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The Chief of the Malaria Section has the honour to communicate hereunder the following note

✓
MALARIA IN SOUTH-WESTERN AND NORTH-WESTERN NIGERIAN COMMUNITIES

by

✓
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1. INTRODUCTION

It is proposed to compare the epidemiology of malaria in representative communities in north-western and in south-western Nigeria. The latter is an area which has attracted the attention of malariologists for over half a century so that there is justification for fairly firm assertions about the pattern of the disease there, but records from the north are much less comprehensive and deductions from them are correspondingly tentative.

The community chosen as representative of south-western Nigeria is that inhabiting the town of Ilaro in Abeokuta Province. This community was intensively studied by the Nigerian Malaria Service during the years 1949-1953 and the observations made then have been recorded in Malaria Service Bulletin No. 3 (Nigeria, 1955). Supplementary observations have since been made on a similar community living at Eggan Village in the Ikeja Division of the Western Region of Nigeria.

The community chosen as representative of north-western Nigeria is that inhabiting the Birnin-Kebbi District and its surroundings in Gwandu Emirate in Sokoto Province. Since 1952 this area has been under the observation of the Nigerian Malaria Service in connexion with the Western Sokoto Malaria Control Project, a large-scale pilot project conducted by the Medical Services of the Northern Region of Nigeria and by the Nigerian Malaria Service with assistance from the World Health Organization and from the United Nations Children's Fund.

The location of these communities is shown on the map on Fig. 1. That they are separated by only six degrees of latitude in no way suggests the contrasts they present. These are in part shown in Table 1.

