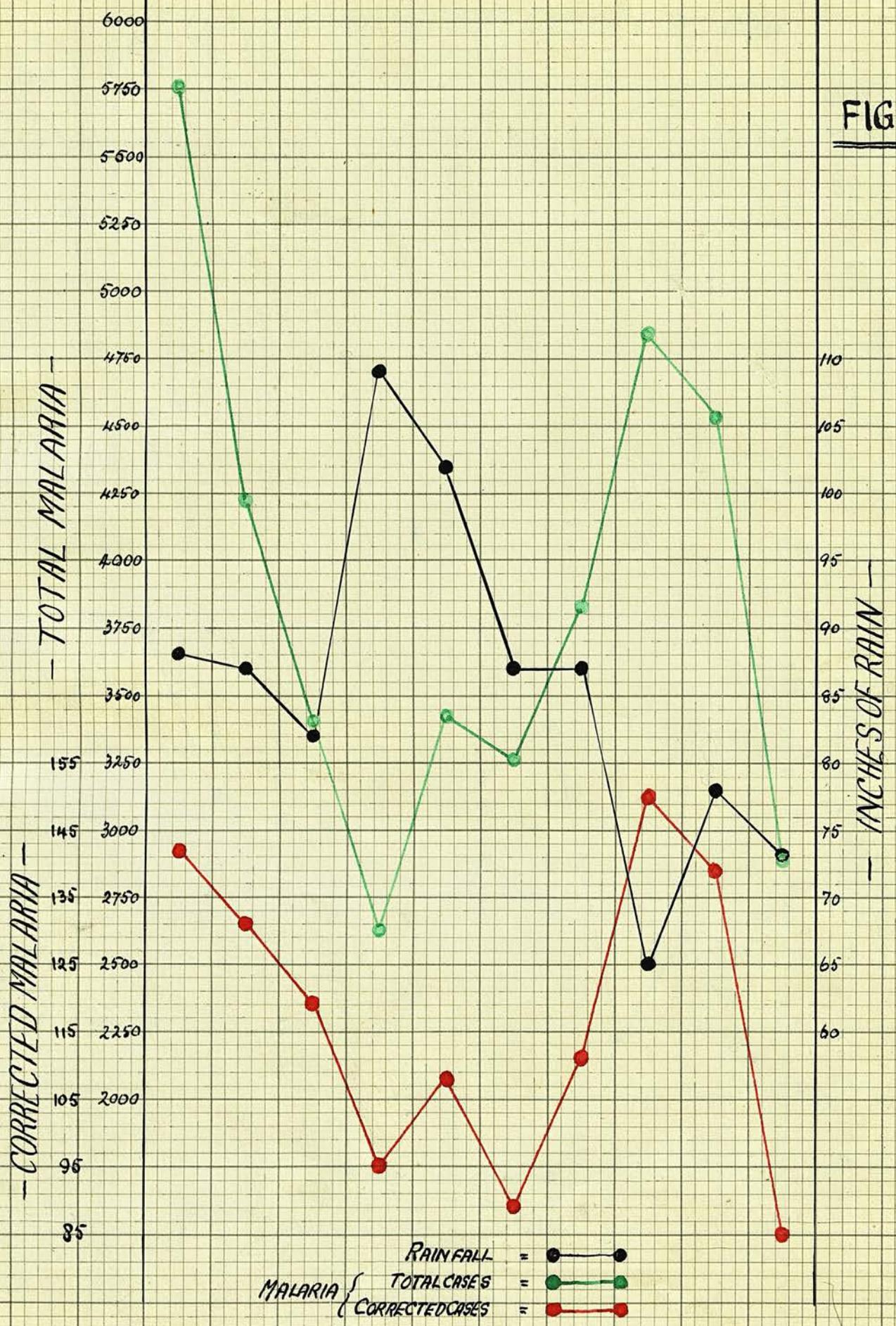
16. 1917 and 1926, as with Essequibo, and also Demerara, will be mentioned later. Though drawn to separate scales, the total and corrected curves compare very closely. No estates closed down during the period under review: the total curve is therefore more representative of the actual malaria in the county.

17. The high malarial figures for 1917 are largely occasioned by three of the estates, namely, Mara (397), Providence & Everton (354) and Rose Hall (456) - that is, nearly forty and fifty percent respectively of the inhabitants sought treatment during the course of the year.

18. The estates in Berbice are much more scattered over the county, or at least its northern parts, than Demerara. More value will result from the study of sub-groups.

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

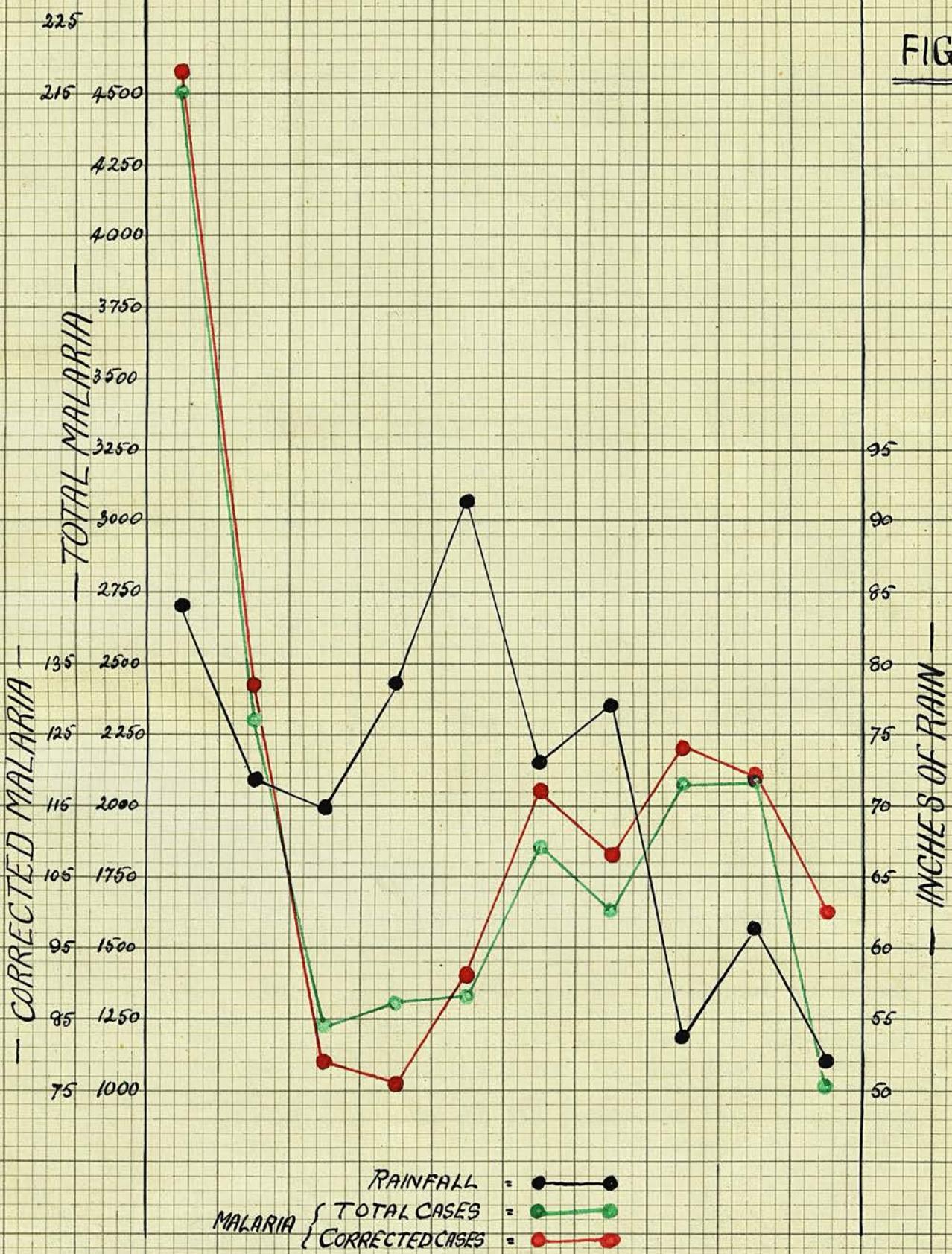
FIG: 9



DEMERARA

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG: 10



RAINFALL = ●—●  
 MALARIA { TOTAL CASES = ●—●  
 { CORRECTED CASES = ●—●

BERBICE

19. The graph for British Guiana (FIG. 11, over) combines those for each county. Perhaps still more graphically is the contrast between malaria and rainfall revealed. In 1921 the three curves run parallel; but it will be seen that the rainfall between 1920 and 1921 varies throughout the Colony, being similar in Essequibo, less in 1921 in Demerara, and more in 1921 in Berbice: the combined average results in the very small annual rise from 1920 to 1921 of two inches of rainfall, hardly warranting the statement, therefore, that it invalidates the argument of the inverse ratio mentioned above.

20. The year 1917 has already been mentioned as exceptional. In Demerara and Berbice the figures for malaria, both total and corrected, are much higher than for any succeeding year. From 1917 to 1919 there is an almost precipitous decline. It is unfortunate that the ten year period initially chosen was commenced in 1917, although the results were not then foreseen. It is hoped, later, to take the preceding decade, as well as the years 1927 and 1928, and then to compare the whole.

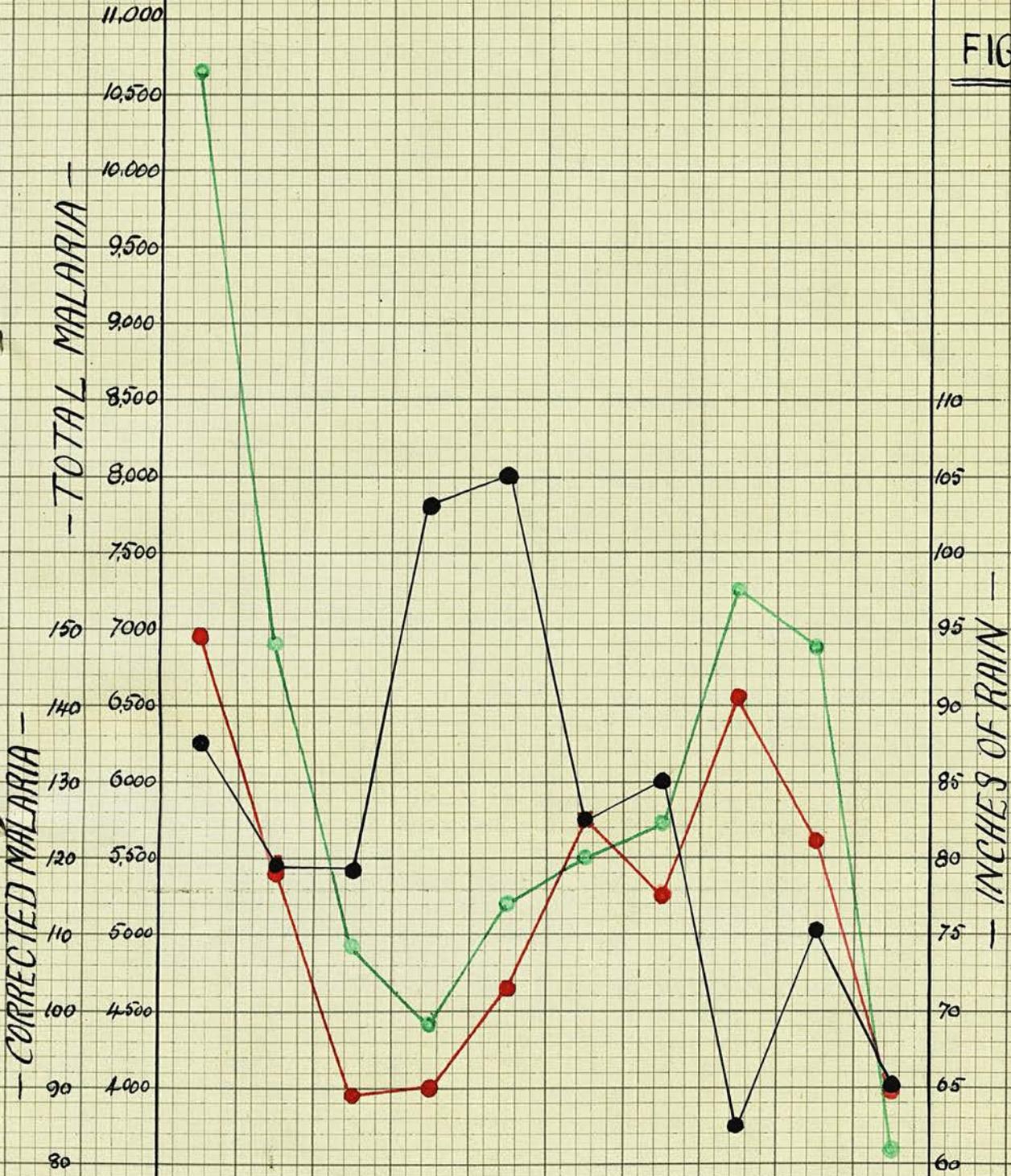
21. If it be true that epidemic waves do pass across the Colony starting from the west, it will be interesting to notice whether a marked increase in the proportion of cases has occurred in the year or years immediately preceding 1917, in view of the exceptional prevalence of malaria in that year in Berbice, and in the high but somewhat less marked figures for Demerara - as though the majority of the epidemic cases were distributed fairly evenly over the latter part of 1916 and the earlier part of 1917 in that county.

22. 1926 has been referred to throughout as a year demanding special reference and consideration. When concerned with Public Hospitals, in sub-section (a), paragraph 16, it was pointed out that an adequate study of conditions in relation to malaria could only be made if the years had been considered as from July to June instead of January to December, in view of the memorable drought which occurred from the latter half of 1925 to the end of the first quarter in 1926. Now that over two years have elapsed the full effects, with the figures for 1927 and 1928, can be studied, and should prove of special value.

23. In Figure 11 both the rainfall and the malaria have fallen, the latter being more marked than the former.

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG: 11



RAINFALL : ● — ●  
 MALARIA } TOTAL CASES = ● — ●  
 CORRECTED CASES = ● — ●

BRITISH GUIANA



In the first half of 1925 the recorded rainfall was high. It is this which has, despite the absence of rain for the last six months of the year, resulted in a nett rise for the year over that which prevailed in 1924. The figures for 1926, will be modified in accordance with the number of inches of rain that fell for the remaining nine months of the year following the end of the drought. This, was low throughout the Colony, only Plantations Schoon Ord (85"), Wales (87"), Diamond (92"), and La Bonne Intention (112"), being over eighty inches. The average for the Colony in 1926 was 65.3", an exceptionally low figure, and only exceeded in 1924 by three inches of rain less (62.4).

24. A comparison between these years, 1924 and 1926, is interesting. In both cases the rainfall is remarkably low, and yet in 1924 the malaria rises to 141 cases per thousand inhabitants on estates, and in 1926 it drops to 90 per thousand. That is, while the former year follows the inverse ratio referred to above, 1926 disagrees. But while in 1924 the rainfall, though low, was equally distributed throughout the year - that is, with normal wet seasons - that in 1926 was restricted to nine months, and in 1925 to six months, with, in between, nine months continuous dry weather. The state of a tropical country, with a normally high rainfall, after such a drought can well be imagined. The face of the country was painted a dead brown instead of the usual brilliant green. Marsh-land, ponds, and many of the roadside canals were completely dried up. The effects on Anopheline breeding must have been pronounced, and continued.

25. Further, if the inverse ratio is correct, the comparatively high rainfall in the first half of 1925 would show a corresponding reduction in the malaria; and this is actually reflected in the total and corrected curves for that year. The full effects of the drought have not yet become manifest. Early in 1926, however, they probably have. And so great is the reduction of Anophelines, following on the top of a lessened malarial rate, that any temporary rise that may have occurred as a result of the lowered rainfall is swamped by the lessened malaria during the closing months of the drought. The end result was a marked drop in the malaria.

26. Turning back to Figure 2, which shows the corrected malaria for in-patients for Public Hospitals, it is seen that the figures for the North

West District, Suddie and Bartica show a rise in the proportion of malaria during 1926; and, as was mentioned in paragraph 16 (sub-section (a)), that these three hospitals are all in the county of Essequibo. While the figures for Demerara and Berbice show a decline in the malaria. It is difficult to interpret this rise in the malarial in-patients when it is not corroborated by the estate figures. That it is restricted to Essequibo is noteworthy. In this county, as Table VII shows, the average rainfall (97.7") is higher than for the other two counties. Further, Essequibo, being much less populated and consequently more heavily planted with "bush", besides having its many villages scattered along an extensive and narrow and well-watered coastland, would doubtless be much less affected by drought than the other counties. Thus in the case of Suddie hospital which receives patients from these villages the rise in malaria would simply follow upon the lessened rainfall. In the case of the estates, on the other hand, whose water supply, as a result of systematic control for the requirements of the sugar industry, would be more strictly limited, the effect of the drought might be more severe on the Anopheline breeding.

27. The enormous rise in the malaria at the North West District Hospital - more than four times the figures for 1925, and much higher than any previous year of the ten considered (being 255 per thousand in-patients), probably depended upon some local cause: but so little is known of that district with regard to malaria, especially its real incidence up the rivers, that any attempt at arriving at a solution would be largely guess-work.

28. It is not impossible that in a drought-stricken district the cases of malaria that do occur may be of exceptional severity - due, not inconceivably, to the bites of fewer but decidedly more vicious infected Anophelines: and as such, a larger percentage of persons attacked would seek hospital treatment. But if this was so there is no reason why such cases should be restricted to Essequibo.

29. Further, in prolonged drought, general health must be affected. Cases normally moderate may show more severe manifestations. But pending more exact information, nothing more definite can be stated.

B. STATISTICAL (contd) - (d) Comparison with 1906-1911.

The Surgeon General (Dr Godfrey) in 1906 began a series of graphs of each of the estates to determine what effects the general distribution of quinine as a prophylactic measure might have on the incidence of malaria. These were added to each year. It was considered sufficient for the purpose to give the average population for the five year period chosen. The total malarial figures only were charted, no correction being made in proportion to the population.

2. This paper has been taken as it stands, without further confirmation. To the figures have been added the annual rainfall on each estate (on many estates at that period this was not taken), and the totals for each county have been added up and averaged - that is, population, total malaria and rainfall.

3. From the start it must be admitted that the malarial totals in many cases appear grossly excessive, and cannot under any consideration be looked upon as actual independent cases of malaria. For example, on no less than five estates during 1906-1907 (the years were not then counted from January to December) the recorded malaria figures exceed the actual average estate population, while in seventeen others they exceed fifty per cent of it. A few examples may be chosen of the former -

Plantation Friends:	pop. 714; malaria, 960:
"	Lusignan: pop. 2631; malaria, 2925:
"	Leonora: pop. 2174; malaria, 2434:
"	Marionville: pop. 927; malaria, 1186.

4. What may have occurred is that in view of the prophylactic measures about to be started all employees who were/or had recently suffered from fever were advised to report for treatment. And having done so once, would probably repeat their visit on one or more occasions during the year. In this way the abnormal figures would be obtained. But until this has been ascertained, and the malaria figures previous to 1906 studied a definite reason cannot be given.

5. Quinine was not administered on all the estates in 1906, but a number at later periods in the half decade. Ten estates in Demerara and one in Berbice commenced prophylactic treatment in 1906; one (Albion) in 1908; two in Demerara, two in Berbice and four in Essequibo (Taymouth Manor was then active) in 1909;

suffering/

and ten in Demerara, one in Essequibo and six in Berbice only commenced in 1910-1911.

6. It was emphasised in the Report that the beneficial effects of this treatment were very marked despite the greatly increased rainfall in the later years! It would be very interesting to know whether this noticeable reduction, especially in 1910-1911, when all of the estates were under the influence of quinine, was entirely due to that drug, or whether the very fact of the increased rainfall had not something to do with it in accordance with the suggestion outlined above that malaria decreases with increased rainfall, within limits, and vice versa. Table VIII is given below-

TABLE VIII. SHOWING AVERAGE (FIVE YEAR) ESTATE POPULATION, MALARIA AND RAINFALL BETWEEN 1906-1907 AND 1910-1911, FOR EACH COUNTY.

1906-1907		1907-1908		1908-1909		1909-1910		1910-1911	
M	R"	M	R	M	R	M	R	M	R
<u>ESSEQUIBO.</u>		Average (5yr) estate population - <u>1,387</u> (5)							
1237	130	683	91	855	110	856	98	765	109
(5)	(4)	(5)	(4)	(5)	(4)	(5)	(5)	(5)	(5)
<u>DEMERRARA.</u>		Average (5yr) estate population - <u>1,525</u> (22)							
1042	127	784	104 <sup>x</sup>	814	88	724	107	508	104
(22)	(10)	(22)	(10)	(22)	(8)	(22)	(22)	(22)	(22)
x Includes Rainfall for Providence - 175" ? error.									
<u>BERBICE.</u>		Average (5yr) estate population - <u>1,089</u> (10)							
670	106	728	88	601	88	708	95	621	104
(10)	(9)	(10)	(9)	(10)	(9)	(10)	(10)	(10)	(10)
<u>COLONY.</u>		Average (5yr) estate population - <u>1,334</u>							
983	121	732	94	757	95	763	100	631	106

NOTE:- The numbers in brackets refer to the number of estates from which the average was taken.

7. Although this work has been referred to, as being practically the only previous statistical research of any kind on the subject of malaria, it is realised that until the reasons for these high figures have been made clear little can be extracted from them. Certainly, if the suggestion made in paragraph 4 that they were the definite result of a special appeal to the coolies is correct, it would be natural to expect a falling off of attendances at the estate hospitals with each succeeding year, and so a drop in the malaria figures irrespective of the real incidence. Otherwise, for all three counties, there is both a decline in the malaria and the rainfall over the first two years. In the next two years there appears little relation *between* them, although with Demerara the inverse ratio holds good. In 1910 to 1911, however, there is in each county a definitely lower malarial figure with a noticeably higher rainfall.

8. Granted that the figures are abnormally high, there can be no question that there used to be very much more malaria at this period on sugar estates than there is to-day. The term malaria must be used with caution, really, when considering those earlier figures. "Fever" or "Febricula" would be nearer the mark; and many cases other than malarial ones would be included - the fever from Ancylostomiasis, for example, which is too often overlooked, and which is all too prevalent.

9. The rainfall, too, appears on the average to be persistently higher than that which obtains in the more recent period under review. The steady clearing of the bush and the increase of the acreage under rice might be natural factors in reduction.

10. While it has been suggested that malaria, within limits, varies inversely as the rainfall it is not assumed that the mean is constant. Where in Essequibo for example the rainfall is steadily maintained at a higher level than that in Berbice it need not follow that the malarial rate for Essequibo must necessarily be less than that for Berbice: rather, that within a district with an equivalent range of rainfall the malaria will alternate inversely within that range. So, in the earlier period discussed, where both the malaria and the rainfall are materially higher than is the case in more recent times they may yet vary inversely on their own higher level. Much more work will have to be done, however, before this can be removed from the sphere of conjecture.

B. STATISTICAL (contd) (e) Local Considerations on Estates -

Division of the estates into a large number of small groups for separate consideration may hardly seem justified when only the crude figures relating to population, rainfall and malaria are available. But where in many cases the average figures for a county are appreciably modified by one or two individual estates in a limited part of the district, this becomes necessary. This division, however, was really intended not merely for these figures but ultimately for a complete malarial survey bringing all important factors into consideration, such as population in relation to acreage, house and bush and water acreage, and also Anopheline, parasite and splenic indices, and so on, which have as yet hardly been attempted. Further, in view of the suggestion that malarial incidence is affected, within limits, inversely with the rainfall, a study of estates individually is vital in corroboration with the county findings. The effect of local environment is also discussed.

2. Much of what is to follow in this sub-section must necessarily at present be based largely upon observation and odd notes, as a result of occasional visits to the district in question, rather than on measured evidence. Frequently, estate plans are hopelessly out of date: often there are none, or at least not obtainable through the usual channels. But little of value from existing plans can be extracted from the point of view of malarial research, except possibly house acreage. It is hoped later on to have such plans drawn up primarily for this purpose: this is referred to in the last section.

3. In sub-section (b), paragraph 7, the estates were divided into two large groups, three smaller groups, and two somewhat isolated estates. It will be more convenient to treat these after sub-division, and starting from the west of the Colony. Below is a list of such Groups:-

A. Aroabisce Coast (Essequibo).

Hampton Court		(1st smaller group).
Anna Regina		
Golden Fleece		

B. Island of Wakenaam (Essequibo River).

Marionville		(1st isolated estate).
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C. West Coast(Demerara).

Tuschen & de Kinderen  
 Uitvlugt  
 Leonora

|| (2nd smaller group).

D. West Bank(Demerara).

Versailles  
 Schoon Ord  
 Nismes  
 Wales

E. East Bank(Demerara).

(Ruimveldt)  
 Houston  
 Providence  
 Farm  
 Diamond

|| (1st larger group).

F. East Coast(Demerara).

Ogle  
 Vryheid's Lust  
 La Bonne Intention  
 Mon Repos

G. East Coast(Demerara).

Lusignan  
 Non Pareil  
 Enmore  
 Cove & John  
 Hope

H. East Coast(Demerara).

La Bonne Mere )  
 Cane Grove )

I. West Coast(Berbice).

Bath  
 Blairmont

|| (2nd larger group).

J. East Bank(Berbice River).

Mara

|| (2nd isolated estate).

K. East Bank & Canje Creek(Berbice).

Everton & Providence  
 Friends

|| (2nd larger group, contd).

Rose Hall		
<u>L. East Coast</u> (Berbice).		(2nd larger group,Contd)
Albion Port Mourant		
<u>M. Corentyne River</u> (Berbice).		
Springlands Skeldon.		(3rd smaller group).

4. In each Group is given the total population irrespective of any decline in the actual number of estates forming that Group owing to closing down; the total number of malarial cases occurring; the average rainfall for the district comprising the Group; and the corrected malaria figures - cases of malaria per thousand of the Group population. Graphs (FIGURES 12 - 24) are included for each Group, showing these figures. The importance of an individual study of estates will be seen in the remarkable way in which the figures vary in each Group, as represented on the graphs.

5. Each Group will be discussed shortly, on the same plan, and mostly in more or less note form.

Naturally, it has not been possible to visit all of the estates: others again have had but a cursory inspection: while the few have been studied more closely.

6. Examination of some of the children on estates, or in villages adjoining them, has been made, but the consideration of clinical matter will be left to a separate section (Section C).



GROUP A. Aroabisce Coast (Essequibo County).(1) HAMPTON COURT. (2) ANNA REGINA. (3) GOLDEN FLEECE.

Average Annual Population	-	2899.
"	"	Malaria - 242.
"	"	Rainfall - 89.4 inches.
Corrected Malaria	-	83 per thousand.

At one time very flourishing, these estates have found it increasingly difficult to keep going. Golden Fleece closed down in 1921; Anna Regina has just closed (1928); Hampton Court will probably close soon. Possibly due increased cost of transport as compared with other estates nearer Georgetown.

Anna Regina about twice the acreage of Hampton Court which adjoins it. Golden Fleece further east, and separated by villages which occur at intervals all along this coast. One of these - Taymouth Manor - was formerly an estate.

All three estates fully exposed to Atlantic breeze, which is often very strong, although estates are slightly sheltered by narrow strip of trees and bush between main road and shore.

Land quite flat. Anna Regina particularly is not infrequently flooded along coast by spring tides. There is, too, a wide open stretch of land in front of this estate with practically no bush; generally mud. This must reflect advantageously on estate in comparative freedom from Anopheline breeding. The malaria per thousand for this estate averages only 91 cases (Table VII). Golden Fleece similar. Much more bush around Hampton Court (115 per thousand).

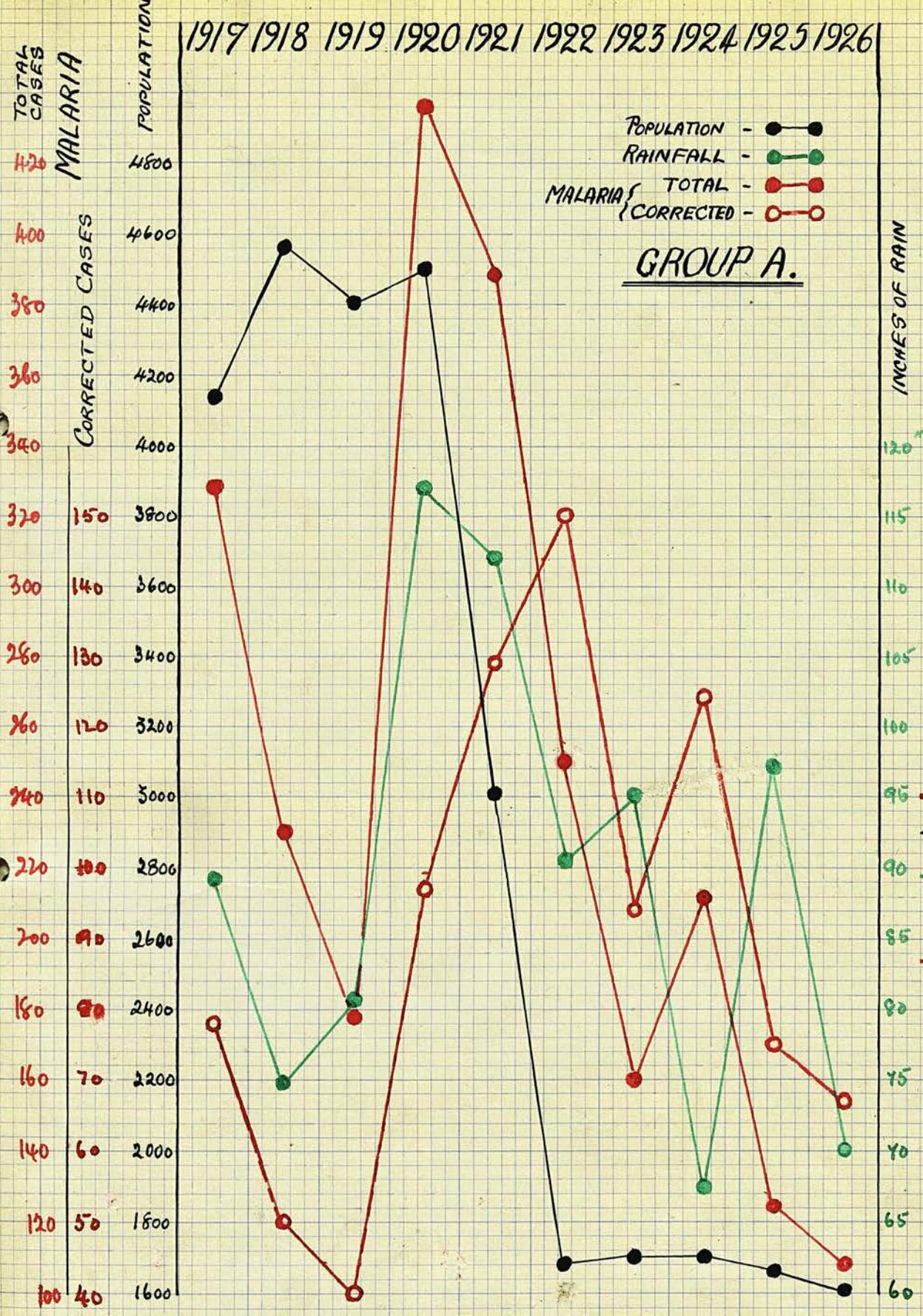
Graph (FIG. 12) shows marked effect of closure of Golden Fleece on Population curve. Total malaria drops proportionally: not so the Corrected curve - due partly to figures for Hampton Court being no longer affected by low malaria of Golden Fleece.

Rainfall agrees closely with that for Essequibo county (FIG. 8). Exceptional rise in 1920 - 1921 shows accompanying rise in malaria (Total curve); but corrected curve continues to rise in 1921 & 1922 despite decline in rainfall, and continues inversely till 1925 - 1926. Especially noticeable in 1924.

1917 and 1926, two exceptional years, have already been mentioned in paragraphs 20 to 23 of the preceding sub-section.

Despite the steadily maintained population between 1922 & 1926, the malaria varies appreciably. Very suggestive here that rainfall plays predominant part in deciding incidence.

FIG:12



GROUP B. Island of Wakenaam (Essequibo River).MARIONVILLE.

Average Annual Population	-	798.
"	"	Malaria - 105.
"	"	Rainfall - 94.7 inches.
Corrected Malaria	-	131 per thousand.

Over six thousand persons reside on this one island in the Essequibo River: somewhat less on an adjacent island (Leguan) where rice cultivation is the predominant occupation. Where, on Wakenaam, there were formerly seventeen estates, there is now but the one remaining active. The estate includes the centre third or half of the island.

There are many villages round the island, especially the western side, where Plantation Marionville is chiefly situated. Apart from the actual cane fields most of the island is covered with bush, often dense bush in the interior. Very flat, the land is generally swampy and mosquitoes are abundant. Nearly every child is "big-bellied" with an enlarged spleen. Hookworm is rife also.

The northern wider end is mostly sandy: in fact, with many of these islands sand is taking the place of earth (clay) by degrees. This should ultimately be beneficial and reduce Anophelines. There is less malaria among the school-children at Zelandia, a village at the north-west corner of the island, than elsewhere. This will be dealt with fully in the next section. Northern end also more wind-swept.

Graph (FIG. 13) shows a steadily lessening population from 1917 to 1924. Increase in 1925 due to more land being put under cultivation. No proportionate reduction in total malaria; actually an increase. Corrected curve agrees closely with total curve, the proportion showing higher than the total. This occurs frequently in other Groups. Almost seems as if amount of malaria is independent of population, or finds its own level irrespective of rise or fall in population.

Rainfall is heavy; fourth highest in Colony. With this there is comparatively high malaria (139 per 1,000), but at this higher level the drop in the malaria with rise in rainfall is very noticeable, even including the exceptional rainfall of 1920 & 1921, and including the year 1926.

It is probable that the Government Medical Officer normally resident on the island will soon be withdrawn, and a Dispenser substituted, as a measure of economy. The estate may also soon be closing down. If so, rice cultivation may take its place.

MALARIA { TOTAL & CORRECTED

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

POPULATION

1200

1150

1100

1050

1000

950

900

850

800

750

700

650

600

550

500

140

135

130

125

120

115

110

105

100

95

90

85

80

75

70

65

60

POPULATION ●—●

RAINFALL —○—

MALARIA { TOTAL \*—\*

          CORRECTED -○-

GROUP B.

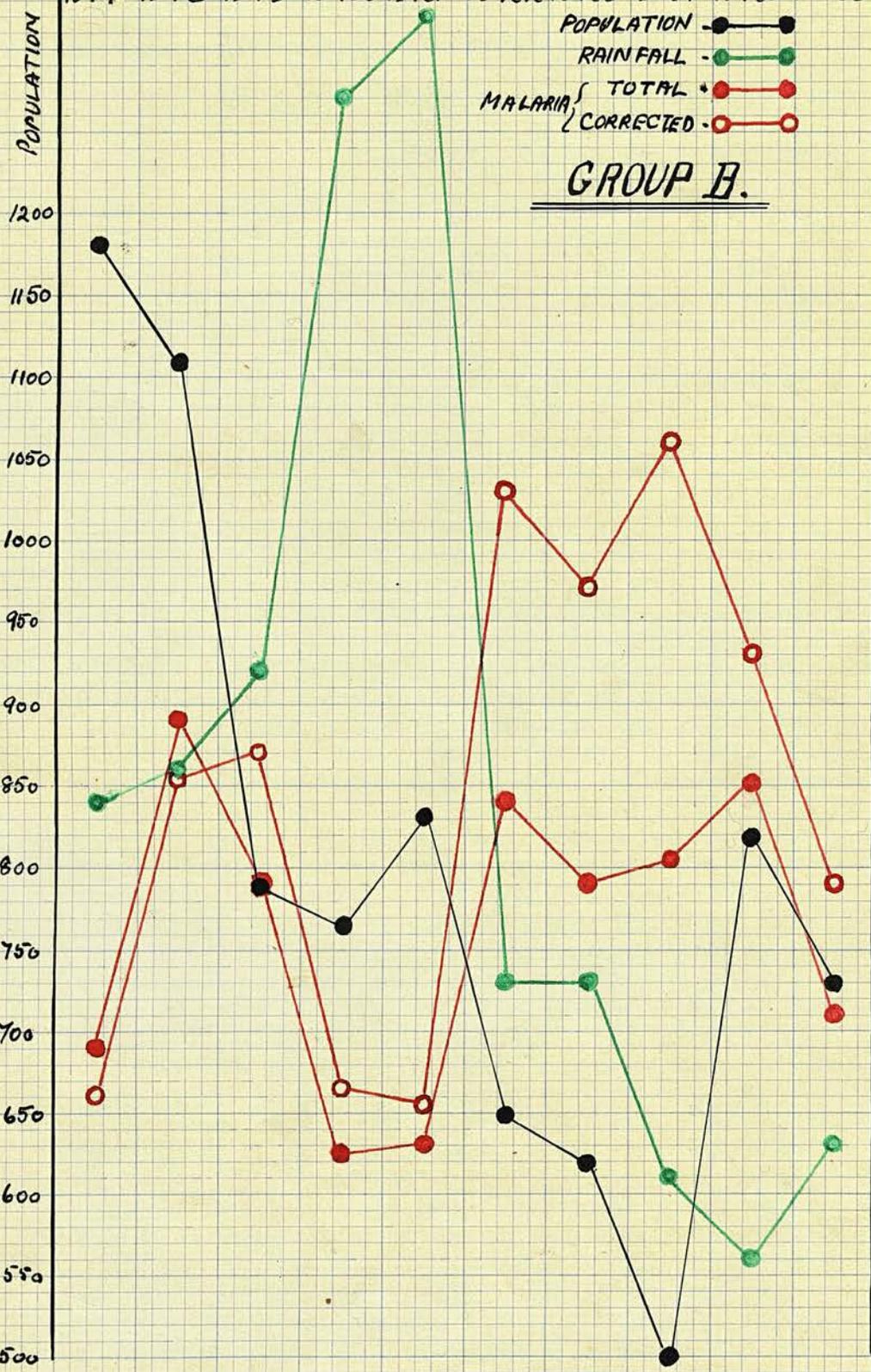
FIG: 13

95 —○— 94.7"

131 —○—

798 —●—

105 —●—



GROUP C. West Coast (Demerara County).(1) TUSCHEN & de KINDEREN. (2) UITVLUGT. (3) LEONORA.

(Uitvlugt, pronounced Eye-fluct).

Average Annual Population	-	10,004.
" " Malaria	-	803.
" " Rainfall	-	89.6 inches.
Corrected Malaria	-	80 per thousand.

This Group of estates lies nearly midway between the Essequibo and Demerara Rivers and on the curve of the coast-line directly facing the prevalent wind-north-west. At the same time the land between the two rivers is thickly set with bush. A train journey from Vreed-en-hoop, directly opposite Georgetown on the west bank of the Demerara river, to Parika at the mouth of the Essequibo river, will soon reveal this, the line cutting through bush nearly the whole way.

These estates are fairly flourishing - comparatively - and the buildings and adjacent lands in good state of repair. The banks of many of the canals are regularly cleaned, and the populated parts of the estates fairly well cleared of bush, though not as much as they might be. This is far from being the case, however, with the intervening villages, which are set in the midst of bush, where sanitation is far from good, and where swampy areas are frequent.

Many of these areas with stagnant water are artificial, having been caused as the result of making road surface material - "burnt earth". Clay is dug from such an area and stacked near-by: covered with logs and set alight. But the areas have not been filled in afterwards, and water soon accumulates.

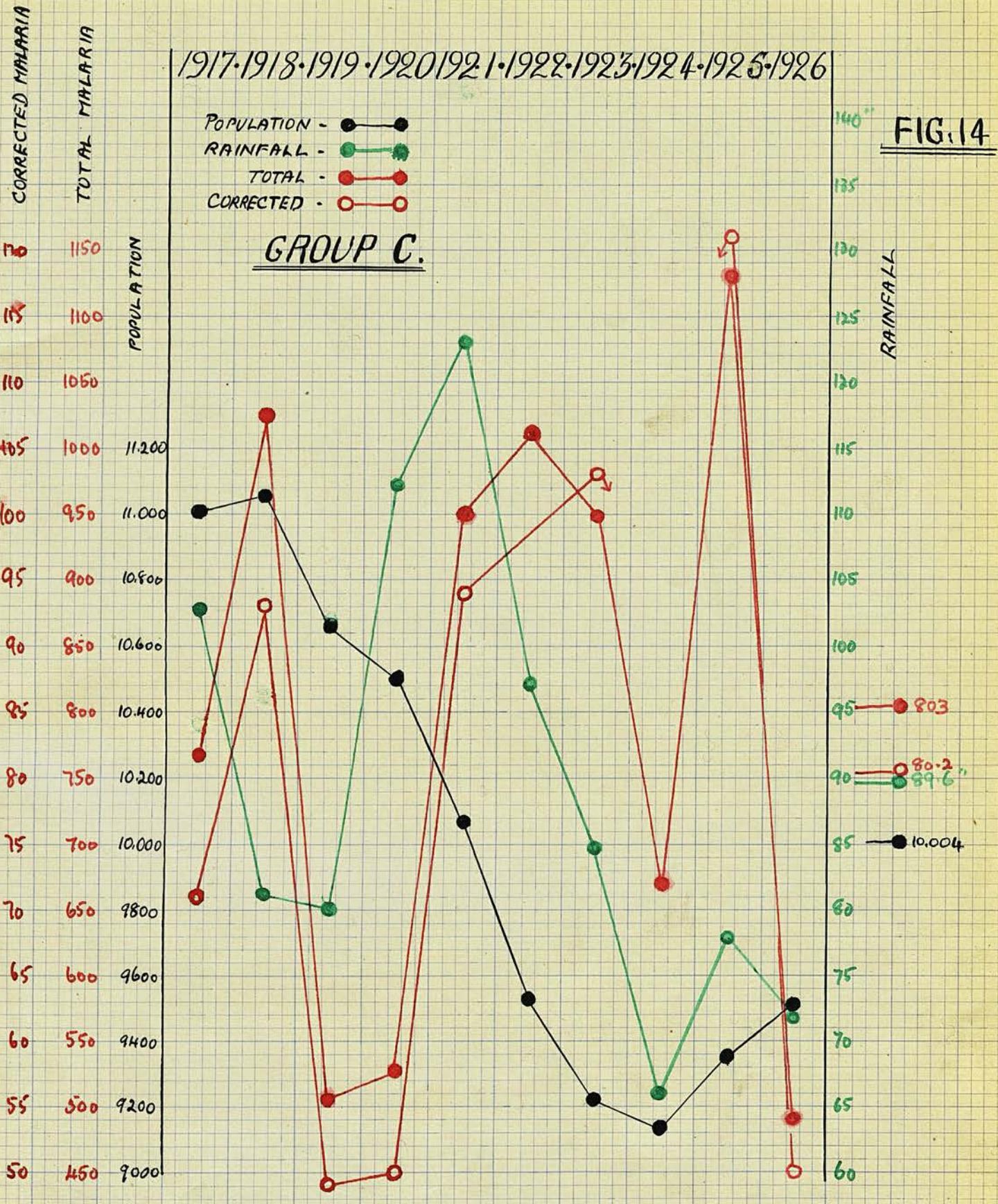
FIGURE 14 shows a fairly steady decline in the population without a corresponding drop in the malaria. This graph is difficult to interpret. Due, probably, to fact that it is a combination of estates showing markedly different malaria figures: e.g., Corrected average for Uitvlugt, 38; for Leonora, 178 per 1,000. The 1921 rise in malaria is due entirely to Leonora (224 per thousand), de Kinderen & Uitvlugt being 64 & 40 per 1,000 respectively; and is maintained by Leonora in 1922 (278 per 1,000). Separate graphs of each show inverse ratio, except Leonora for 1922 where extreme rise in rainfall (132") shows also rise in malaria, rainfall for other two being 79" & 81". This marked difference in rainfall between adjacent estates peculiar: needs checking. Leonora's much higher malaria incidence may be due its being nearest to Group C.