Fig.1

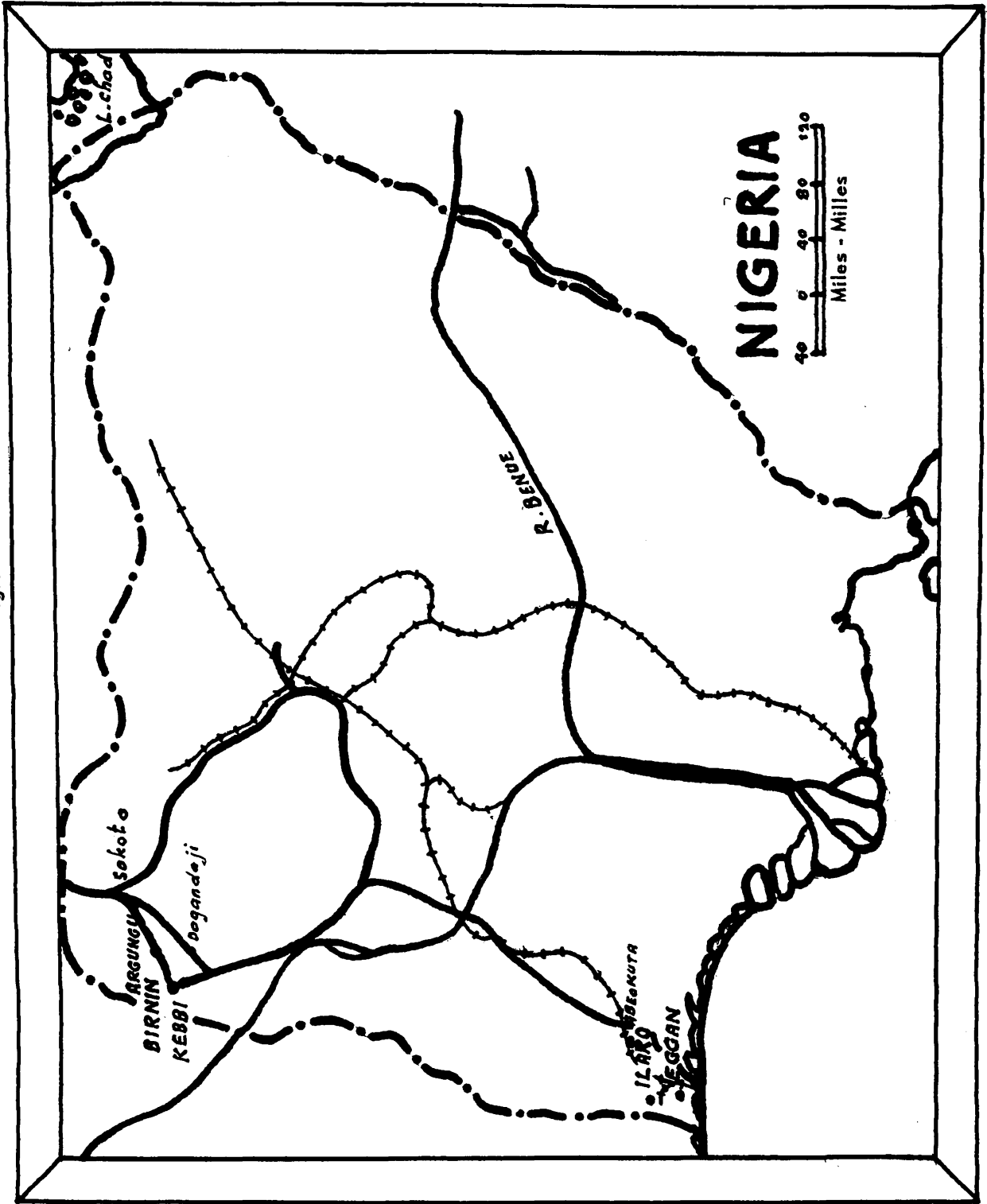


Table 1
Contrasts between representative communities
of South-western and North-western Nigeria

	South-western	North-western
(1) Race	Yoruba	Hausa and Fulani
(2) Religion	Christian, Moslem and animist	Moslem
(3) Vegetation zone inhabited	Secondary forest with patchy clearing.	Open savannah with clear riverine flood-plains
(4) Habitation	Rectangular mud-walled dwellings roofed with corrugated iron or palm-leaf thatch. Occasional houses built of concrete blocks.	Circular "bee-hive" huts with mud-walls and conical thatched roofs of grass. Richer inhabitants live in oblong adobe "shagifas". Fulani inhabit movable wattle huts hemi-spherical in shape
(5) Food-crops	Yam, cassava, bananas, maize	Millet, rice, maize
(6) Principal exports	Cocoa, palm products	Ground-nuts, hides and skins, tobacco
(7) Live-stock	Sheep, goats, occasionally pigs, poultry	Cattle, goats, donkeys, horses, sheep, poultry
(8) Local administration	Elected village and district councils	Emir in council with appointed District and Village Heads.

2. CLIMATE

The climate of the two zones governs many of their differences. A characteristic year's rainfall is shown in Table 2 and in Fig. 2, illustrating how in the south-west some precipitation occurs during most months although substantial recessions are usual during December, January and February and again in August, but how in the north the annual fall is practically confined to the months of June, July, August and September.

Table 2
Rainfall at Ilaro and at Birnin-Kebbi during a typical year

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total in Inches
Ilaro	2.1	0.2	7.68	6.54	7.81	7.18	0.80	1.13	5.43	7.80	2.85	0.17	49.69
Birnin Kebbi	0.0	0.0	0.0	0.91	0.31	6.24	8.69	9.88	4.99	0.45	0.0	0.0	31.47

Temperature and humidity too are different in the two regions. In the south-west these are relatively stable whereas the north experiences the wide swings associated with lands adjacent to deserts. Table 3 shows these factors as recorded respectively at Abeokuta and at Sokoto, the nearest stations to the areas under consideration where regular records are kept.

Table 3.
Representative records of temperature and humidity as experienced in South-western and in North-western Nigeria

Abeokuta, south-western Nigeria

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Mean T ^o F.	81.1	85.1	84.9	84.2	83.1	79.7	78.9	77.7	79.5	81.6	84.3	81.7
Max T ^o F	96	102	98	99	98	93	90	90	91	96	97	98
Min. T ^o F	56	68	67	70	70	68	70	67	70	68	71	63
Hum. %	75	77	75	74	78	84	85	80	82	78	77	76

Sokoto, north-western Nigeria

Mean T ^o F.	76.7	82.3	88.1	88.3	86.9	83.2	79.9	79.1	79.0	84.1	80.3	72.6
Max T ^o F	92.6	97.6	102.0	103.0	97.2	91.6	87.6	86.0	87.4	96.7	96.7	88.1
Min. T ^o F	60.9	66.6	74.2	73.5	76.8	74.8	72.1	72.2	70.6	71.6	63.8	57.1
Hum. %	14	13	11	9	42	51	61	68	65	32	13	12

3. MALARIA VECTORS

These climatic differences naturally affect the mosquito populations of the two regions. A. gambiae and A. funestus are indeed the vectors of malaria in both areas but their seasonal densities differ markedly from one to the other. Yet as Figures 3 and 4 show, there is an overall similarity in the trends of vector densities between both areas. These figures, on which the average anopheles (per room/day) densities tabulated in Table 4 are graphically represented on a Calendar-Logarithmic scale, show the relative stability of the A. funestus population in spite of a general spring regression and compensating autumn increase, and the contrasting fluctuations of the numbers of A. gambiae explosively increasing after rain.