1917-1918-1919-1920-1921-1922-1923-1924-1925-1926

FIG. 14

- POPULATION - ●—●
- RAINFALL - ●—●
- TOTAL - ●—●
- CORRECTED - ○—○

GROUP C.



95 —●— 803  
 90 —○— 80.2  
 85 —●— 10.004  
 80 —●— 89.6

GROUP D. West Bank (Demerara County).(1) VERSAILLES. (2) SCHOON ORD. (3) NISMES. (4) WALES.

Average Annual Population	-	2715.
"	"	Malaria
	-	311.
"	"	Rainfall
	-	91.4 inches.
Corrected Malaria	-	115 per thousand.

Plantation Wales is nearly three times the size of any of the other three estates: better upkeep is also maintained. Wales is perhaps a slight exception to the general statement (on a ten year basis) that estates along the banks of rivers show a higher degree of malaria than those situated along the actual coast land of the Colony. This is appreciated on looking at the map of the Colony (frontispiece) showing a ten year average of the malaria.

Though Wales has highest rainfall of the four estates (96.2") it has the lowest malaria (89 per 1,000); while Versailles with lowest rainfall (85.1") has the highest (excluding Nismes, which is averaged on three years' figures only including the generally high 1917) malaria (154 per thousand); Schoon Ord coming between with slightly less rainfall than Wales (95.7") and slightly more malaria (107 per 1,000).

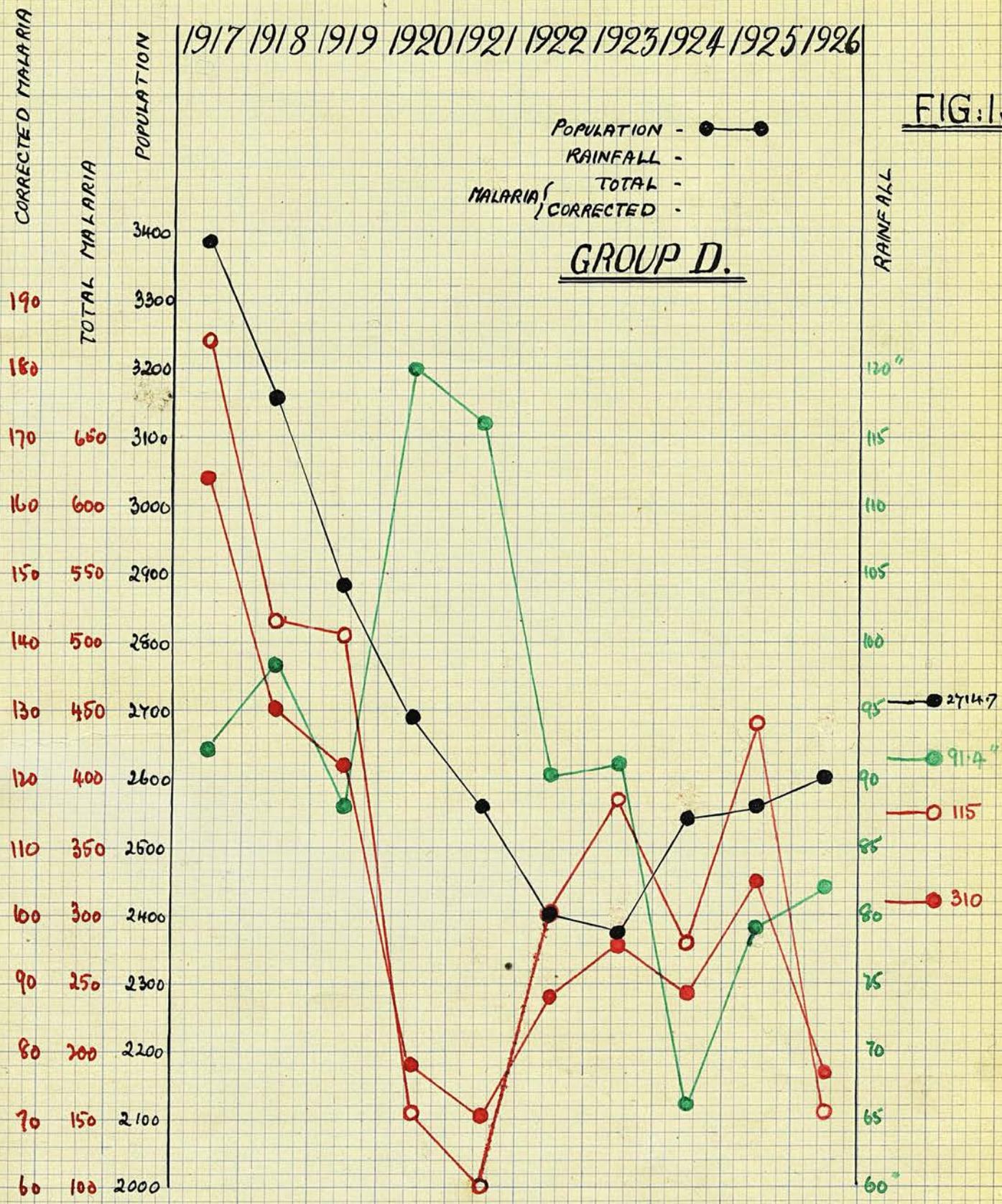
The three smaller estates (Nismes was closed in 1919) were never particularly flourishing, and have always shown a high malarial rate. 50% of the population of Versailles in 1917 were recorded as suffering from Malaria. The country is very marshy, bush is everywhere and mosquitoes extremely prevalent. Most of the canals need cleaning; banks are sadly overgrown: a lack of repair everywhere, though less so with Schoon Ord. The inhabitants of the villages are obviously poor, and spleens are prominent.

FIGURE 15. shows some relation between the declining population and malaria, as also during the increase in the last four years; but practically all estates show this increased malaria then.

Rainfall curve follows curve for Demerara (FIG. 9) moderately closely. There is slight rise in 1926 which is unusual. Occurs also with Group E - estates on opposite bank of river, but in no others in Demerara.

Inverse ratios shown in almost every year, including 1917 & 1926, markedly so (as with Group B - Marionville) in 1920 to 1921 - so definitely as to be almost conclusive: must, however, be corroborated with temperature & humidity. Marked decline in malaria in 1920 probably influenced also as result of closure of Plantation Nismes in 1919. - i.e., removal of worst estate (190 per 1,000).

FIG. 15





GROUP E. East Bank (Demerara County).

(1) HOUSTON. (2) PROVIDENCE. (3) FARM. (4) DIAMOND.

Average Annual Population	-	7031.
"	"	Malaria
	-	1160.
"	"	Rainfall
	-	93,2 inches.
Corrected Malaria	-	166 per thousand.

RUIIMVELDT separates these estates from Georgetown (Sub-section (b), paragraph 12).

Plantation Diamond is largest estate in Colony, over 7000 acres being under cultivation. The smallest, Houston (under 500 persons), closed down in 1921.

Although these estates on the map are shown as extending to river bank there is a thick belt of trees and undergrowth separating houses from water's edge. Main road cuts through or passes nearest areas to river; either side of this is fairly clear of bush. The nethermost parts ("aback" of the estates) are set right in midst of bush. Plantation Farm is certainly more free from bush than remainder.

Estates as a whole are in good condition; waterways kept clean and sanitary measures ensured in the coolies' dwellings; many of older type ranges (rows of one or two roomed houses) being replaced with modern detached huts.

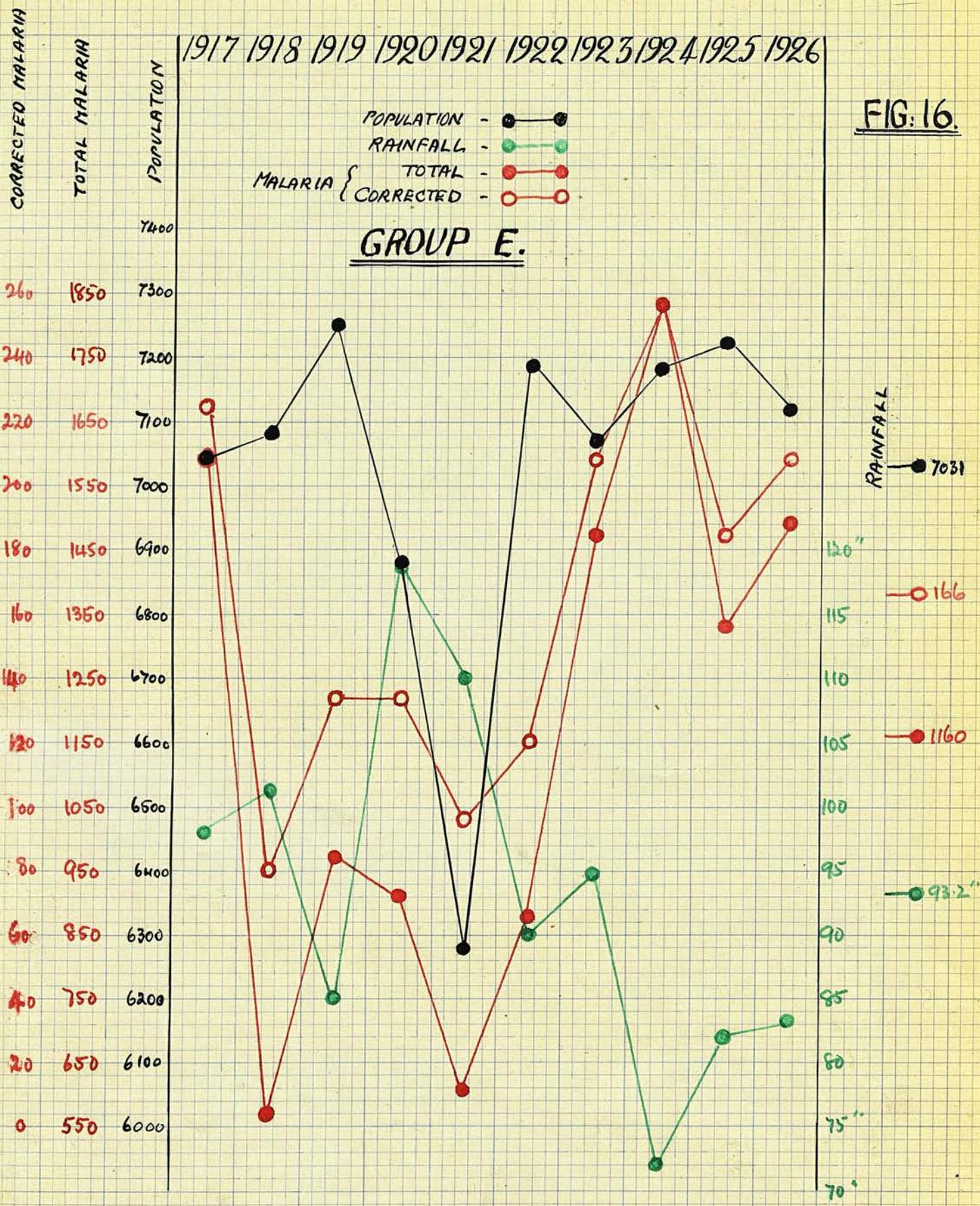
Graph (FIG. 16) shows steady population except 1920 & 1921; reduction chiefly in Providence & Diamond.

Rainfall similar to Group D on opposite bank. Increasing rainfall in 1920 seems to act as check on rising malaria in 1919, but steady reduction in rainfall between 1920 & 1924 shows exactly parallel rise in malaria during that period, again checked by rising rainfall in 1925.

1919 to 1922 is interesting. Malaria tends to show more gradual curve and fall than rainfall, so that curves run parallel in 1920-1921. Also shown in Group F (FIG. 17, over). Half year curves would probably show this better. Malaria seems to take slightly longer to recover upward curve - that is, infection takes longer to spread, than time taken for rainfall to show change from high to lower. Thus (1922 to 1923) malaria curve is still rising as result of marked fall in rain curve (1921-1922), though latter has again begun to rise in 1923. The 1922-1923 curves thus run parallel. The exact reverse is seen in 1919 to 1921, where the 1920-1921 curves run parallel. This may possibly account for some of the divergence of opinion existing as to rainfall in relation to incidence.

The low figures for Farm (74 per 1,000) are masked by the higher malarial rates for the others.

FIG. 16.



GROUP F. East Coast (Demerara County).(1) OGLE. (2) VRYHEID'S LUST. (3) LA BONNE INTENTION. (4) MON REPOS.

Average Annual Population	-	5494.
" " Malaria	-	316.
" " Rainfall	-	83.9 inches.
Corrected Malaria	-	58 per thousand.

This Group has been separated off from Group G because a large village, Buxton, separates them. This village (or town almost, being third largest in Colony) is somewhat congested and closely set with houses, and probably compares in malarial prevalence with a position midway between these two Groups.

It is not easy to state quite why these estates in Group F have uniformly low malarial figures (57, 68, 47 & 52 per 1,000 respectively), as compared to the generally higher figures in Group G, unless because much more exposed to Atlantic wind. Group F have only open lands between sea & estates, and face more N. West. Group G are further round the coast and separated by a thick belt of bush. Group F., further, comes within Group III previously mentioned in Sub-section (b), paragraphs 35 et seq., as being estates with populations of 1,000 to 2,000 (Mon Repos being slightly under), and showing the lowest malarial rates. Group G, on the other hand coming in Group IV, showing the highest. A possible explanation was there given.

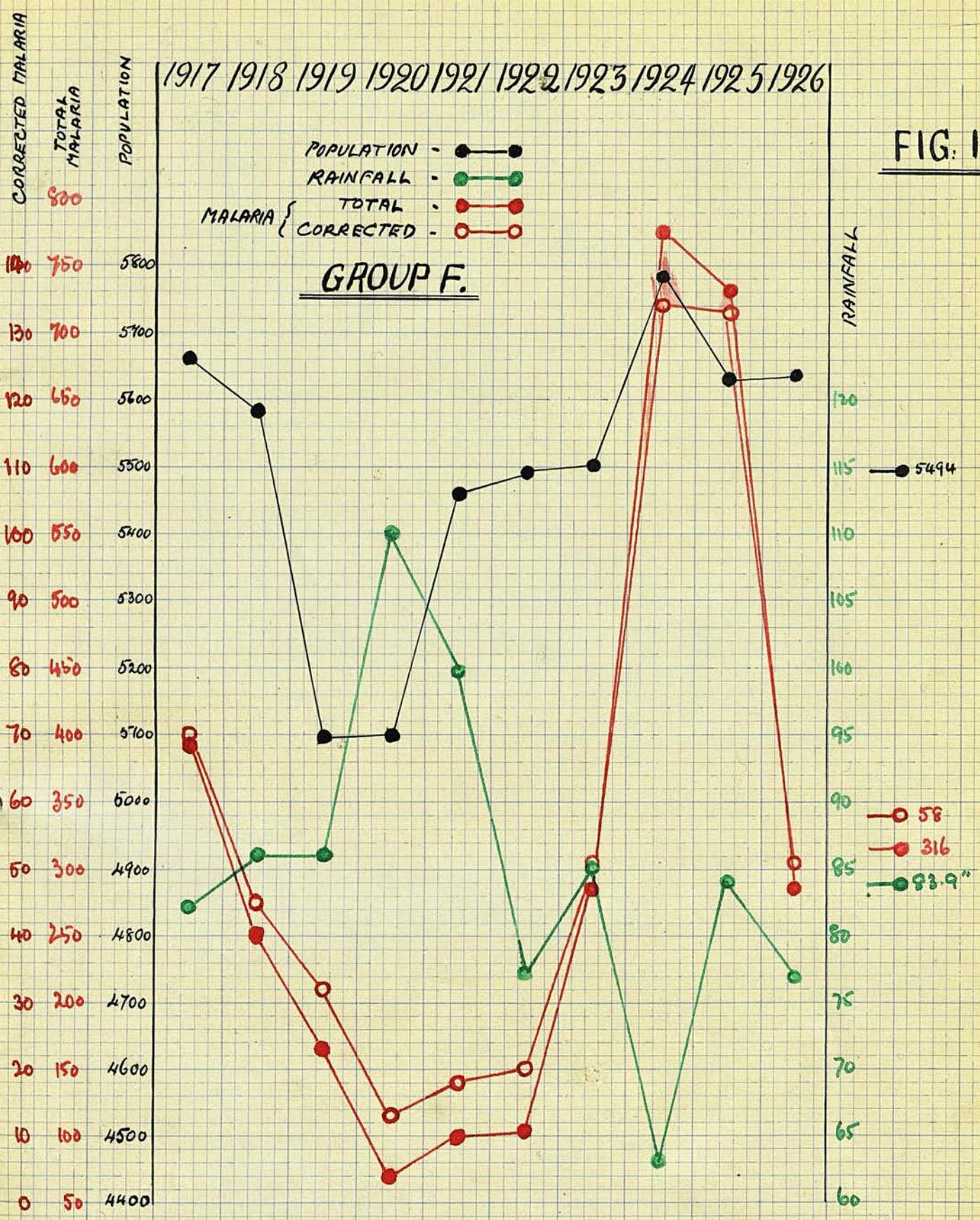
FIGURE 17 shows fairly steady population, the malaria tending to correspond on the whole; but irrespective of population Total & Corrected curves are closely comparable, suggesting malarial level independent of population (as in Group B, para. 4).

High rainfall - low malaria (& vice versa) is clearly manifested. Following the sharp rise in malaria in 1924, with the equally sharp drop in the rainfall, the delayed fall is again seen resulting in parallel curves in 1925-1926; although the latter year must be treated with caution in view of the drought.

Although figures have been charted exactly as obtained from Reports, it seems hardly possible that for two consecutive years at Plantation Ogle there should have been only one person with sufficiently severe malaria as to require hospital treatment. Similarly at Mon Repos. It is possible that the cases have been classed under another heading, though this was searched for. L.B. Intention, however, shows but seventeen cases for the same two years.

Further study is necessary to account for low average.

FIG. 17.



GROUP G. East Coast (Demerara County).

- (1) LUSIGNAN. (2) NON PAREIL. (3) ENMORE. (4) HOPE.  
 (5) COVE & JOHN.

Average Annual Population	-	8641.
" " Malaria	-	1094.
" " Rainfall	-	78.5 inches.
Corrected Malaria	-	127 per thousand.

Hope and Cove & John became inactive in 1921, the hospitals also closing. Both were small estates, with rapidly declining population. That of the other three each came within the 2,000 to 3,000 group (GROUP IV). Non Pareil with the highest rainfall of the three (84.2") shows the lowest malaria per 1,000 (109); while Lusignan & Enmore with similar rainfalls much lower than Non Pareil (77.8" & 76.7") each show high malarial figures (135 & 132 per 1,000). Hope, while active, averages the lowest rainfall of all (71.6") and the highest proportion of malaria (175). Figures, all of them, which reveal a marked fidelity to the inverse ratio propounded. (Cove & John estates had no separate rainfalls recorded: they were adjacent to Enmore). But this ratio is on a much higher malarial level than that obtaining for Group F.

Why there should be so high a malarial rate is uncertain. Reasons have already been suggested under Group F. The three large estates are all well run, though there is a tendency to over-economise. The average, however, is not so high as the river estates (Groups D & E).

FIGURE 18 shows gradual & slight decline in population, due less to Lusignan & Non Pareil than the other three. Malarial curves roughly agree, but approximation between Total & Corrected curves shows comparative independence.

Rainfall is similar to, but varies slightly from, that in Group F. The exceptional rise in 1921 of the malaria is due to the Lusignan figure (281 per 1,000) which is more than three times that in 1920, and seems suggestive of error or some special appeal to the labourers to attend for treatment. Such is quite likely, and frequently happens, especially when another doctor has replaced the former one and shows renewed keenness. It is noticeable that the rise occurred in the same year as the closing of Hope, & Cove & John. Otherwise it must be considered as disagreeing with the theory.

A full investigation into the causes why these two Groups (F. & G.) should so markedly differ will probably prove of special interest.

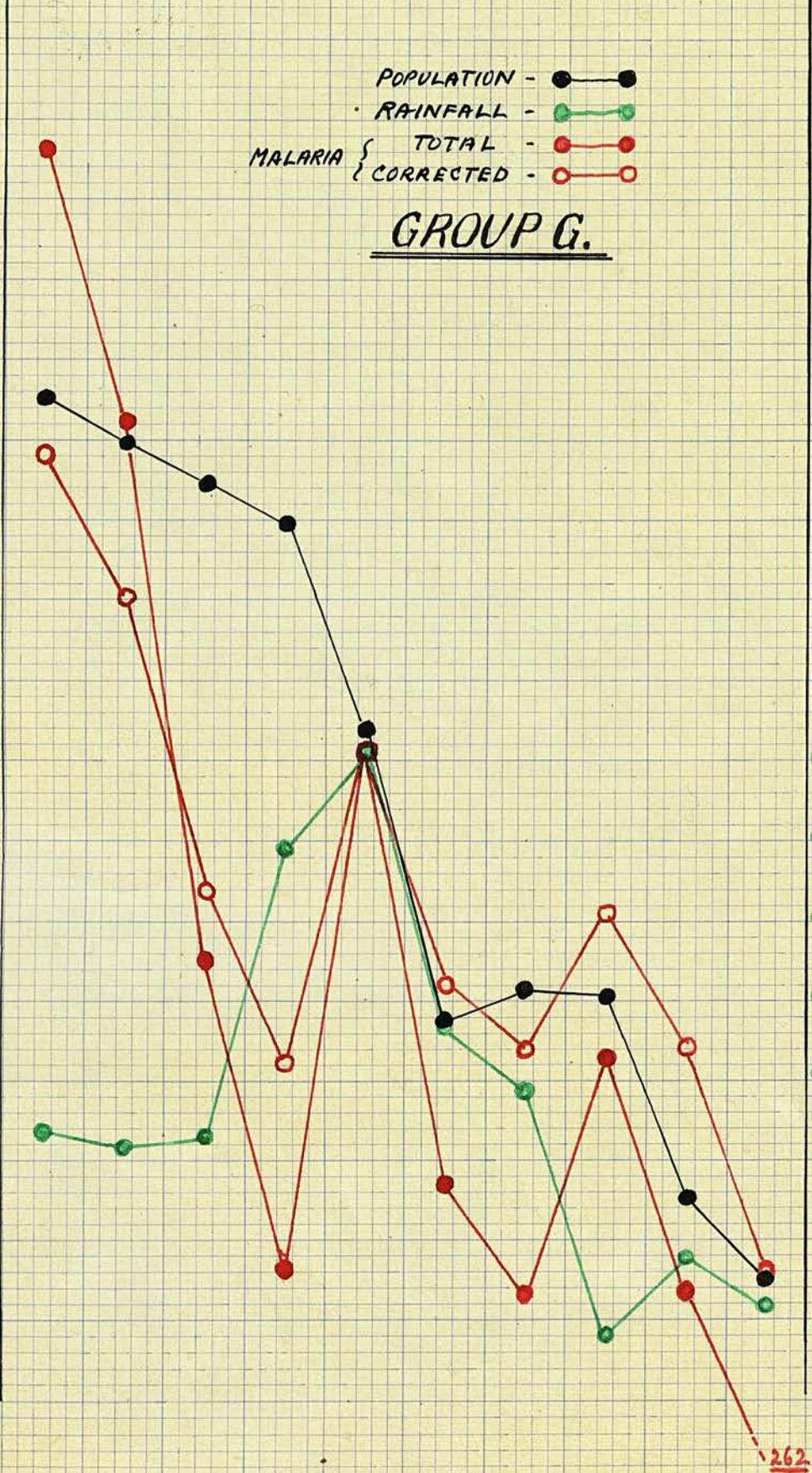
FIG. 18.

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

CORRECTED MALARIA  
TOTAL MALARIA  
POPULATION  
RAINFALL

POPULATION - ●  
RAINFALL - ●  
MALARIA { TOTAL - ●  
CORRECTED - ○

GROUP G.



GROUP H. East Coast (Demerara).(1) La Bonne Mere; & (2) Cane Grove.

Average Annual Population	-	1378.		
"	"	Malaria	-	191.
"	"	Rainfall	-	73.1 inches.
Corrected Malaria	-	140 per thousand.		

This Group has really consisted of one active estate throughout the ten year period; but as the population has been given, and as malarial patients would attend Cane Grove Hospital, it has been considered as two.

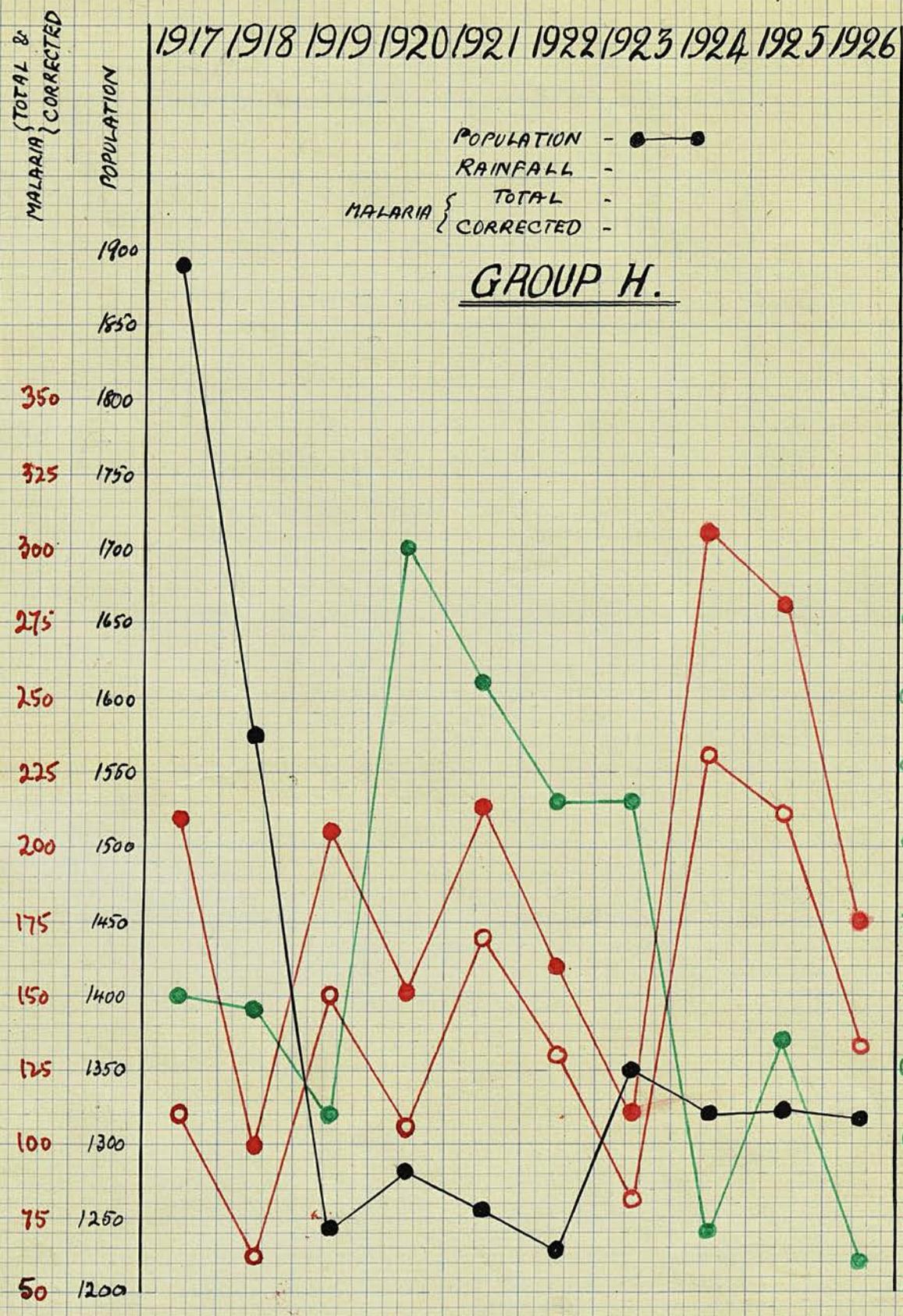
Situated much more inland than the former Group Cane Grove yet bears, in its degree of malaria, a very close resemblance to the previous Group, and to Enmore in particular, which is the nearest estate to it.

Rainfall is slightly less (73.1") than Enmore (76.7") and the malaria, inversely, (139 per 1,000) is slightly more than Enmore (132 per thousand).

The Graph (FIGURE 19) differs in some respects from that in FIG. 18. From 1917 to 1918 there was a reduction of over three hundred in the population of Cane Grove; but thereafter it remained fairly constant. The malaria, however, shows quite an independent curve, and the Total and Corrected figures agree closely showing factors affecting incidence other than an alteration in number of inhabitants.

A blunting of the malarial curve in 1924-1925 following the sharp decline in the rainfall is again somewhat typical, tending to result in parallel curves the ensuing year; but here, the reverse is not the case in 1919 to 1920 following the increased rainfall. Some local factor may have produced the additional "peak" seen in 1919, and which is not represented in Group G. Individual estate graphs of this Group (not reproduced here) reveal considerable variation in these first few years of the decade. Cane Grove has not yet been visited, but its isolation from other estates might not unnaturally produce local effects peculiar to itself.

FIG. 19



RAINFALL

● 191  
 ● 73.1"  
 ● 1378 140



GROUP I. West Coast (Berbice County).(1) BATH. (2). BLAIRMONT.

Average Annual Population -	3779.
" " Malaria ----	464.
" " Rainfall ---	73.2 inches.
Corrected Malaria ----	123 per thousand.

Although grouped together these two estates are fairly widely separated. Bath is really on the West Coast of Berbice; Blairmont more on the west bank of the Berbice River. The former therefore more exposed, the latter sheltered and surrounded by thick bush. Considerable funds have been allotted towards elimination of mosquitoes and breeding grounds at latter Plantation by owners, even to provision of special medical officer. Mosquito-proofing of overseers' quarters seems little to have succeeded there. Improvements are proceeding annually - new ranges, repairs, &c. Still over-bushed, and with too much water about, as disused canals, and marshy areas. Wide stretch of open country west of Bath free from bush, also east: decidedly fewer mosquitoes.

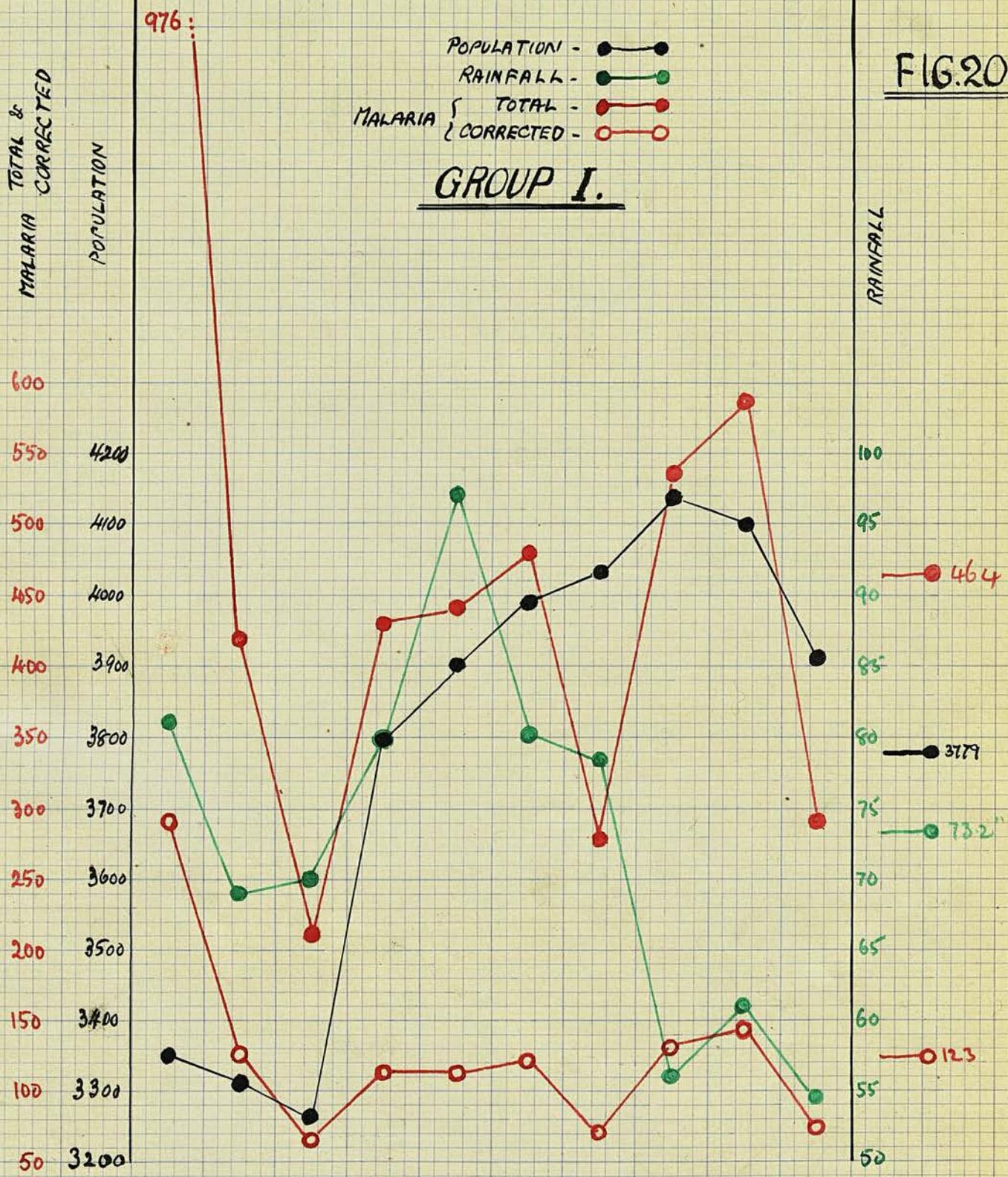
Rainfall throughout Berbice much lower than rest of Colony. No estate exceeds annual average of 83 inches; yet malaria high. Rainfall for Bath similar to coastal rainfall of Groups G. & H., also Group L. on east coast; that for Blairmont similar to up-river rainfalls (former, 68.1"; latter, 78.3"); hardly on same comparative levels therefore. Bath malaria low with low rainfall: only twice exceeds 10% of population during ten years. Blairmont malaria high with comparative low rainfall (160 per thousand). Combined graphs will thus mask each other.

Graph (FIG. 20) shows steadily increasing population: corrected malaria curve agrees closely with Total curve; practically independent of population curve. Individual curves show inverse ratio, though malaria rises in Blairmont with marked rise in rainfall in 1920; continued increased rain in 1921 is not followed by further rise in malaria; while drop in rainfall in 1922 shows marked rise in malaria. (Separate graphs not shown here; but seen in Tab. VII).

Exceptional total malaria in 1917 (Bath 236 & Blairmont 740 totals) cannot really be judged without previous years for comparison. Through the estates for Berbice there is not such an obvious inverse ratio as with Demerara; or at least it is only less pronounced.

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG. 20.



GROUP J. East Bank (Berbice River).(1) MARA.

Average Annual Population	-	432.
" " Malaria	-	86.
" " Rainfall	-	82.9 inches.
Corrected Malaria	-	199 per thousand.

The approach to Plantation Mara by road is through practically continuous bush - one rutted grass-grown track nearly overhung with trees for twenty-six miles. The estate is set in the midst of bush and adjoins the river bank. Prevailing temperature is high, and the district extremely sheltered. Though there are numerous small streams the actual land is some few feet above river level and not specially marshy in the immediate vicinity of the estate. Sanitation generally is somewhat primitive, the distance precluding more than one or two annual visits. There is no longer to be a Resident Medical Officer, a Dispenser being substituted. Repairs are everywhere needed; canals overgrown, banks uncut; houses, huts and out-houses gradually falling to pieces. The super-abundant mosquitoes are an absolute plague. Sand-flies also. (so-called sand-flies: really Simuliidae).

It is no wonder that the population is declining, though cheap river transport is available. FIGURE 21 shows quite a unique rainfall as compared with other Berbice estates. It is interesting that while most other estates show a high rainfall in 1921 with a concomitant low malaria, Mara shows just the reverse. In 1919, however, there is less malaria with the higher rainfall. The drought in 1925-1926 would probably affect Mara less than other estates, and there is a rise in the malarial curves though with less rainfall.

It cannot yet be said whether infection is spread from estates lower down the Berbice river - or more probably from New Amsterdam itself when the inhabitants repair to the town for fresh food supplies; or whether the intense malaria in Mara adds to the parasite rate lower down the river. Again, there may be little or no connection, and the degree of malaria in the two groups finds its own independent level. There is probably much more Sub-tertian malaria in Mara than at the mouth of the river, where Benign Tertian is prevalent.

The higher temperature and higher humidity may well play a conspicuous part in determining the higher incidence.

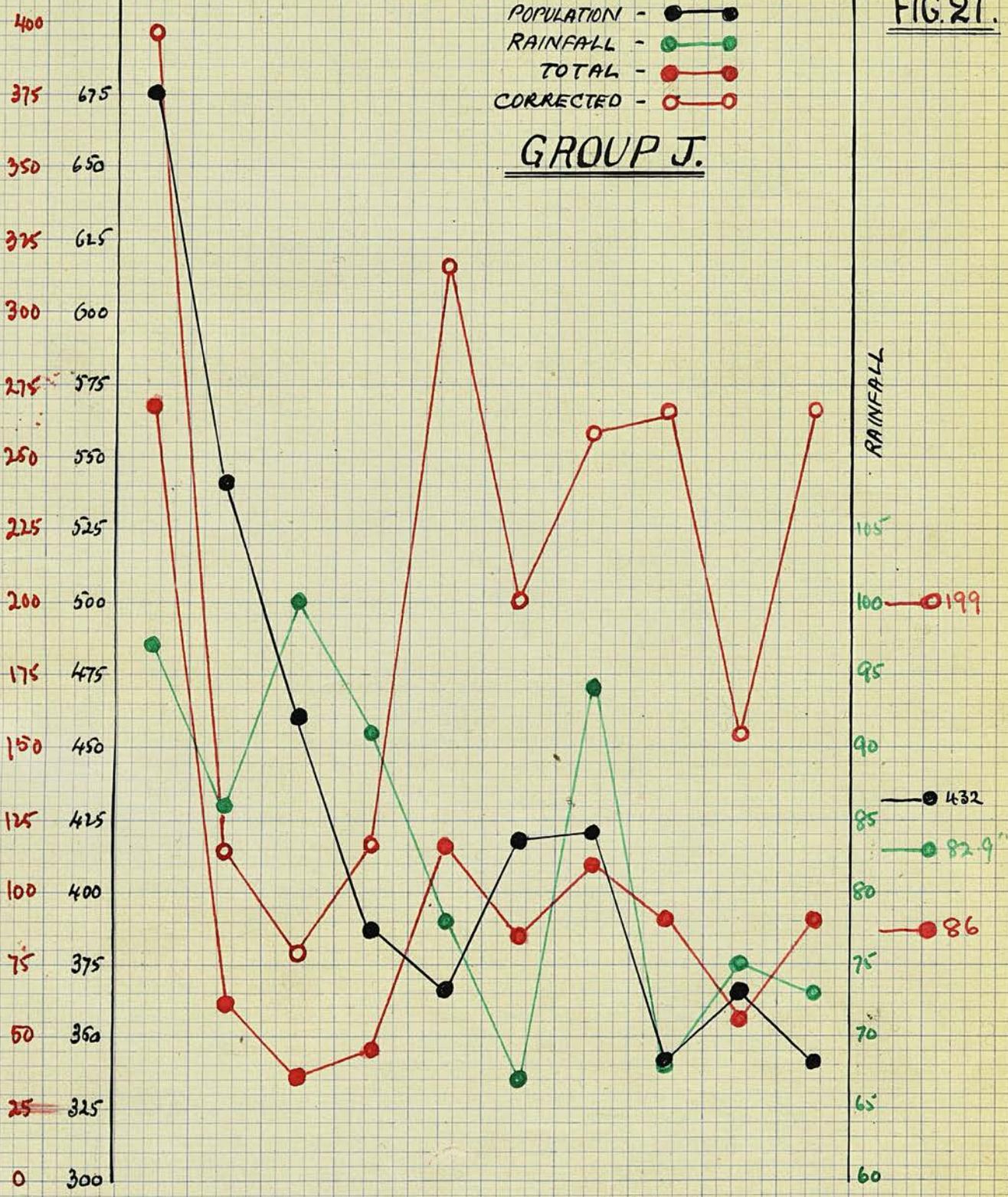
TOTAL &  
MALARIA  
CORRECTED  
POPULATION

1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG. 21.