Table 4
Comparison of average anopheles densities per room day
from uncontrolled areas in south-western
and north-western Nigeria

A. funestus

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Ilaro	2.9	1.3	1.1	0.3	0.9	2.0	1.8	2.7	2.1	2.2	2.6	6.8
Dogandaji [†]	2.8	1.0	1.8	0.0	0.0	0.0	1.2	7.8	13.5	31.5	10.5	3.0
Argungu [‡]	5.0	3.8	5.4	1.0	0.3	0.0	3.7	4.3	10.1	51.7	39.5	12.6

A. gambiae

Ilaro	0.1	0.1	0.1	0.2	1.8	2.5	3.4	1.8	1.8	6.4	5.3	0.4
Dogandaji	0.3	0.5	0.3	1.5	0.5	1.2	9.2	55.0	121.0	31.0	3.0	20.5
Argungu	8.3	28.5	16.0	15.8	23.5	84.3	166.5	132.0	136.9	214.9	37.9	18.8

+ Dogandaji is a north-western Nigerian town in an area relatively free from surface water

‡ Argungu is a north-western Nigerian town situated on the banks of the Sokoto River.

Little seasonal variation has been found in the infectivity rates of mosquitoes investigated in south-western Nigeria. At Ilaro during the pre-control year 1949-1950, from dissections of over 4000 anopheles, sporozoite rates for each quarter remained virtually constant. For A. gambiae these were 4.3%, 5.7%, 5.9% and 4.0% respectively and for A. funestus 4.8%, 3.5%, 5.2% and 3.3% (Nigeria, 1955). This picture is in absolute contrast to that found in north-western Nigeria where it is almost impossible to find sporozoites at the end of the dry season (March and April) but where infected mosquitoes are common in the rains, a finding probably related to the short life that is to be expected for mosquitoes under the adverse climatic conditions of the northern dry season.

In that area, during a dry season survey when over 2000 mosquitoes were dissected only two (one A. gambiae and one A. funestus) were found to harbour sporozoites. A wet-season survey found in 1500 dissections, a sporozoite rate in A. gambiae of 3.7% and in A. funestus of 2.3%. In terms of infective densities, these different findings are arresting. This is shown in Table 5.

Table 5
Average infective densities of vector species of
anopheles in north-western and south-western Nigeria at
maximum and minimum seasons of malaria transmission

		North-western Nigeria		South-western Nigeria
		(Argungu)	(Dogandaji)	(Ilaro)
Maximum Transmission (October)	Average Anopheles Density	266.6	62.5	8.6
	Sporozoite Rate	3%	3%	4.6%
	Average Infective Density	7.4	1.9	0.4
Minimum Transmission (April)	Average Anopheles Density	16.8	1.5	0.5
	Sporozoite Rate	0.1	0.1	4.6%
	Average Infective Density	0.02	0.002	0.02