POPULATION - ●—●  
RAINFALL - ●—●  
TOTAL - ●—●  
CORRECTED - ○—○

GROUP J.



GROUP K. East Bank & Canje Creek (Berbice River).

(1) EVERTON & PROVIDENCE. (2) FRIENDS. (3) ROSE HALL.

Average Annual Population	-	3701.
" " Malaria	-	545.
" " Rainfall	-	74.5 inches.
Corrected Malaria	-	147 per thousand.

Rose Hall is somewhat separated from the others, situated as it is up the Canje Creek -(branch of Berbice River)- and much nearer the coast. But it bears much the same relation to the creek as the others to the river. These estates have not especially been visited, but being "river estates" they are much less exposed to the prevailing wind, Blairmont, though across the river, coming in a direct line between them and it. Rose Hall is nearly four and three times the size of Friends and Providence respectively, and approaches in population the estates of Group L, further to the east.

While Friends and Providence both showed a persistent decline during the decade, that of Rose Hall increased from 2774 to 3157 persons, the combined graph (FIG. 22) masking the decline of the former.

The rainfall curve is fairly typical of that for Berbice as a whole (FIG. 10). The inverse ratio is not shown so clearly, though the lowest rainfall at Rose Hall (70.6") is commensurate with a high malarial rate (152 per thousand): Providence, however, has a higher rainfall (79.3") with the high corrected rate of 163. Plantation Friends has the lowest malaria of the three (103 per 1,000) with a rainfall of 73.5". It is also the furthest up the river, though perhaps less opposite Blairmont than the others.

The exceptional rise in the malaria in 1917 though higher for all estates was especially so for Providence (354) and Rose Hall (456 per 1,000).

The continued drop in the malaria from 1919 to 1921 is in marked contrast to the sharp and persistent rise in the rainfall during that time, the exact reverse holding good for 1921 to 1922.

The blunt curve in the Total & Corrected graph for Malaria between 1921 and 1925 suggests the delayed effect previously mentioned, with the consequent parallel curves in 1925-1926. This may have resulted from the notable and continued decline in the rainfall between 1921 and 1924.

The closely agreeing malaria curves do not bear an equal approximation to the population curve.

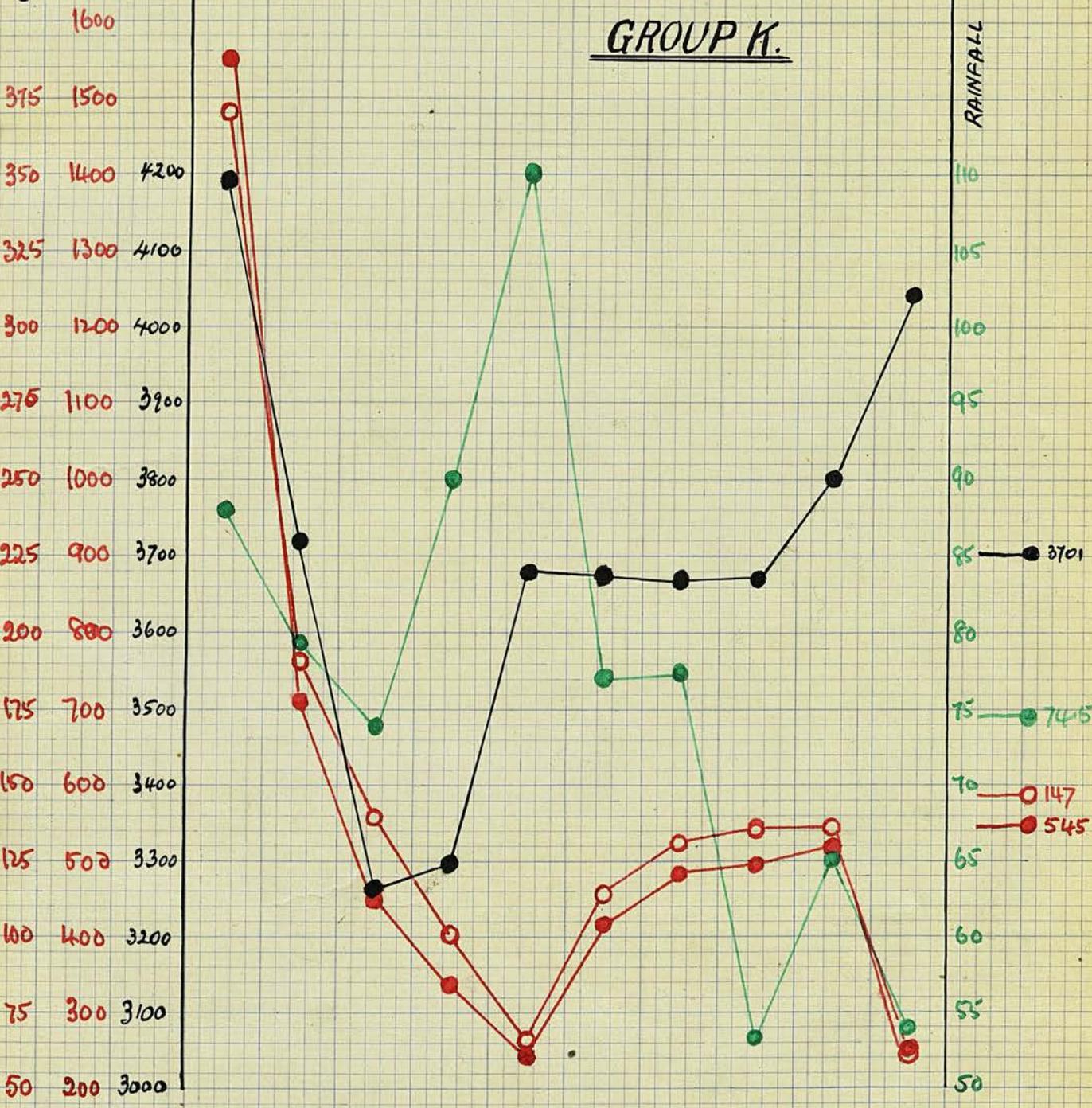
1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

FIG. 22

CORRECTED MALARIA  
TOTAL MALARIA  
POPULATION

POPULATION - ●-●-  
RAINFALL -  
MALARIA { TOTAL -  
CORRECTED -

GROUP K.



RAINFALL

110  
105  
100  
95  
90  
85 3701  
80  
75 745  
70 147  
65 545  
60  
55  
50

GROUP L. East Coast (Berbice County).(1) ALBION. (2). PORT MOURANT.

Average Annual Population	-	9655.
"	"	Malaria - 599.
"	"	Rainfall - 59.4 inches.
Corrected Malaria	-	62 per thousand.

These two estates, both coming into Group V as estates with populations of over three thousand, show many points of difference from other Groups. They are not only coastal estates, but the expanse of land that separates them from the shore is a wide open stretch of barren country almost completely free of bush or vegetation of any kind, an area frequently flooded at high tides, often merely an expanse of mud, with brackish water.

The estates themselves are thoroughly well organised and kept in good state of repair. The coolies daily travel to the cane fields a back of the estates, and return therefrom, by means of a private railroad (Port Mourant in particular). More pains than is usual seems to be taken over their general welfare, housing and sanitary conditions. This is especially so with regard to Port Mourant.

It is probably this comparative freedom from bush that has resulted in a very low average rainfall - the lowest of all the Groups. That for Port Mourant is slightly lower and more regular than Albion (55.3" compared with 63.5").

FIGURE 23 shows a rising population until 1923, and then a slight reduction. Albion has increased somewhat at the expense of Port Mourant. It cannot be said, however, that the degree of malaria has varied proportionately. It appears to maintain its own level irrespective of any rise or fall in the number of inhabitants. The malaria curves, too, closely agree.

Between 1919 and 1925 inclusive there is a marked and proportional inverse ratio occurring between the rainfall and the malaria, which can hardly be coincidence. This is despite the apparent contradiction noted above that with a low rainfall on the average there is also a low malarial rate. The suggestion is manifest that with well managed estates, comparatively freed from bush, and exposed to the Atlantic breeze there must be both less rainfall and a less degree of malaria. But that at this level there is still this inverse ratio between them.



CORRECTED }  
 TOTAL }  
 POPULATION  
 1000  
 950  
 900  
 850  
 800  
 750  
 700  
 650  
 600  
 550  
 500  
 450  
 400  
 350  
 300  
 250  
 8000  
 8200  
 8400  
 8600  
 8800  
 9000  
 9200  
 9400  
 9600  
 9800  
 10000  
 10200  
 10400

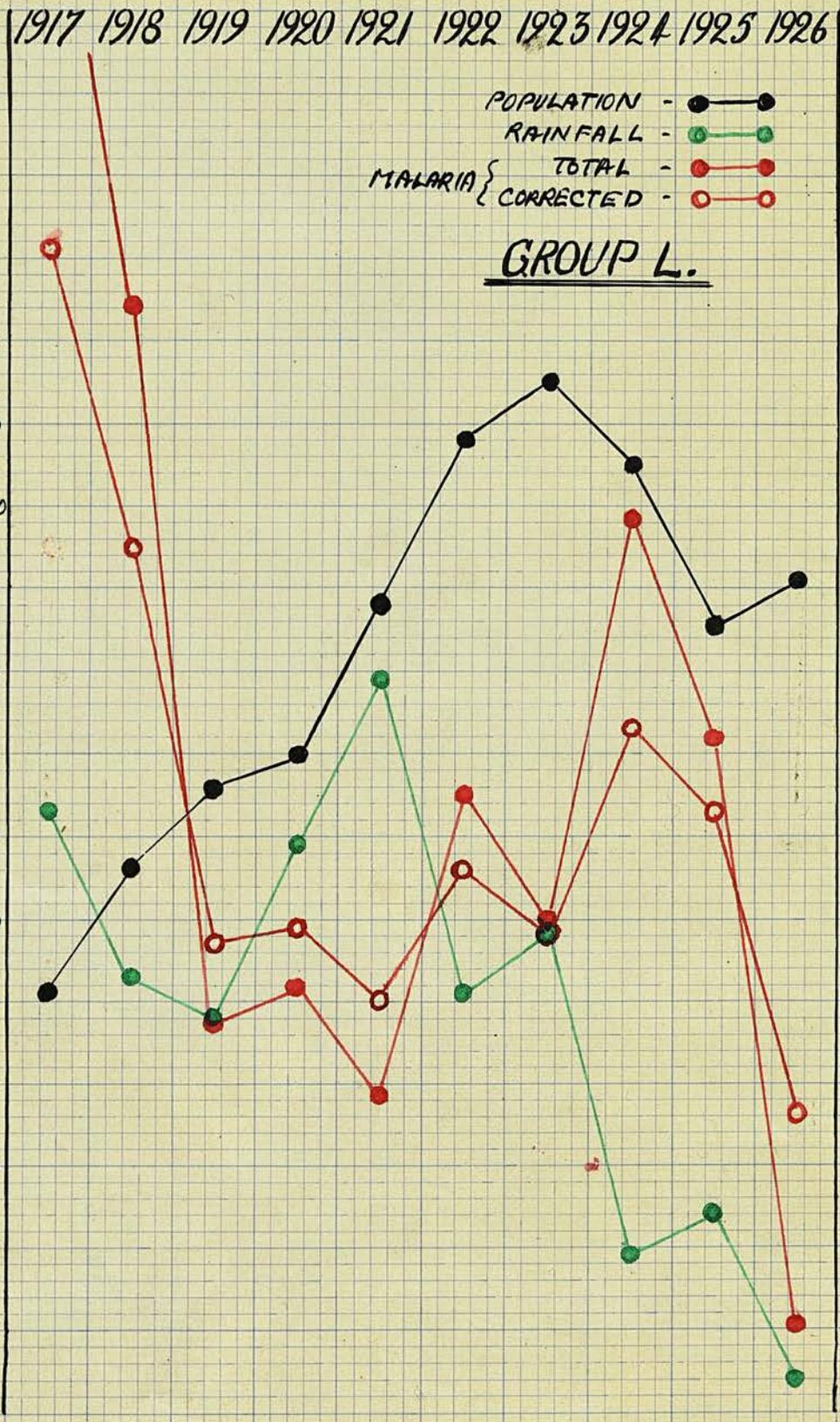
1917 1918 1919 1920 1921 1922 1923 1924 1925 1926

POPULATION - ●—●  
 RAINFALL - ●—●  
 MALARIA { TOTAL - ●—●  
 CORRECTED - ○—○

GROUP L.

RAINFALL  
 ●—● 9650  
 ●—● 599  
 ○—○ 62  
 ●—● 59.4  
 80  
 75  
 70  
 65  
 60  
 55  
 50  
 45  
 40  
 35

FIG. 23.





GROUP M. Courantyne Coast (Berbice County).

(1) SPRINGLANDS. (2) SKELDON.

Average Annual Population	-	1994.
"	"	Malaria - 225.
"	"	Rainfall - 66.7 inches.
Corrected Malaria	-	113 per thousand.

These estates are very remote from the rest of the estates in the Colony, and in reality border the river which separates British from Dutch Guiana.

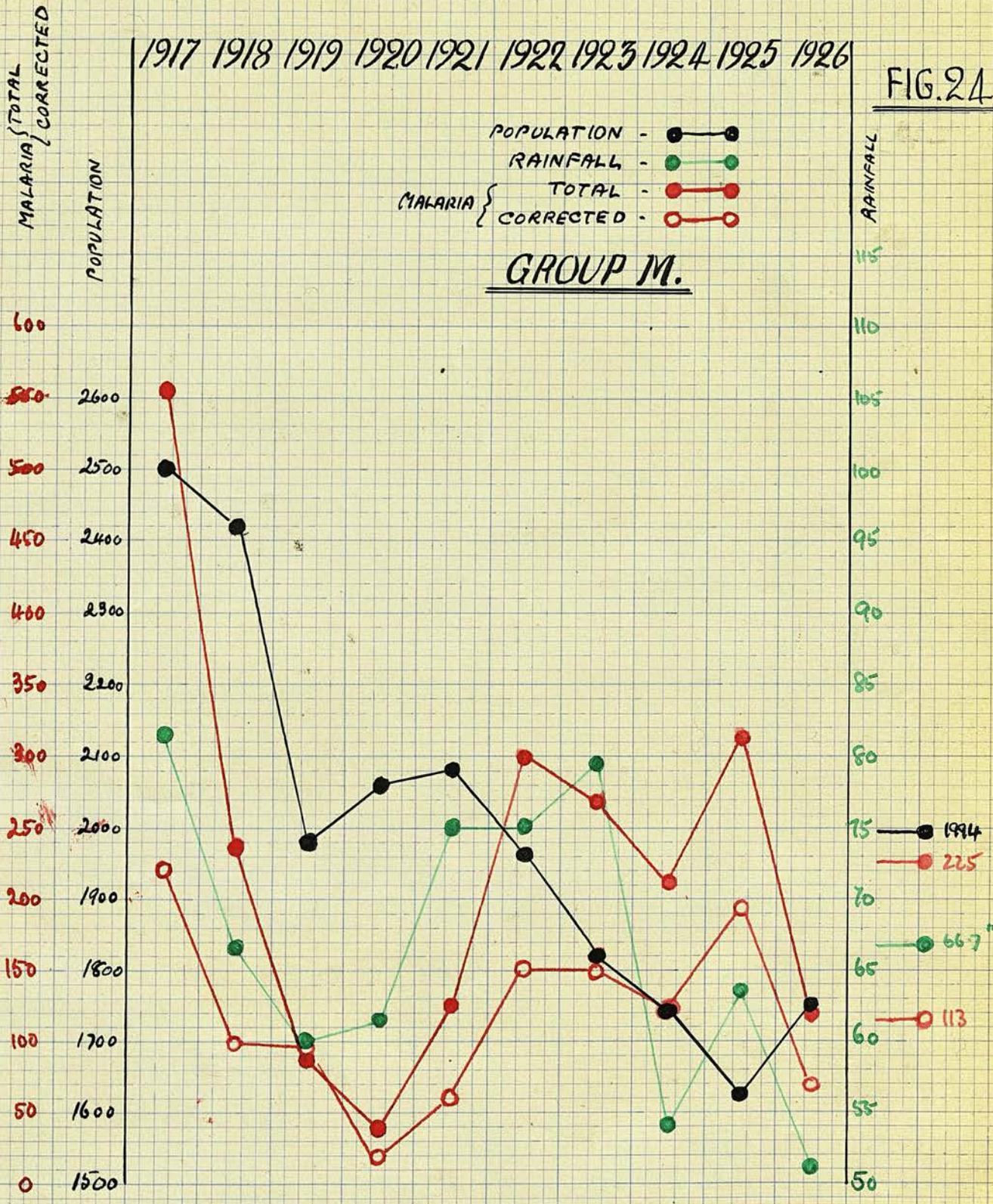
The same open stretch of country continues more or less unchanged as far as Springlands which is thus quite exposed. Skeldon is further round to the east and on a bend in the river, and as such is probably much more sheltered, and approached conditions similar to river estates. Besides possible local factors this may account in some measure for the vastly different figures for each. While the average rainfall for each is closely similar, as might be expected in two adjacent estates (66.4" & 67.1" respectively) there is an extreme difference in the proportion of malaria, that for Springlands being only 28 per thousand, while that for Skeldon averages as high as 128 per thousand on the ten year basis, or ten per cent more. Until each is studied individually full reasons for this cannot be given, but it seems likely that their geographical position has much to do with it.

An examination of their combined graphs (FIG. 24) will not be so valuable as an individual study. In this respect Springlands does tend to show little of the inverse relation between rainfall and malaria; but the figures are so small (only eleven cases are reported for three consecutive years, 1919 - 1921) as to be of little value. With Skeldon, however, there is this alternating rise and fall so frequently referred to. This is in the individual graphs which are not here represented. In the combined graph this is masked.

Despite a gradually lessening population there is again little or no resemblance with the total malaria curve, showing the rate of infection to be independent of change in number of inhabitants, and to depend, in its variation, upon other factors. This has appeared one of the most constant features in all the Groups examined.

Owing to the width of the river, the proximity to Dutch Guiana probably has little effect on the malarial incidence or spread of infection.

FIG. 24



B. STATISTICAL - (b) to (e), Estates & Rainfall. Concluded.

As a result of the study of individual estates and Groups, more especially in relation to rainfall and topography, certain fairly definite indications have emerged which should prove of value in ultimately assessing the importance of the different factors concerned in deciding malarial incidence. These may briefly be summed up here.

(i) Coastal estates - that is, estates along the front lands of the Colony and thus more exposed to the prevailing north-west wind - are generally less malarious than those situated more inland along the river banks ("river estates") and thus more sheltered. (Ref. Frontispiece Map).

(ii) Estates which are less surrounded by and generally contain less bush, and which have an open expanse free from bush between them and the prevailing wind, are less subject to malarial infection. So, the converse.

(iii) That, within limits, there appears to be an inverse ratio between the malaria and the rainfall (as based on the annual figures, and this is important); so that a rise in the rainfall results in a proportionate decline in the malaria, and vice versa, except (1) where there is an extreme and undue rise in the rainfall which tends to cause a rise in the malaria, and (2) where an outstanding drop in the annual rainfall, as in the case of prolonged and absolute drought, is followed by a lowered malarial rate.

(iv) That the mean of such a ratio is not necessarily constant, but in any district, Group, or individual estate may be materially higher or lower both in rainfall and malaria, the inverse ratio still holding good.

(v) That the rainfall, from year to year, can sometimes more rapidly show a change from low to high or high to low, than can the malaria, and especially after any marked change whether in the malaria or the rainfall. Interpreted, this infers that, for example, when after a sharp rise in the rainfall there is also a quick decline of the malaria, although the following year may show a sudden drop in the rainfall there is not the accompanying rise in the malaria, in consequence

of which the two curves for that year run parallel. That is to say, there has been such a marked diminution in the number of fresh cases and re-infections, that it takes longer than a year to recover the normal position, during which year the rainfall has again changed and increased, thus showing a rise in the rainfall and the malaria.

(vi) The degree of malaria in relation to size of estate according to population is interesting, and shows generally that the smaller the estate the higher the incidence, with the exception of one important Group (IV) of between two and three thousand inhabitants which shows an incidence as high as that for the smallest estates. Tentative reasons have been given (Sub-section (b), paragraphs 35 et seq.).

(vii) Closing down of smaller estates, mostly with a high degree of malaria, seems temporally to have an unfortunate effect on those adjacent estates remaining, as though the smaller number of employees per infected Anopheline results in a higher malarial rate.

(viii) The comparative independence of the Total curve for malaria, as contrasted with a varying population has been very noticeable. While there has been a rough semblance on some of the estates, the majority have shown no proportionate decline in the number of malarial cases with the steadily lessening population. This has further been enhanced by the close approximation of the Corrected curve with the Total curve. The malaria seems to choose its own level whether the number of people increases or decreases. A monthly chart in this respect should do much to show whether this is actually the case, or whether possibly it depends upon the actual time of closure of the estate or reduction in the employees in relation to the wet or dry seasons. Certainly there is the indication that the incidence of malaria depends less on the human factor than on the mosquito factor, in British Guiana.

### C. SPLEEN RATES.

During the course of a tour in the County of Essequibo, a number of children were examined with a view to determine some general estimation of the spleen, parasite and Anopheline rates; it was thought that after such a preliminary survey better ideas would be obtained on which to base a more complete and systematic examination.

Notice of the intended visit was sent out in advance so that as many children as possible would be collected together at a convenient place, such as a school or estate hospital, at the time of arrival. The routine was the same in each place. A blood film (thin) was prepared from each child after a prick of the tip of the middle finger of the left hand; the degree of Anaemia, if any, was then roughly gauged by the appearance of the conjunctiva of the lower lid; finally, the child was made to bend downwards while the right hand felt for the spleen. Three hundred and twelve children were thus examined in seven different districts.

2. It was unfortunately impossible to examine the blood films on returning from the tour, and they were brought back to England. The reason for this was that the Leishman stain, such as it was, could not be made to stain properly: those that had been so stained were decolourised with spirit, and the whole examination of the slides held over. On arrival in England renewed attempts were made, over a period of three months, but with little better success, although some of them took the stain sufficiently well to show the parasites. Nearly eight months had elapsed however between the time of taking the specimens and their final examination, and although packed carefully, film-side to film-side, the tropical climate may have affected them. It is regrettable in view of the likelihood of their showing a very high parasite index judging from the few that were able to be examined.

3. As far as possible in the same districts, and chiefly in the huts and ranges where the children resided, a large number (about five hundred) Anophelines, mostly engorged, were collected just as it was getting dark. These, kept in 70% spirit, have also been brought home, paraffin-sealed in glass phials. Attempts have been made to section some of these with paraffin (celloidin could not be used as yet as a horizontal microtome was not available), but the

results so far have been disappointing. After immersion in spirit for so long they have become extremely brittle, although addition to the fixing fluid of a little dilute glacial acetic acid has slightly lessened this.

4. The following is a brief description of the places referred to -

(1) Onderneeming School. This is situated about three miles nearer the Essequibo river from Suddie hospital. It is an industrial school used entirely for boys sent by magistrates to be reformed. The school is in its own ground which is large and spacious and free from bush. The boys are employed in a number of useful occupations, are strictly controlled, and are immediately treated when sick either by a Dispenser or a visiting Medical Officer. A sick ward is provided.

(2) Hampton Court has already been referred to when dealing with sugar estates.

(3) Plantations Aurora & Affiance, two formerly active sugar estates, on the west bank of the Essequibo river near its mouth. Bush is abundant, as also disused canals and marsh. The people are extremely poor and their general resistance low.

(4) Zelandia, once a sugar estate, is a village at the north western corner of the Island of Wakenaam, exposed to the Atlantic, with a sandy soil. The examination took place at the small school.

(5) Fredericksburg is a village on the eastern side of the same island. The school is fairly large and collects the children from the whole of the eastern side of the island. They live in scattered huts, mostly palm-thatched, beside the road, in the midst of bush.

(6) McKay is also a small village south of the estate of Marionville on the west side of the island. All these villages are much the same. The school was the place chosen in both villages.

5. Table IX(over) shows the number of children examined, with the number and percentage of enlarged spleens.

TABLE IX. SHOWING TOTAL NUMBER OF CASES EXAMINED,  
NUMBER AND PERCENTAGE OF ENLARGED SPLEENS.

	PERSONS EXAMINED	NO. WITH ENLARGED SPLEENS	PERCENTAGE
(1) Onderneeming School	103	47	46
(2) Hampton Court	48	38	80
(3) Aurora	34	32	94
(4) Affiance	42	39	93
(5) Fredericksburg	27	17	63
(6) Zelandia	20	8	40
(7) McKay	37	20	54
	311	201	64.6%

6. These figures are admittedly small for random sampling, but give some idea of the prevalence of malaria. Assuming, for the present, that no other condition is responsible for causing the splenic enlargement, that nearly two-thirds of the inhabitants have suffered or are suffering from this one disease is sufficiently alarming. Where treatment is prompt and controlled at Onderneeming the percentage is comparatively low. Probably the boys with such spleens had them on entry, or most of them. Excluding these the percentage rises to over seventy.

7. The real extent of malaria is better seen here in the case of Hampton Court. In Table VII the average proportion of malarial cases coming to the estate hospital was 115 per thousand. And yet 80 per cent of 48 children on the same estate showed palpable spleens.

8. Practically every child at Plantations Aurora and Affiance had enlarged spleens, only five out of seventy-six being negative. This is commensurate with the ideal conditions for the breeding of *Amphelines* mentioned above.

9. Zelandia is interesting, in that the comparatively low spleen rate - that is, as compared with those for Fredericksburg and McKay on the same island - occurs in a district where, though there is a good deal of bush, the constant breeze which is sometimes very strong and the sandy soil offer less suitable surroundings for mosquitoes. As compared with the estate of Marionville (Table VII; 139 per thousand average) these three villages portray the truth in regard to the malaria much more vividly. Some evidence is gained of the large number of persons that must suffer from malarial attacks, both fresh cases and relapses, who yet do not trouble to visit the hospitals. No record is kept, however, as to how many of these people receive treatment at the hand of the resident Medical Officer or from Dispensaries, other than at the hospital.

10. It has so far been assumed that enlarged spleens are due to malaria. Ancylostomiasis is also very prevalent in Wakenaam, as in other districts of the Colony, and allowance must be made for this. Other diseases producing splenic hypertrophy may be disregarded as not likely to influence the figures appreciably.

11. At the time of examination the enlarged spleen was placed into one of six categories, as follows:- Just palpable; reaching one quarter the distance from the costal margin (roughly midway between anterior axillary and nipple lines) to the umbilicus; half the distance; three-quarters the distance; reaching to the umbilicus; and lastly, those which were so enlarged that they extended beyond the mid line of the abdomen. One child had a spleen which actually extended to the right iliac fossa.

12. There is some justification for assuming that the size of an enlarged spleen varies directly with the degree of malaria in the patient. The greater the enlargement, the more has that patient been subject to malarial attacks in the past, and the more likely still to be harbouring parasites in the internal organs, if not in the peripheral blood. In countries where malaria is less common this may not be so true. This, however, disregards the possibility of an examination having taken place during the course of an epidemic: it may be so, but the general enlargement would equally affect all sufferers proportionally.



The comparative value in any group examined therefore remains. To gauge, therefore, what may be called the spleen 'status quo' of any community - that is, the average position of the enlarged spleen of all those examined (and the larger the proportion examined the greater the accuracy), arbitrary values may be assessed to each category rising numerically with each further degree of enlargement. Thus, negative spleens would be given the unit figure 1; each of the remaining six categories would be assessed in order the figures 2, 3, 4, 5, 6 & 7. To take an example: supposing fifty cases were examined. If all of them showed negative spleens the splenic status (S.S.) would be fifty multiplied by one = 50, divided by the total examined (50) = 1. Again, if all of them happened to have spleens reaching to beyond the umbilicus the S.S. would be  $7 \times 50$  divided by 50, leaving 7. The S.S. of a community would thus range somewhere between these extremes: the nearer the approach to unity, the healthier (from the point of view of the malaria). Again, supposing ten of the fifty showed negative spleens, twenty-five showed just palpable spleens, twelve gave enlargement reaching to half way to the umbilicus, and three reached beyond it, the figures would be as follows:-

$$\frac{(10 \times 1) + (25 \times 2) + (12 \times 4) + (3 \times 7)}{50} = 2.58 \text{ (S.S.)}$$

(The figures in heavy type are the assessed values).

13. Such an S.S. would appear very high indeed in a temperate climate, and high enough to be alarming in any civilized community in the tropics: and yet it will be shown that much higher ones than this occurred in the places examined. It only remains to translate the S.S. figure into graphical representation by reference to the body, if desired. But in a very short time the S.S. figure itself comes to be appreciated without further interpretation.

14. It is on these lines that an idea of the malarial endemicity of the districts examined has been obtained. It is intended to pursue this method on a more extensive scale, and compare the findings with other rates and indices, as well as with hospital and estate figures of total and corrected malaria. If the ratio is sufficiently accurate, the method is much simpler and can be employed on a vastly larger scale than any of the other methods.

TABLE X. SHOWING RESULTS OF EXAMINATION OF 311 CASES(CHILDREN)AS TO SPLENIC ENLARGEMENT, TOGETHER WITH ASSESSED VALUES & SPLENIC STATUS(S.S.).

( N = Not palpable; / = Just palpable;  $\frac{1}{4}$  = reaching  $\frac{1}{4}$ -way to Umbilicus;  $\frac{1}{2}$  = half-way;  $\frac{3}{4}$  = three-quarter-way; U = reaching to Umbilicus; U/ = beyond umbilicus.)

	N	/	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	U	U/	S.S.
Value:-	1	2	3	4	5	6	7	
Onderneem:	56	34	9	2	1	0	1	1.66
Hampton Ct:	10	14	12	3	6	1	2	2.83
Aurora	2	5	9	6	8	2	2	3.79
Affiance	3	5	6	9	8	8	3	4.19
Frederick:	10	5	3	6	1	1	1	2.63
Zelandia	12	5	2	0	0	1	0	1.70
McKay	17	9	3	4	2	2	0	2.63
Totals	110	77	44	30	26	15	9	2.57

15. In accordance with what has been written in the description of these places, together with the percentages recorded in Table IX, there is a very close resemblance. Affiance and Aurora are certainly the most malarious districts; Onderneeming is naturally low, and Zelandia's low figure has been satisfactorily accounted for.

16. When compared with the percentages of enlarged spleens in Table IX, a slightly different order is noticed: thus, though Onderneeming shows a higher percentage of enlarged spleens, than Zelandia, the S.S. for the former is lower. And this is probably in accordance with facts. Though the number of enlarged spleens is greater, they average a smaller size, than Zelandia. More prompt treatment checks undue enlargement.

Again, though Affiance may have slightly fewer children proportionately with splenic enlargement, Table X shows the spleens of these

children to average a greater size, than Aurora. This suggests either that malarial attacks are more intense (whether through greater toxicity, or more prolonged, or though more vicious mosquitoes, &c) or that treatment is more neglected.

17. Too much stress is not laid on these actual figures, which are too small to base such conclusions really; but they are used rather to show the principles aimed at, and the uses that may be made from them. This also applies below.

18. So far, no account has been taken of the different ages of the children concerned. Three age periods have been chosen - 1 - 5 years; 6 - 10 years; and 11 - 15 years.

TABLE XI. SHOWING SPLENIC ENLARGEMENT IN CHILDREN AGED UP TO 5 YEARS, TOGETHER WITH SPLENIC STATUS.

	N	/	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	U	U/	S.S.
	1	2	3	4	5	6	7	
Ondernee.	NONE.							
Hamp. Ct.	8	5	7	2	3	0	1	2.65
Aurora	0	4	2	1	1	1	1	3.60
Affiance	1	2	2	2	5	3	1	4.31
Fredericksburg:	NONE; McKay: NONE.							
	9	11	11	5	9	4	3	3.34

(As there were only 2 cases at Zelandia, it is omitted).

19. The S.S. **3.34** is higher than the average for all ages (2.57) which is what is expected; splenic enlargement at these years being more pronounced. Affiance here shows a much higher S.S. than that for Aurora; this should follow if the previous sentence is correct.

20. Most of the boys at Onderneeming School are between ten and eighteen years of age. At Fredericksburg and McKay schools it so happened that none so young as five or less turned up.

TABLE XII. AS FOR TABLE XI, BUT CHILDREN 6 - 10 YEARS.

	N	/	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	U	U/	S.S.
	1	2	3	4	5	6	7	
Onderneem.	4	3	2	0	1	0	0	2.10
Hampt.Ct.	2	8	5	1	3	1	0	2.90
Aurora	1	1	2	1	2	0	0	3.29
Affiance	1	0	3	5	2	3	1	4.33
Frederic.	5	3	2	2	1	0	0	2.30
Zelandia	7	4	2	0	0	1	0	1.93
McKay	6	8	3	1	1	2	0	2.47
	26	27	19	10	10	7	1	2.76

TABLE XIII. AS FOR TABLE XI, BUT CHILDREN 11 - 15 YEARS.

	N	/	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	U	U/	S.S.
	1	2	3	4	5	6	7	
Onderneem.	29	18	5	2	0	0	0	1.63
Hampt.Ct.	0	1	0	0	0	0	0	2.00
Aurora	1	0	2	2	0	1	0	3.50
Affiance	1	3	1	2	1	2	1	3.81
Frederic.	5	2	1	4	0	1	1	2.78
Zelandia	4	0	0	0	0	0	0	1.00
McKay	12	1	0	3	1	0	0	1.82
	52	25	9	13	2	4	2	2.14

21. As age increases there appears a decided lessening of the Splenic Status; that is, it tends to approach unity (3.84; 2.76; 2.14). But there is a fallacy here that must be guarded

against. A decreasing S.S., with increasing age, was expected, in accordance with the generally accepted findings that splenic enlargement is not so pronounced in older children and adults, as compared with children up to the age of five or six years (so, DANIELS, British Guiana Medical Annual, 1895: enlargement & pigmentation of spleen absent under one month, more and more frequent up to five years of age; progressively less frequent with advancing age). But a smaller average spleen in an older child or adult does not necessarily infer a less degree of malaria, only a less obvious manifestation of it in the spleen. These splenic figures, therefore, together with the S.S., become less reliable as evidence for malarial incidence with increasing age after five or six years. At most, however, in themselves they serve for comparative purposes in regard to the different districts and villages, and may justifiably be used and used extensively.

22. More detailed analysis in the case of the present figures would not be wise and would serve no useful purpose: but where a much larger series of children had been examined such analysis of the different age periods in relation to school ages, occupations and the like would be especially valuable. It remains to see whether Males or Females among the children examined show a greater degree of splenic enlargement. As there are only boys at Onderneeming, this school will not be considered. Only the totals for the remaining six places will be given as the numbers for individual districts, small enough, would be halved in the separate estimation of male and female.

TABLE XIV. SHOWING THE SPLENIC STATUS OF MALE & FEMALE CHILDREN, ALL AGES, IN ALL DISTRICTS (6).

	N	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	U	U/	S.S.	
	1	2	3	4	5	6	7	
<u>MALES</u>	34	17	14	20	14	11	3 (113)	3.07
<u>FEMALES</u>	20	26	21	8	11	4	5 (95)	2.95

23. Males, therefore, tend to average slightly larger spleens than females on the basis of two hundred and eight cases in six separate districts.

It is possible that with much larger figures even this margin of difference would be reduced. At the same time, of the older children the males would be more likely to be exposed to the bite of the Anopheline than the females, as most of them other than during school hours would be employed in out-door occupations.

24. In estimating the degree of ANAEMIA the children were classed into one of four categories: Negative; Slight degree (/); Moderate degree (//); and Severe (///). It was realised, however, that these categories would be practically valueless without ascertaining also whether the children harboured any helminthic infection - and judging from periodical reports in this direction in different parts of the Colony a very large percentage of the children do, especially hookworms and ascaris infections. But this was not possible on the tour in question. The Table is given below.

TABLE XV. SHOWING DEGREE OF ANAEMIA (ROUGHLY ESTIMATED) IN EACH OF THE SEVEN DISTRICTS FOR MALES AND FEMALES (CHILDREN, ALL AGES).

	N		/		//		///		TOTALS
	M	F	M	F	M	F	M	F	
Hampt. Ct.	3	3	9	14	6	7	4	2	48
Aurora	3	3	11	6	3	5	-	3	34
Affiance	-	2	15	4	8	8	2	3	42
Frederic.	6	4	2	5	4	2	4	-	27
Zelandia	5	1	8	2	3	1	-	-	20
McKay	6	8	7	10	4	1	1	-	37
	23	21	52	41	28	24	11	8	208
Onderne:	27	-	44	-	25	-	7	-	103
	50	21	96	41	53	24	18	8	311

25. There was a slight excess of males over females, excluding Onderneeming. The fairly high proportion of anaemia at this school, as contrasted with the lower splenic status, is noticeable. This is undoubtedly referable to helminthic infection. Of the remainder, only 21% suggested no anaemia, 44% slight anaemia, 25% moderate and about ten% severe anaemia.

26. Although the blood films previously referred to were discarded a few took the stain well. On these a differential count was made (on a rough basis of 100 white cells counted). As strong evidence that much of the above anaemia must be due to vermes these counts are given. They are taken from all the groups irrespective of age, sex, and spleen.

TABLE XVI. SHOWING RANDOM BLOOD COUNTS AMONG THE 311 CHILDREN EXAMINED TO REVEAL INTENSITY OF HELMINTHIC INFECTION PRESENT.

REFERENCE NO.	POLY-MORPH	LARGE MONOS	LARGE LYMPH	SMALL LYMPH	EOSINOPHIL	) %
A. 1	49	13	19	3	16	
A. 2	36	9	18	22	15	
A. 15	52	5	8	27	8	
O. 65	50	16	4	8	22	
O. 66	51	16	13	4	16	
O. 67	57	16	12	12	3	
O. 68	44	40	8	2	6	
O. 69	16	20	32	20	12	
O. 70	54	13	12	5	16	
O. 72	31	26	21	10	13	
O. 73	52	7	20	1	20	
O. 74	42	19	16	11	12	
O. 75	55	18	14	5	8	
Z. 1	29	19	10	15	27	
Z. 4	29	20	9	21	21	
Z. 9	X 16	32	13	12	27	

27. It was not uncommon to find four eosinophils, and even more, in a single well spread field. Where the percentage is moderately high, the eosinophils seem to have increased at the expense of the lymphocytes chiefly; where very high, at the expense of these and the polymorphs. The high count of the Large Mononuclears is also evident.

*per cent*

28. Further analysis of these blood counts is not proposed, as without stool examination and the searching for parasites it is not of much use.

29. No reference has been made to the various races among the 311 children examined. The majority of these were East Indian - those at Onderneeming were nearly all Black and Mixed - with a few Aborigines and Portuguese. The figures were too small for the purposes of spleen discrimination. Nor has mention been made of concomitant conditions noted at the time - ulcers, presence of chiggers, &c. But these have no direct bearing on malaria.



#### D. ENTOMOLOGICAL (& PROTOZOOLOGICAL).

Only an outline of some of the more salient features will be given with reference to the general distribution of the different parasites, and concerning the commoner malaria-carrying Anophelines, together with the details of a small piece of work undertaken to initiate a study of a more exact determination of the preferential habitat of Anophelines in relation to shade and other organisms.

2. Various papers have appeared, written by different authors working in British Guiana, on special aspects of mosquito research - such as, The Breeding Places of Mosquitoes in the City of Georgetown (WISE, 1911); Experiments with Crude Carbolic Acid as a Larvicide in British Guiana (WISE & MINNETT, 1912); and The Use of Fish Indiginous to British Guiana for the Control of Mosquitoes Breeding in Water Containers (HASLAM, 1926); besides many other papers published in the British Guiana Medical Annual and other Journals extending back for many years. These contain much of value that may be utilized, and to a limited extent have been, in preventive work. But until such papers are collected and carefully compared and annotated, they are apt to be overlooked. Such is intended before proceeding further in the attempt to formulate a definite plan of campaign on a wholesale scale against the disease.

3. Of the different parasites concerned in human malaria those of *Haemamoeba* (*Plasmodium*) *vivax* and *Laverania malariae* (*Plasmodium falciparum*) are by far the most common. That of Quartan malaria is comparatively rare - probably more so than is locally supposed. Clinically, it is almost never determined, at least now-a-days. Were the distribution of Benign tertian malaria plotted on the map of the Colony it would be found to follow fairly closely the coast lands and the banks of the lower reaches of the rivers. No specific research appears ever to have been attempted to prove this, but it is common knowledge amongst the medical fraternity, and indirectly with the people by the "every-other-day fever" sign. Sub-tertian (Malignant) malaria on the other hand seems much more restricted to the hinterland - for example, in the diamond fields. No reason for this has yet been forthcoming, nor

is it known whether or no separate species of mosquitoes are responsible, but this does not seem probable.

4. Although six species of Anophelines have been recorded in the Colony, two only are of real importance in the spread of malaria; namely:-

(1) Cellia argyrotarsis R. Desvoidy (THEOBALD)

(Anopheles argyritarsis Robineau-Desvoidy: Anopheles albitarsis Arribalzaga).

and (2) Cellia albipes Theobald

(Anopheles tarsimaculata Goeldi: Anopheles argyrotarsis, sub-species albipes Theobald).

The remaining four are given below:-

- (3) Anopheles lutzii Theobald
- (4) Anopheles mediopunctatus (Theobald) DYAR & KNAB
- (5) Anopheles nimba Theobald
- (6) Anopheles nigra Theobald.

5. As far as can be gathered from cursory reading of earlier papers the second (Cellia albipes) appeared to be the more common. During the investigation outlined below, and from the collection brought home obtained from Essequibo, as well as a few collections taken in Demerara on the east and west banks of the river, the former (Cellia argyrotarsis) would appear now to take precedence.