Fig. 3

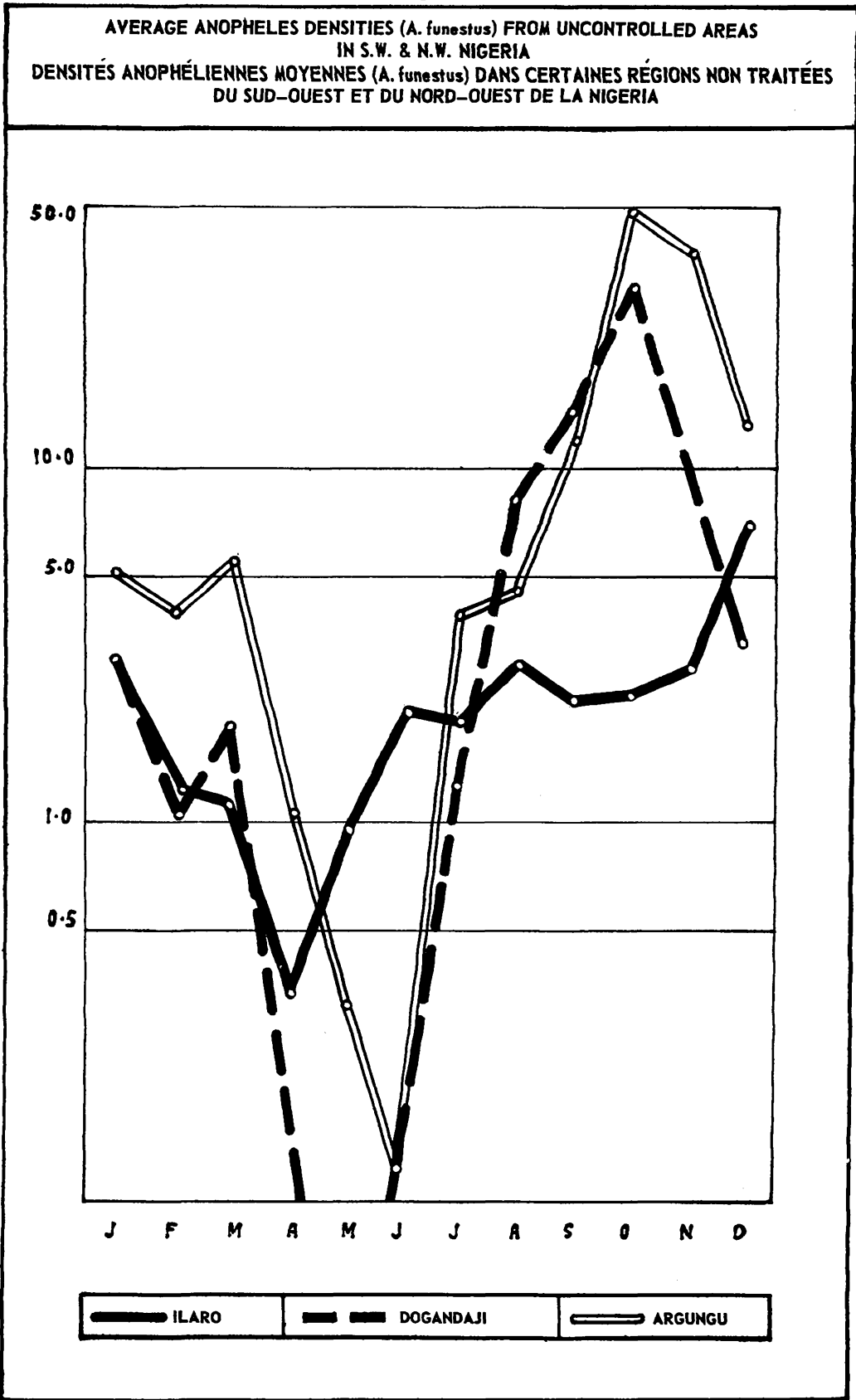
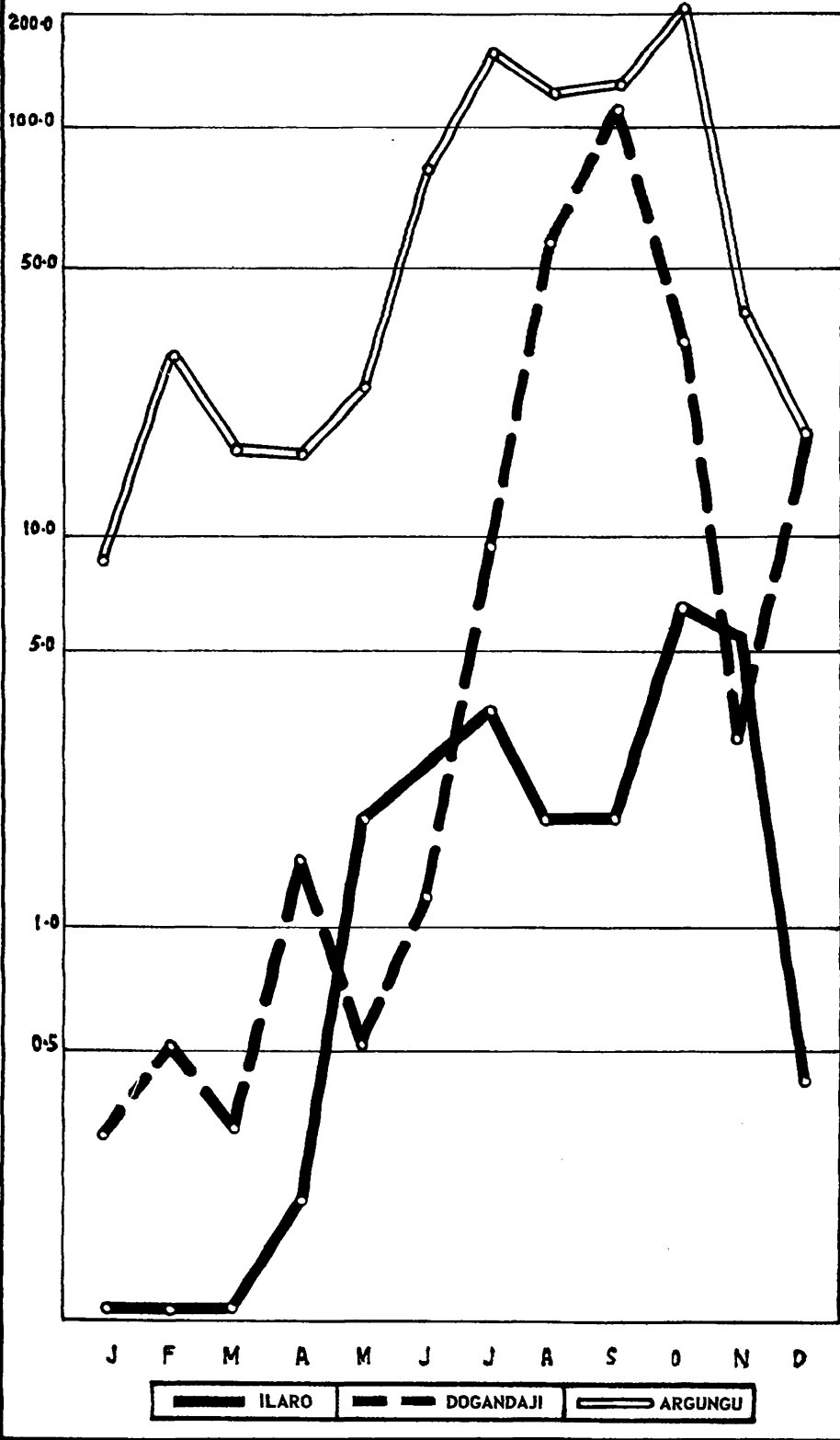