6. In parenthesis, a point of interest in this connection may be mentioned. While endeavouring to ascertain whether the ejecta of Anophelines (C. argyrotarsis) might contain unchanged parasites, during the actual time of absorption while the proboscis was in the skin, a number of Anophelines were allowed to settle on the hand unmolested and watched during the process of engorgement. It was thought that possibly it was when rubbing the area afterwards that some of the clear fluid excreted produced the irritation and desire to scratch. Over fifty such insects were permitted to bite, and the fluid collected on to a slide. The examination, however, proved negative. The blood was known to contain parasites at the time.

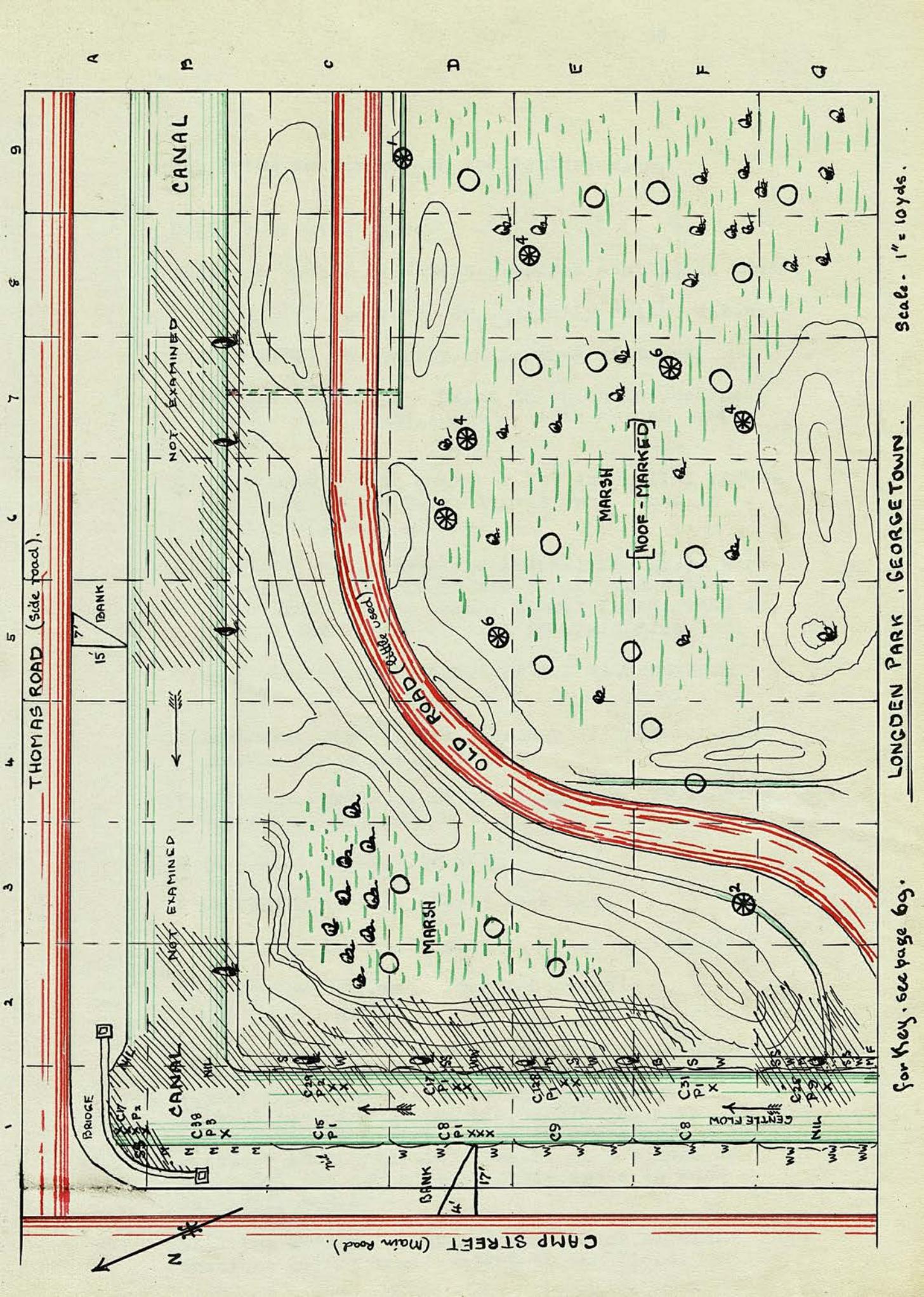
The first expulsion of fluid was forcible and fell in a drop at some distance from the mosquito. But thereafter, with increased and excessive engorgement it trickled down one of the hind legs and invariably hung suspended, until sufficient caused it to fall, directly from that part of the last tarsal joint and segment which, while snowy white in the *Cellia argyrotarsis*, has a "very persistent deep black basal band" (Theobald, Vol. 1, p. 125) in the *Cellia albipes*. It is probably coincidence, but it suggested the possibility of some bleaching action on the part of the fluid which, maintained for a long number of generations, might have the ultimate effect as seen in *Cellia argyrotarsis*.

7. Slight modifications from Theobald's description of *Cellia Argyrotarsis* have been noted - for example, he does not mention the distinct metallic gold spots along the outer posterior margin of the eyes which are simply described as "black" - this need not be further discussed here.

8. The sketch(over) shows the piece of ground which was used to investigate the comparative frequency of Anophelines and the relation of their actual breeding areas to shade, types of water vegetation and other water animals. This area was primarily chosen because the whole field, of which this is a corner, was shortly to undergo bonification by re-levelling and grading, and it was thought such an examination before and after bonification, particularly ~~the~~ adjoining canal, would determine whether the Anophelines which formerly were hatched in numerous pot-holes and water-filled hoof-marks in the field would after bonification continue their breeding at the edges of the canal.

9. Specimens of all the water insects and other animals were collected at the time of the examinations and deposited in glass tubes filled with 70% spirit. These were brought home to England and have very kindly been identified, so far as possible, by the Keepers concerned at the Natural History Department in the British Museum.

10. The area was divided accurately into portions of ten yards square each, including the canal which separated the field from the road and along the bank of which trees were planted at intervals. The shade afforded from these throughout the day-time was recorded by super-imposed lines of shading.



THOMAS ROAD (side road).

CAMP STREET (Main Road).

CANAL

CANAL

OLD ROAD (see page 69)

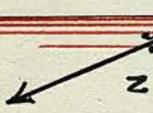
MARSH

MARSH

[ROOF-MARKED]

NOT EXAMINED

NOT EXAMINED



Scale - 1" = 10 yds.

LONGDEN PARK, GEORGETOWN.

for Key, see page 69.

11. Below is the key to the lettering, &c.

ROADS indicated in red.

CANALS & MARSHY GROUND (Hoof-marked mostly) in Green.

CONTOUR LINES indicate dry, slightly raised areas.

SHADED LINES show daily shade area of trees.

ASTERISKS IN CIRCLE - Sites in which Anopheline larvae were found, together with actual number found.

EMPTY CIRCLE - Site examined for Anopheline larvae but none found. Culex larvae were found in nearly all such places.

A CROSS (X) indicates where Anopheline larvae were found at the edges of the canal. The number of crosses is the actual number found; that is, during the course of that ten yard area.

C indicates Culex larvae, together with number found.

P indicates pupae found, together with number. No anopheline pupae were noted.

W indicates presence of "water-spiders". WW showing same in abundance.

M indicates may-fly larvae.

S indicates shrimps. SS in abundance.

F indicates the small fish known as "millions".

B indicates Notonecta (water-boatmen).

12. Twenty "dips", with an ordinary white enamel soup ladle dipper, were made in each hundred square yard area, either in one place, or two lots of ten each in two places. In the field the areas were not strictly kept to where some more suitable spot presented itself. At the edge of the canal the two most suitable spots in each ten yards were chosen.

13. The sketch represents the series of examinations before bonification of the field.

These examinations were made on three separate occasions with roughly three or four days interval at 2 - 3 p.m. This was through necessity rather than by choice. At each examination notes were made as to sunshine, level of canal water, speed of flow (if any), and stage of growth of larvae. Also, it was noted whether the wind was strong, slight or absent, and if the water was rippled.

14. Water vegetation consisted chiefly of rank grass which provided a certain amount of shelter and shade. Small patches occurred of a flat-leaved plant which, though giving little shade, afforded a fair degree of shelter for the larvae, which were frequently found about the stems at the surface.

15. Results of the first examination showed fairly definitely that the larvae direct shaded and sheltered breeding places. Only four were found on the western edge of the canal in areas where the only shade was that of grass stems; while in the shelter and shade of the bridge at the northern end four were found in a small area. On the east side, although only small numbers were found they were continuous the whole length. (The above refers to Anopheline larvae only).

16. The more indifferent *Culex* was found on both sides, but certainly more frequently on the shaded east side.

17. Where water "spiders" were abundant no larvae were caught, with the exception of one area (D 1). An abundance of small shrimps (A 1) appeared to make no difference to the breeding of Anopheline larvae, though *Culex* larvae were perhaps fewer. No larvae or pupae were caught at the junction of the two branches of the canal. The flow of the water here, with rippling of the surface probably accounted for this. In the area F 1, the distance between adjacent trees permitted of an area quite unshaded. A large number of *Culex* and a single Anopheline were found. The grass shelter was only slight.

18. The results of the dipping in the field were conclusive evidence of the suitability of small, sheltered and nearly vertical edged depressions about one foot in diameter, as sites for the breeding of Anophelines. At the time of the investigations the field was perhaps drier than at other times prevailed, and yet the larvae were

found in eight out of twenty-six such depressions. It is probable that in so small an area of water, the first dip would send all the larvae to the bottom; although a pause was taken before the second and remaining dips the same thing might happen again, and thus a negative result be obtained where a few might have been present. Also, the number caught in the ten or twenty dips would be but a fraction of those actually there. The type of depression in which they were found was quite distinct. Formerly hoof-marks, the land had sunk with the previous rains leaving depressions between hillocks quite a foot in height. Those which were very small and deep, and with over-hanging grass which shut out most of the light, were almost invariably negative; while those of about a foot in diameter with clean edges and admitting of a degree of light, and not too deep, generally contained larvae. Culex larvae did not seem so particular.

19. Of the possible larvicides, the Notonecta were not definitely seen to attack or be eating larvae. Shrimps on more than one occasion were seen with larvae in their feet, but not pupae, though only a few of these were seen. The most interesting were the water "spiders". Quite a number were caught with a large batch of culex eggs firmly clasped. The under aspect of the rafts were approximated to the belly and mouth. It seemed probable that the rafts were caught by the "spiders" shortly before hatching out, and the young larvae captured on emerging; or else that the juices of the larvae in the eggs were sucked out by the "spiders". May-fly larvae almost definitely were feeding on the culex larvae. In no case were Anopheline larvae seen caught by any of the water animals. Millions were only observed in the area G 1.

20. One or two other specimens were collected but which have not been charted on the sketch as the numbers were few. These included water-bugs, a water beetle, tadpoles and one or two small fish. It is not known if these were larvicidal. The list, together with their names is appended.

	<u>COMMON OR LOCAL NAME</u>	<u>SCIENTIFIC NAME</u>
(1)	"Millions"	Acanthocephalus ? reticulatus ? melanogonus

	<u>COMMON OR LOCAL NAME</u>	<u>SCIENTIFIC NAME</u>
(2)	Water bug ("Water spiders")	Belostoma sp. (probably B. anura, H.S.)
(3)	Do. larva	Larva of Do.
(4)	-----	Ranatra annulipes, Montandon.
This single specimen has been accepted by the British Museum.		
(5)	Water beetle	Tropisternus sp. (family Hydrophilidae.)
(6)	Tadpoles	(?) Hyla sp. (Little known of S. American frogs').
(7)	(Fish)	Lebistes reticulatus Peters (family Pocciliidae).
(8)	( Do. )	Cichlasma bimaculatum Linn. (family Cichlidae).

21. The second examination following bonification unfortunately took place when there had been a long spell of dry weather. There were naturally no breeding places left in the field itself, all the holes having been filled in, and the general surface graded off to the canal banks. In the canal itself very few mosquitoes were found breeding, and only one Anopheline larva (D 1); but whether this was the effect of the dry weather, or partly that and bonification it is difficult to say. The level of the water was decidedly lower, but there was no reason why breeding should have discontinued.

22. During the collection of Anophelines in Essequibo, mostly in the ranges of the estate coolies and in thatched huts in the villages, certain points of interest in regard to the habits of the insects were noted. Some of the more definite of these are summed up briefly below -

(1) A fairly constant time, shortly after darkness had set in, was found to be the best for collecting; before this the coolies sitting



in the doorway, or more often squatting on the dried clay floor beside the doorway in the common verandah or roofed passage way of the range, did not seem to be disturbed by many mosquitoes, nor were more than a few found within. But quite suddenly the air seemed filled with them in comparison and "swatting" and scratching became general. Nor, after this, was it difficult to find them inside. The room is <sup>then, by the people,</sup> more or less closed in and the smoke from the fire increased. However unhygienic the atmosphere may be or become it is very soon appreciated that a smoky atmosphere is less discomforting than the persistent attacks of mosquitoes.

(2) Anophelines varied considerably in their choice of a resting place, both before and after a meal of blood. Those fully engorged seemed to prefer either a position very near the floor on the wall or under the bed, or very near the ceiling (or roof as it generally was). The former is quite understandable with a loaded abdomen; but the reason for the former is more difficult, unless it was - anywhere, high or low, so long as it was a place where they were not likely to be interrupted, and where it was dark.

(3) The average height from the floor where the majority were to be found was about four feet; frequently this was on the wall just at the level of the "bed" - this was often simply a wooden frame over which sacking had been flung, and with or without a sheet. A favourite place also was the under side of the mosquito-net - or what once was a mosquito-net - where there was one, under the horizontal over-head part which was commonly of calico or similar material.

(4) Where there were clothes hanging up, or over a horse, numerous Anophelines could be found in their folds; but not in the case of clothes with a very rough surface such as woollen, suggesting that the surface interfered with settling, or that their legs would become entangled in it. Highly odourous or uriniferous garments (and there were not a few) were generally avoided.

(5) So far as the actual walls were concerned

there appeared to be a marked dislike to surfaces more or less covered with magazine pictures and prints - unless these were partially torn from the wall, even slightly, when the posterior surface often revealed one or two; as though the white colour was distasteful, or the shiny surface precluded a firm hold, or possibly because of the smell of the ink and paper. Wooden surfaces were appreciated by both *Culex* and *Anopheline*, the former especially choosing the lintel of the door.

(6) Where there were one or more persons with fever in the room a definitely larger number of mosquitoes were observed, not necessarily engorged; in other huts there seemed a conspicuous absence of mosquitoes for no accountable reason. One room of a number in a single range would thus occasionally be found almost free of insects. On enquiry, the occupants agreed that it was so often for quite long periods - "M'squitoes no hav'um here - get-um next door" was all that could be got out of them. On one occasion a number of ants were seen in a long line from the floor to the roof, and ~~these~~ may have frightened the mosquitoes off. Again, while it was a simple matter to collect specimens in one room - by using a glass tube with a little chloroformed wool at the bottom and encircling it over them against the wall or other object - in other rooms the *Anophelines* seemed unusually active and flew off at the slightest approach. It is possible that where young children are numerous in a room the insects would tend to become more wary, but this hardly warrants the assumption that the mosquitoes' sojourn in the one room would continue, which would be necessary. Possibly the age of the insect, or a particularly lively brood might account for it.

(7) The "kitchen" or small closed-in lean-to at the back was generally quite free of both the *Culex* and the *Anopheline*. The ever-present fire and smoky atmosphere was no doubt the reason.

23. A more exact knowledge of these seemingly small points is wanted; and their interpretation and avoidance would do much to lessen the general discomfort which obtains.

## E. PREVENTIVE METHODS AND POSSIBILITIES.

Experience in malarious countries has proved over and over again that much preventive work is often undertaken and large sums of money spent, without appreciable results; and that this is more often than not due to a lack of adequate knowledge of the existing facts and a blind adherence to principles irrespective of local conditions. A notable example in this respect is the wholesale clearance of bush to eliminate a shade-loving species of Anopheline, only to pave the way for the entry of a sun-loving species not previously suspected of being there.

2. In British Guiana, before any extensive or wholesale anti-malarial measures are promulgated, such preliminaries are of paramount importance. Only the fringe of the subject has in reality been touched during the past years, although experience alone and the application of its lessons has done not a little to mitigate some of the worse offending factors. How much more cheaply this could have been effected following systematic research will only be realised after this is accomplished. Such research may well occupy a whole-time service of a medical officer, expert on the subject, together with trained assistants, quite two or three years.

3. It is comparatively easy to suggest measures that will be effective in the reduction of malaria where unlimited funds are available - or even where the strictest possibly economy is not vital. It is another matter in a Colony in straitened financial circumstances, where the allotted vote for all anti-malarial measures, creative, constructive, destructive and preventive, is less than £1,000 per annum, and for an area larger than England and Wales.

4. Much is already being done that in the long run must prove of ultimate benefit, although the total figures do not at present show any appreciable decline in the number of fresh admissions to hospital, nor of cases treated. But this may in part be due to an increased attendance. Again, cases are less likely to-day to be left untreated for very long. The actual death-rate from malaria must be falling. With regard to present measures

bonification of the land probably ranks first in importance, as both clearance of bush and elimination of breeding areas, besides permanent levelling of the ground and controlled drainage, is included. Along the coast-lands where the ground is absolutely flat, the effects are enhanced. It is just possible, however, that such bonification might be more effective from the purely preventive standpoint if it were restricted to land surrounding and including the more intensely malarial districts, rather than around the larger towns where the proportion of malaria is less.

2. Second in importance, perhaps, comes "fishing" of the larger water reservoirs and ponds - the introduction of living species known to be active larvicides - together with surface oiling and the use of Paris green. Not less important is the regular cutting and cleaning of the banks of canals and ditches and the adjacent water edges. But while the latter can be more insisted upon the former methods require continued supervision and maintenance by numerous trained assistants, at considerably more cost. In fact, though sprayers are employed their extensive use is greatly restricted, and much of what is done is wasted because of the impossibility of repetition at short enough intervals.

3. The free distribution of quinine by the Government, or at cost price or less, seems formerly to have been taken advantage of to a much greater extent than at present. The question of the value of prophylactic quinine is very far from being solved. In a country malarially endemic the daily dosage of ten grains would theoretically have to be continued throughout the year - with probably worse results than a few attacks of malaria. The discussion is not relevant here, but it may be added that at a meeting of Practitioners in the Colony recently, many of whom had been long resident in British Guiana, opinion was almost unanimous against such prophylaxis, irrespective of dose or period maintained.

4. Laws exist in the Colony for the punishment of those in whose gardens, gutters, &c., mosquitoes are found breeding. Water-butts and tanks must be screened. Were these laws strictly and unequivocally enforced, malaria in the towns would practically cease to exist save by the introduction of infected persons from without. But although

much is done, it is not enough. There is considerable variation, also, in the different districts of the one town. This was brought to the fore in the paper previously referred to (D para 2) by Dr Wise in 1911.

5. From the statistical evidence submitted in this paper some points arise which may serve to show how in other ways, if somewhat more general and less defined, the problem of prevention may be approached.

6. Before any field work is begun it is eminently desirable to have drawn up and analysed the statistical evidence of malaria, over as long a period as there are reports available, not only of the Colony as a whole, or of its individual counties, but for each separate district, hospital and estate hospital. Details are kept in the Public Hospitals of the district of origin of the patient. Were these record books enquired into thoroughly a very exact comparative study would be possible. That the figures themselves might be based on error - such as diagnosis - does not necessarily invalidate their use. At most, correct diagnoses must exceed incorrect ones. But however large the average error, it is reasonable to assume that that error is more or less equally applicable to all the figures from all the districts. Knowing HOW MANY cases of malaria have occurred at any one place in itself does not help matters; but that number AS COMPARED WITH other places, granting an equality of error, must be useful. Comparisons between malaria as obtains in Public Hospitals and that occurring on sugar estates has shown the validity of this supposition. To have before one the map of the Colony on which is carefully charted the results of the analysis of such statistics, and to be aware of what has gone before, provides the basis for further investigation of special branches of the subject. Care must be taken, however, in assessing the value of the figures, not only collectively, but year by year, and even decade by decade, to allow for the changes that may have taken place as the result of medical advance, usage and inclusiveness of diagnostic terms, movement of the population, rise and fall of industries, outstanding natural or economic events, special campaigns against the disease, and such like.

7. Nor are the mere figures for malaria sufficient. Existence of other disease, with comparative figures, is essential. Thus, Ancylostomiasis in British Guiana is extremely prevalent. More damage is done by infection with the nematode *Ascaris*, of which hundreds are sometimes removed from single individuals, than is realised. In fact, to attempt systematic examinations of the blood and spleen without consistently examining the stool for the presence of ova is valueless.

8. Annual figures, as has been shown, are not always the most useful. Thus, had the years been dated from July to June, the effects of the drought in 1925-1926 would have been fully exposed. Monthly figures, still more useful, are vitally necessary in a country with two wet and two dry seasons. Nor should these just simply be worked out to date and then left; but a continuous chart, added to month by month as the reports come in, together with the keeping of notes at the time in regard to any special reason for a change in incidence. So, for example, an appeal to the coolies in that locality to come for treatment, would account for a rise in the total cases which otherwise would be assigned to an increase in incidence. Parallel charts of the rainfall, wind strength and direction, humidity and other meteorological factors should of course be kept.

9. This preliminary aspect of preventive work has deliberately been stressed, because it is so often overlooked. Once completed, it is a comparatively simple matter, and of negligible cost, to continue it. New light on the disease is continually unfolding. Even the initial cost is minimal compared with almost any form of field work, requiring no apparatus; the advantages to be gained are really great, and probably of much more inclusive and permanent value than a whole series of isolated but disconnected experiments.

10. Thus, in the present study, there is some evidence to show that an epidemic of the disease may pass across the Colony from west to east: two such "waves" have been indicated, one shorter than the other. This, in only ten years of figures. With a longer period a definite cycle might emerge. If this be true, the optimum time for intensive preventive work can be gauged. Further, such

work, if restricted more or less to an imaginary line which divided Essequibo from the other two counties, might in advance prevent any further spread of an epidemic eastwards. Meanwhile the one previous to this will have reached Berbice, and finally have passed out of the Colony and died down. No new epidemic taking its place, from the west, the average level of the malaria in these counties must drop. This imaginary line would devolve itself into special points of entry of the people into Demerara, such as the boat from Bartica, or the North West District. Once checked, intensive measures and treatment could be pushed gradually westward into Essequibo in the populated areas.

11. Movement of the population on a large scale is not feasible, but encouragement may be provided to spread to healthier areas. Thus, it has been shown fairly conclusively that estates situated along the coast show on the average a decidedly lower malarial rate than those further up the rivers. There is no shortage of coast-land suitable for cultivation in British Guiana. With the increased acreage under rice each year prohibiting the use of land other than the immediate coastal belt where it is sufficiently wind-swept would be advantageous: in return for which concessions must be granted.

12. The inroads of the sea have compelled the leaving of shore trees and bush uncut to act as a binder to the land, as being much more economical than artificial measures; but the height of this barrier to the free play of the wind can be reduced to and kept at a minimum.

13. Keeping an open stretch of land between the sea and the estates is an important factor, as revealed in the case of the estates of Anna Regina on the Aroabisce coast, and those of Albion and Port Mourant in Berbice. It is seen again in Group F, on the east coast of Demerara, as compared with Group G, where a thick belt of trees shelters the estates.

14. Stress has been laid throughout on the importance of bush in helping to determine the incidence on estates. Those with a super-abundance of such vegetation have been shown to have a higher incidence than those not so encumbered. This is one of the reasons why estates up-rivers are more

malarious. Although the existence of water suitable to Anopheline breeding has not been studied comparatively on the different estates note has been made of those estates where repairs generally are wanting, and where many canals, now no longer used, are potent sources of breeding, chiefly in derelict and smaller estates. But it cannot be supposed that there is so great a difference between the water areas of the larger estates, as breeding grounds, as to account for the great differences in the malarial rates. Infact, the largest ones where the actual water surface must necessarily be the most extensive in proportion to acreage of estate and barge transit, actually show the smallest percentage of malaria. Those again, which were classed in the second largest group (Group IV) as having between 2,000 and 3,000 workers, showed the highest malarial rate. Thus, with water acreage only slightly less than that for the largest estates (proportionally) there is extreme contrast in the degree of malaria. Whereas, as has been said, the estates in Group IV with high malaria are almost invariably set in the midst of bush; and those in Group V with lowest malaria are noticeably free from bush. The inference is strong that bush, rather than suitable water, is the more important in helping to determine the malaria.

15. This may be supplemented from the point of view of the mosquito. Text-books on the subject of malarial prevention appear to lay emphasis on every aspect of the importance of water in the breeding of Anophelines; but comparatively little is devoted to the subject of vegetation, except in a general way. It is suggested that the bush, not the water, is of prime importance to the mosquito; and the Anopheline certainly shows discrimination in its choice of breeding area. It matters little to the female whether there is a great sheet of water available: she wants enough and no more. But she is a nocturnal insect. No matter how suitable the actual water, unless there is adequate shade - not only for the larvae, which is a simple matter, but for the young imagoes after hatching, during the heat of the day, her labours are largely wasted. And in British Guiana the two malarial Anophelines are shade lovers.

16. A single small bush may appear ample for so diminutive an insect; but it is very doubtful if



this is the case. In the first place the hatch may be prolific, but what appears of very much more importance is that if the shade was restricted to a solitary bush the natural enemies of mosquitoes, such as dragon-flies and bats, would very quickly know of it and the brood be decimated. Whereas, were the young insects at liberty to vary, however slightly, their immediate habitat an immense measure of security would follow. Further, within the confines of such limited umbrage, while shade might be sufficient, shelter would not. Wind is not always constant in its direction, and what was protection one day might be danger the next: the leeward may become the windward. In the shelter of a fair expanse of bush this would be minimised. Finally, there must be a greater variety of vegetable juices as food where there is more bush, site selection is possible, and there is a safety in numbers even with mosquitoes.

17. Rather than spend endless sums of money on treating water surfaces - only a fraction of which area actually contains larvae - and re-treating them at close intervals, it seems that absolute bush clearance on either side of canals and ditches or around ponds for an adequate distance, or even leaving an isolated bush now and then for ornamental purposes, would equally serve the purpose and be more permanent and less costly. Such would not be possible to the same extent around towns and villages as in the case of the sugar estates, and even the rice fields. In marshy areas there is generally sufficient vegetation for the insects but too often the edges are surrounded with bush.

18. The tendency of the front lands of sugar estates to be turned over to rice cultivation has been mentioned. Provided the land is unobstructed between the estate and the sea there should not be any greater danger than before; but it appears advisable for the Health authorities to be notified in advance of such a move, so that measures may be taken to see that the land is left more or less bonified before being handed over, and not until that is done. It would depend on what use is to be made of the land, naturally, as to what should be done. If building is to follow, proper levelling and draining is a first essential. But it is suggested that the onus should not be wholly on the purchaser, if sold, but that the original owners should be required at least to leave the land in a fit state.

19. The question of turning the front lands into "flood-lands" for the excess water from the estates is a difficult one. There are enough canals already in Demerara without digging any more; and digging canals is not the whole solution of drainage in a country "billiard-table" flat. There must be many miles of such canals along the coast lands alone. And the more the canals, the more the edges and banks to keep cleaned. It is true that the flood water generally drains off these lands fairly quickly; and the alternating state would be disliked by the Anopheline; but there are mosquitoes enough to warrant some comprehensive plan being executed.

20. Comparison between estates as to population brought out the interesting fact that the larger the estate the less the proportion of malaria thereon - with the notable exception of one Group (IV) - and that where a reduction in the employees took place, as in most estates over the decade, there was the suggestion of a temporary rise in the malaria among those that remained; and thirdly, and apparently contradictory to the above, that according to the total and corrected curves, and their approximation, the malaria seemed to run a fairly independent course as compared with the population.

21. A generalised epidemic, or a local epidemic, or a variation in the mosquito factors, or some other local cause, may and does influence the malarial curve; but as the effects wear away, the curve tends to return to its former position. There is probably, for any individual place or area a mean level of malaria to which it will return following any departure from it, and which will only be permanently raised or lowered if the alterations causing the change are permanent. There is evidence of <sup>this</sup> throughout the graphs given. But the evidence would be much more manifest over a longer number of years. The very fact that malaria still exists in the same areas for generations, and perhaps centuries, practically demands this assumption. The two main factors concerned in malaria are the human factor and the mosquito factor - that is, the two hosts of the parasite. Slight and temporary alteration in the one cannot cause an immediate and similar effect on the other, but it can, by upsetting the existing balance between them, cause a super-added alteration in the same one. Thus, a sudden decline in the population cannot cause an immediate reduction in the

number of infected Anophelines, but by upsetting the existing balance there is a greater proportion of infected Anophelines per head of the reduced population - or, rather, fewer persons to each infected mosquito. The effect of this would be to cause a rise in the malarial rate of employees. Though the number of infected insects would tend to decrease because of there being fewer people, this is counter-balanced or made good by the larger number of malarial patients for them to bite. The ultimate balance must depend upon the parasite which links the two factors together. If the reduction in employees is permanent the malaria will gradually return to its normal level which now will be on a slightly lower level than formerly, and the new standard of balance be maintained. This will take time, and other factors meanwhile may be influencing it, either hastening its accomplishment, or hindering it, such as an altered rainfall. If the reduction is only temporary the former mean level will be attained sooner or later, according as it is modified by ~~by~~ similar outside factors.

22. Thus, where an estate shows a gradually declining population the immediate effect will be as for a temporary reduction, and the malaria will rise; and the later effect will be as for a permanent reduction, and the malaria will fall. But whether these run consecutively, concurrently, or overlapping each other (that is, a second temporary effect superimposed on a first permanent effect) will depend on whether that reduction takes place very gradually, or there is an appreciable reduction at stated intervals. If this be so, then a malarial curve could not be expected to be regular if the dismissals were irregular. If they were regular, appreciable in number, and at fixed periods of time, say every five years, then the malarial curve would show a rise following every dismissals, and then a gradual decline to sub-normal - or the new mean level; again, modified by other factors.

23. This may serve to explain the phenomenon of the temporary rise following the reduction, and the noticeable feature of the comparative independence of the malarial curve from that of the population curve. And from the preventive point of view it is of considerable importance. Were advance notification of the intention to dismiss given to the

Health authorities, where the numbers were appreciable, naturally, those remaining could not only be warned that malaria was likely to be more rife for a time and so to take extra precautions, but a course of treatment might then be administered or an intensive anti-malarial campaign in the field undertaken. If these reductions were at definite intervals, say annually or every two years, so much the better from the standpoint of administration and preparation; but this is less feasible.

24. Analysis in relation to the effect of rainfall has been discussed in some detail, and the conclusions given on page 53 (B. (b) to (e) concluded) need not be repeated; but the reasons for such phenomena have still to be given and their interpretation as regards prevention.

25. A pronounced feature of the graphs showing the rainfall on estates in both county and Group has been the manifest decrease in the proportion of malaria following a rise in the number of inches of rain. This seems to be the reverse of what would naturally be expected - a rise in the rainfall causing an increase in the number of Anophelines, and so an increase in the malaria. An important point to be remembered is that these results are based on annual figures. Were they monthly it would be quite a different argument. Then, it might with equal truth be said that the rise in the rainfall caused a rise in the malaria the following month, giving the effect of an inverse ratio for any one month. But with annual figures this cannot be so. On the other hand, such figures take no notice of the two wet seasons occurring in the same year, one of which is longer than the other: similarly, the dry seasons. The generally accepted statement is that malaria tends to increase especially at the commencement of the rainy seasons, and to perhaps a slightly less extent also at their close. But it is difficult to see how this could produce the results so consistently manifested on the annual graphs. Until monthly figures are worked out, the evidence cannot be considered conclusive, however.

26. There is no doubt about there being more mosquitoes at the onset of the rainy seasons. This is quickly realised by all who come to the Colony. But this by no means infers that therefore there must be more malaria. To take a hypothetical

example: supposing in a given room there were one hundred mosquitoes, and that during the course of the twenty-four hours a single occupant was bitten twenty times. It does not follow that because there are a thousand in the room he will be bitten two hundred times, though he will be bitten more than twenty times. If in each case two per cent of the mosquitoes were infected with malarial parasites he therefore stands a better chance of escaping infection when there are more mosquitoes than when there are less.

27. Again, owing to the more ubiquitous habits of the *Culex* genus, already many times more abundant than the *Anopheles*, an onset of rainfall will suit the indifferent habits of the former on many more occasions than the latter who is decidedly more particular; the increase of culicines will thus be out of proportion to that of anophelines. In the given room, therefore, following rainfall, there is likely to be a greater percentage of culicines among the thousand than there was among the hundred. The proportion of infected *Anopheles* will thus be still less likely to be among the number that bite the occupant.

28. It is true that this may only be temporary, and that as a result of a larger proportion biting there may be an increase of infections taking place, but because the mosquito goes further afield in search of blood and meets new cases. It is possible, too, that at the onset of the rains there is a decline in the temperature and an increase of the humidity, and at such times the general resistance of a person may be lower, and a relapse of former malaria result in a fresh outburst of parasites in the peripheral circulation, though the gametocytes are perhaps not very numerous.

29. Were the converse to be true, and an increase of rain at the onset of the season did produce a higher malarial rate, it must take some time for continued rain to have an adverse effect on *Anopheles* breeding, and still more time for this to be reflected in a lower percentage of infected ones, and so a lower malaria rate; this must mean a continuation of the higher rate for a time, and then a gradual fall. But the malarial curve on the graph does not appear compatible with this.

30. The argument in favour of the inverse ratio appears bluntly contradicted when it is considered that in Essequibo where there is a high average rainfall there is also a high average degree of malaria. Were these the only factors involved it might be decisive. It has been said that though the inverse ratio held good it did not mean that because Essequibo had a high rainfall therefore the malaria should be lower than Berbice with a low rainfall; but that within a district with an equivalent range of rainfall the malaria will vary inversely within that range: the mean level of both may be higher or lower, and at that level the inverse ratio occurs. The point of importance then, is not the rainfall by itself nor the malaria, but the mean level of the two, around which the inverse ratio takes place. It is not the rainfall which decides the high level of the malaria, but factors which decide the mean.

31. Essequibo is over-burdened with bush, and evidence has been forthcoming that where there is more bush there tends to be more malaria, and this irrespective of the acreage of suitable water surface. Where there is more bush there is more rainfall. The bush is therefore a predominant factor in deciding the mean, and the bush, not the high rainfall, that decides the high malaria.

32. Tentative reasons have been given for the occasional single year periods when the curves, on the graphs, for malaria run parallel with that for the rainfall: that the malaria cannot recover its upward (or downward) curve so quickly as the rainfall, especially after an excessive rise or fall in the malaria. This "delay", causing a blunting of the malarial curve, is either more or less beneficial according to whether it occurs as the aftermath of a fall or rise in the malaria.

33. Consideration of these factors in relation to the rainfall have an important bearing on the problem of deciding exactly when an intensive anti-malarial campaign should be commenced. It might seem natural that such work would begin immediately preceding the onset of the rains before the mosquitoes began to multiply excessively; but if the foregoing suggestions obtain the more ideal time would be to "catch" the malaria not, as it were, just before the curve began to rise again, but just as it begins to fall. That is to say, if

following a year with low rainfall and high malaria, reports began to be received showing a reverse position, then would be the time to begin. The preventive work would then be running with, not against, the downward tide of malaria. The combined effect of the natural fall and the artificial reduction would enhance the result, with a strong possibility, in consequence, of "delaying" the recovery until the rainfall was again on the increase when the malaria would stay low, if not lower.

34. In practice, however, field work is largely impossible once the rains have set in, and the plan thus has to be modified. In such a case, it seems advisable to split up the preventive measures into two separate divisions - the field work, and the prophylaxis or anticipatory treatment as it may be termed. Thus, the field-work, consisting of freeing the land adjacent to water surfaces from bush, and other measures, would be undertaken before the rains commenced; and the quinine administration shortly after, but not immediately, the rains had begun, as well as other methods in the houses which check the spread of infection. These must be persisted in so long as the rainfall rises, or continues high. Once this drops there is the likely hood of the malaria rising; but so long as this is "delayed" measures must continue. Thereafter it would be fighting against a rising curve and so not as effective. But, it is hoped, rising not so high as formerly. The next intensive campaign would await similar conditions. If graphs are kept up-to-date, it is probable that such conditions may be anticipated well in advance. Similarly, it is suggested, it would be easier, less costly and more productive of results if epidemics were fought on the decline rather than at the commencement - both, preferably, but so often just when it is dying down all the activities become relaxed and advantage is not taken of the downward trend. It should be more effective fighting with Nature, than against her.

35. The need for large scale plans is pressing. Without these, and with only figures, it is difficult to visualise the various factors. Further, it is much easier to mark alterations or plot in figures at the time of receiving them: the whole is always at hand and collected when required for reference.

In relation here, to estate plans, on as large a scale as possible, it is proposed to draw-in especially— (1) The areas of shade, or bush; (2) the areas of suitable water surface; (3) House acreage; (4) the areas of the latter where children may be more numerous, with a note of the percentage of total children to the population of the district. Once these have been ascertained, but not before, a number of estates will be chosen where, more particularly in regard to the first three, one of these factors is predominant. On each of these the parasite index, the splenic index and status (S.S.), and Anopheline rates will be estimated, with the object of determining the relation between them and the malaria. If it so happens, for example, that there is more malaria on that which shows the highest bush acreage, then measures will be taken if possible to reduce this bush especially in areas in relation to water surfaces, and ultimately watch for a change in the malarial rate - taking into account seasonal changes, of course. If, on the other hand, the estate with the largest number of buildings per unit area emerges as the most malarious, then another estate, similar in size and as far as possible equal in other conditions, will be chosen; this time with a much lower proportion of the area built upon, or at least scattered over a wider area, and similarly determined. And so, with water surface.

36. It may be more suitable to take a village than an estate, or even an isolated part of a village. Thus, a map was commenced, shortly before leaving the Colony, of a village where a main road almost exactly divided the area (Lodge village, on the outskirts of Georgetown and somewhat separated from other villages). The western half was heavily built upon; the eastern mostly bushed, with a few scattered houses. A comparison between the various rates and indices here, on either side, would be very valuable.

37. In these ways, then, it may be possible to gauge the relative importance of the factors responsible for the mean level of malaria in any district, to see whether they vary in different parts of the Colony or are the same throughout, and if the latter, to endeavour to state which predominant factor will, by reduction or alteration, be the means of lowering the permanent level of that mean. Ultimately it may be possible, by assessing values to the different ratios to evolve



a formula for the Colony or counties which will be of service in advance estimation of the probable mean level of malaria in any specific district that is to be opened up. With a knowledge of the various mean levels of malaria throughout the coastlands, a proportion of the anti-malarial funds could be allotted accordingly as they were high or low, or intensive work restricted to one, starting from the highest. In this way there would follow considerable saving, unnecessary expenditure being reduced to a minimum, and little overlapping.

38. Malaria in the diamond fields, and at Bartica, at the junction of the Essequibo and Mazaruni rivers, is a subject for special investigation. It seems to be the case that patients suffer from particularly severe gastric symptoms. The Subtertian form of parasite is prevalent. It is here, too, that the majority of the cases of Blackwater Fever occur. In a country so malarially endemic it is surprising so few cases (about five to ten per annum, with a tendency to increase these last few years) occur. The mortality is high. It was interesting that two, or possibly three, of the cases that occurred were in a comparatively limited area near Kamakusa, the centre, and where there is a small hospital. One such case of Blackwater was brought down, after slight improvement, partly by boat, and the rest of the journey by seaplane. With regard to the latter, it was interesting to keep a record of the patient's pulse as compared with the temperature and altitude. It was taken with every rise of five hundred feet, roughly, and thereafter at short intervals. The patient was full-length on the stretcher accommodation provided. The pulse certainly became fuller and stronger even in the short time in the air, and the spirits of the patient rose wonderfully. There was no recurrence of the blackwater on or after arrival. The rather sudden descent caused momentary giddiness which was severe.

39. Finally, there is great need for more systematic examination of blood films. Were a different drug required for each type of parasite the differentiation would be routine. Meanwhile malaria is largely taken for granted as requiring quinine, and microscopical examination disregarded. Further, in an over-crowded hospital and limited staff, such cannot be done to any extent. The essential is to cut short the acute symptoms, and discharge them (the cases) on return to normal of the temperature. That is all that is possible.

## F. CONCLUSIONS.

These are admittedly tentative and open to correction and modification when the statistics of a longer period of years have been analysed.

- (1) The malarial figures for Public Hospitals in relation to in-patients, and for Estate Hospitals in relation to estate populations have been analysed. It has been shown that malaria is more endemic in the districts which feed the latter than the former.
- (2) Reasons have been advanced for the prevalence of malaria on estates, and comparisons made between the degree of malaria and the number of employees, the rainfall and prevailing wind, and the bush acreage.
- (3) Evidence has been given of the possibility of epidemics passing across the Colony from west to east, varying in intensity and duration.
- (4) The suggestion is put forward, supplemented by graphs, that with annual increase of rainfall there is annual decrease of malaria; with the converse: that this occurs within the limit of extremes, and that following marked changes there may be a delay in the recovery, or the fall, of the incidence of malaria extending beyond the annual period, and irrespective of a slight change of the rainfall within that period.
- (5) That there is a mean level of malaria around which this inverse ratio moves, and that this mean varies in the different districts, a predominant factor in deciding the level of this mean being the extent of bush.
- (6) The importance of bush, in contrast to suitable water surface, with the evidence afforded by malaria on estates, has been emphasised.
- (7) An initial study of spleen rates in the county of Essequibo, together with the details of a method of convenient estimation of the average spleen of a community called the Splenic Status, or S.S., has been outlined, and the marked difference between these findings with those of estate percentages of malaria compared, to reveal the real endemicity of malaria.

(8) A few notes have been appended relating to the distribution of the different parasites of malaria, the important species of Anophelines, and the need for parallel stool examinations to exclude helminthic infections, as evidenced by differential counts.

(9) Under a final section have been advanced the possible causes of the various phenomena revealed, together with a discussion on the comparative importance of these in general preventive work and special anti-malarial campaigns.

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