Fig. 4

AVERAGE ANOPHELES DENSITIES (*A. gambiae*) FROM UNCONTROLLED AREAS
IN S.W. AND N.W. NIGERIA
DENSITÉS ANOPHÉLIENNES MOYENNES (*A.gambiae*) DANS CERTAINES RÉGIONS NON TRAITÉES
DU SUD-OUEST ET DU NORD-OUEST DE LA NIGERIA



4. MALARIA IN THE COMMUNITIES

(i) Incidence

The incidence of malaria in the different parts of Nigeria has been explored by surveys carried out by the Nigerian Malaria Service. Examples of typical results obtained in south-western and in north-western Nigeria are shown in Table 6 and 7 and in Figure 5. They show that in both areas malaria is present in holoendemic proportions but that in the north-west the dry season permits a general fall in both spleen and parasite rates to occur, especially marked in the very young.

Table 6

Spleen and parasite rates in African inhabitants of representative areas in south-western and in north-western Nigeria as observed toward the height of transmission - August and September

Location	Age-group	Spleen Rate	Average enlarged spleen	Parasite Rate
South-western Nigeria	Infants	-	-	11/29 = 38.0
	1 and 2	19/30 = 63.3	2.2	31/37 = 83.8
	3 and 4	11/16 = 68.8	2.2	32/39 = 82.1
	5, 6 and 7	72/101 = 71.2	2.0	76/104 = 73.1
	8, 9 and 10	33/63 = 52.3	1.9	79/105 = 75.2
	11 to 15 inclusive	13/40 = 32.5	1.6	16/33 = 48.5
	Over 15	-	-	10/98 = 10.2
North-western Nigeria	Infants	10/22 = 45.5	2.5	27/34 = 79.5
	1 and 2	63/75 = 84.0	2.7	122/125 = 97.5
	3 and 4	132/142 = 93.0	2.7	172/175 = 98.8
	5, 6 and 7	292/339 = 86.2	2.3	330/358 = 92.5
	8, 9 and 10	250/351 = 65.3	2.0	235/365 = 81.0
	11 to 15 inclusive	121/235 = 51.5	2.0	166/268 = 60.9
	Over 15	1/9 = 11.1	1.0	46/139 = 33.0

Table 7

Spleen and parasite rates in African inhabitants of representative areas in south-western and in north-western Nigeria as observed toward the lowest point of seasonal transmission - April

Location	Age group	Spleen Rate	Average enlarged Spleen	Parasite Rate
South-western Nigeria	Infants	$3/10 = 30.0$	1.7	$5/15 = 33.3$
	1 and 2	$18/21 = 85.6$	2.4	$23/24 = 95.8$
	3 and 4	$21/28 = 75.0$	2.3	$31/37 = 83.8$
	5, 6 and 7	$34/47 = 72.3$	2.1	$39/52 = 75.0$
	8, 9 and 10	$21/28 = 75.0$	1.9	$22/32 = 68.8$
	11 to 15 inclusive	$15/29 = 51.8$	2.0	$19/32 = 59.3$
	Over 15	$37/166 = 22.3$	1.9	$66/190 = 34.8$
North-western Nigeria	Infants	$16/50 = 32.0$	1.5	$20/50 = 40.0$
	1 and 2	$75/122 = 61.5$	2.0	$121/139 = 87.0$
	3 and 4	$100/120 = 83.5$	2.2	$120/132 = 91.0$
	5, 6 and 7	$93/147 = 63.2$	1.8	$103/145 = 71.0$
	8, 9 and 10	$89/167 = 55.4$	1.8	$69/128 = 53.9$
	11 to 15 inclusive	$99/255 = 38.8$	1.8	$79/216 = 36.4$
	Over 15	$7/80 = 8.8$	1.8	$14/80 = 17.5$

Fig. 5A

COMPARISON OF SPLEEN & PARASITE RATES IN REPRESENTATIVE AREAS OF S.W. & N.W. NIGERIA & TOWARD THE LOWEST POINT OF SEASONAL TRANSMISSION

COMPARISON DES INDICES SPLÉNIQUES ET DES INDICES PARASITAIRES DANS CERTAINES RÉGIONS REPRÉSENTATIVES DU SUD-OUEST ET DU NORD-OUEST DE LA NIGERIA AU POINT D'INTENSITÉ MINIMUM DE LA TRANSMISSION SAISONNIÈRE

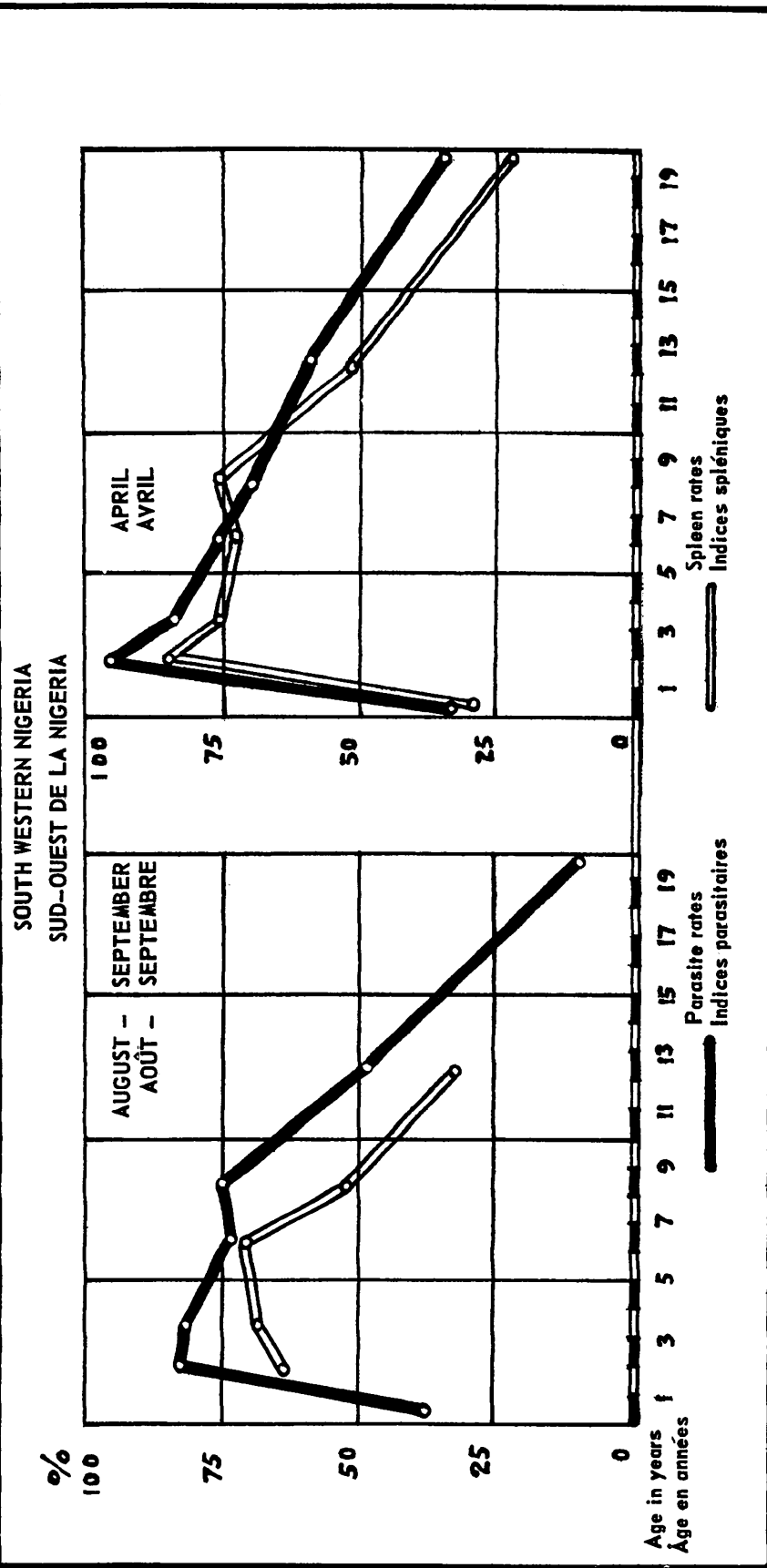
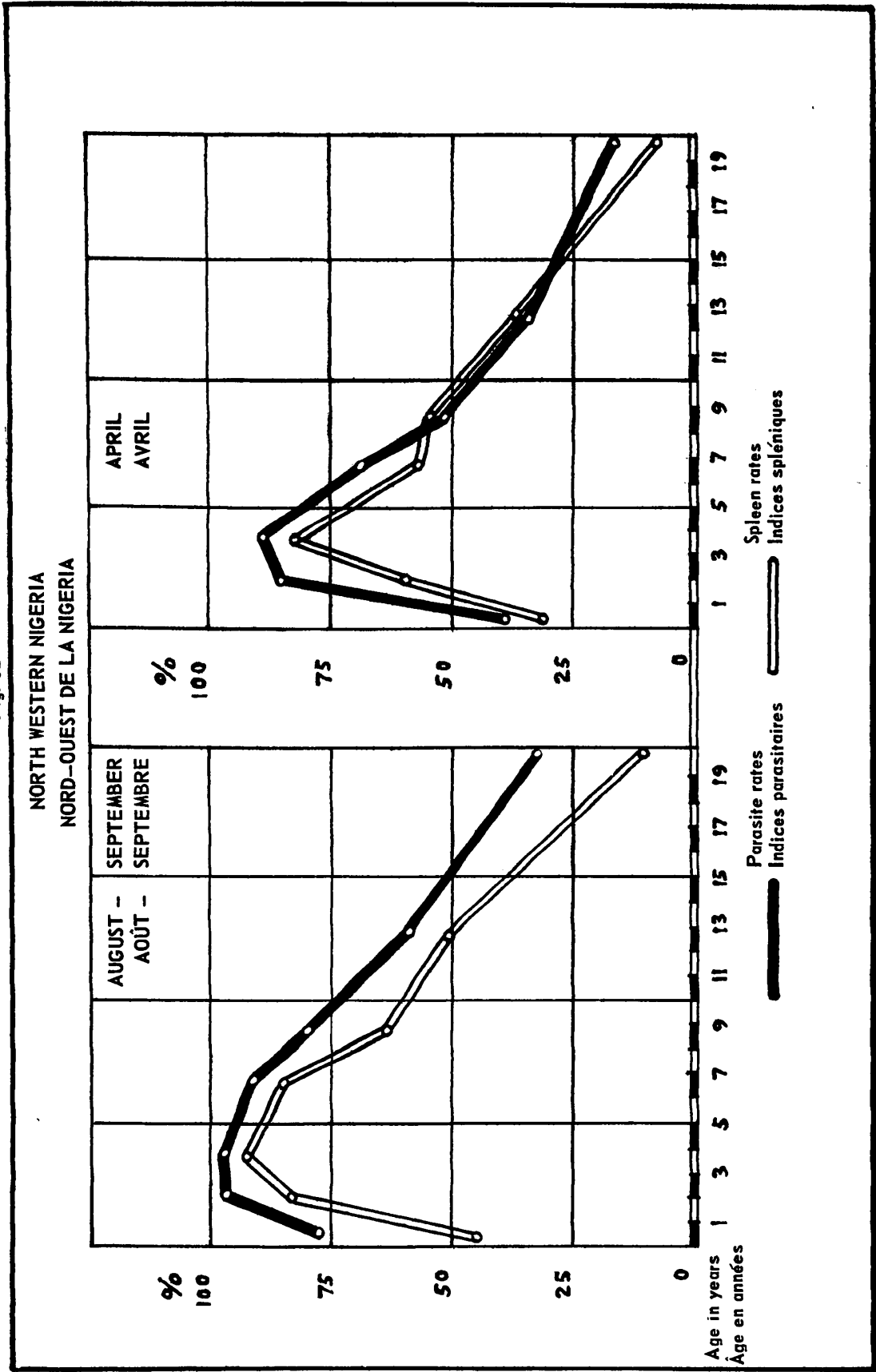


Fig. 5B



Throughout Nigeria P. falciparum is much the commonest malaria parasite, but P. malariae is frequently seen, especially in the younger groups (It occurs in about 20% of children between the ages of 1 and 7 years of age, usually as a mixed infection with P. falciparum.) P. ovale is infrequently seen but it does occur throughout Nigeria.

The density of parasitaemia reached in those infected is somewhat heavier at each age-group in the north-west as compared with the south-west. It is generally speaking, highest in the youngest. By school-age children in all parts of Nigeria seem sufficiently resistant to hold their parasites to average densities of about 200 per cu. mm.

(ii) Malarial mortality

The simple incidence of the infection is however comparatively academic, it is the mortality and morbidity caused by it that are of practical importance. Much effort has been devoted in south-western Nigeria to elucidating the measure of this sickness and death, but in the north this work remains to be done and answers at the present time can only be inferred. There is evidence that whereas in Lagos one child in every three dies before it reaches maturity (Nigeria, 1950) in the more backward parts of northern Nigeria this figure reaches one in every two (Nicholson, 1953). The toll of malaria falls especially on the younger members of this group as is shown for Lagos children in Table 8. (That table was compiled from Lagos autopsy records which substantiate an earlier report on that group by Smith (1943) and agree with reports from similar communities in the Belgian Congo (Duren, 1951) and in Uganda (Davies, 1948).) The impressions of clinicians working in south-western Nigeria (Jelliffe, 1952) that the ages between 6 months and 2 years are especially vulnerable agree with those autopsy findings.

Table 8
Malaria as a cause of death of Africans at different ages
(Bruce-Chwatt, 1952)

	Infants	1 and 2 years	3 and 4 years	5, 6 and 7 years	8, 9 and 10 years	11 - 15 years
No. of autopsies	877	881	643	467	282	390
No. with cerebral malaria	43	77	44	14	4	5
No. with malaria other than cerebral	31	48	47	27	8	2
Total No. with malaria	74	125	91	41	12	7
% with malaria	8.5	14.2	14.2	8.8	4.3	1.8

(iii) Malarial morbidity

It is extraordinarily difficult to estimate the degree of morbidity attributable to malaria in Nigeria. The clinical picture is non-specific and since parasites are so common in the fit, their responsibility for symptoms in the sick becomes a matter of individual assessment for which justification is found in the response to antimalarial therapy. The diagnosis is made, however, with great constancy from year to year in 8-9% of Nigerians admitted to hospital, and in 6-7% of those attending dispensaries.

The individuality of physicians and of dispensers is a more important factor in explaining variations from these averages than any geographical difference inside Nigeria. There is, however, evidence from north-western Nigeria of a pronounced seasonal rise in the frequency with which this diagnosis is made (see Table 9) and that children under 10 years of age account for a disproportionately large number of those cases.

Table 9

Record of incidence of malaria at Argungu Health Centre
over a twelve-month period

Month	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Cases Recorded	1092	733	785	909	864	882	1283	1116	1184	917	1089	888
Diagnosed "Malaria"	101	50	51	62	53	46	187	131	135	113	69	68
Percentage	9.3	6.8	6.5	6.3	6.1	5.2	14.6	11.8	11.4	12.3	6.3	7.6

(25% of cases of "Malaria" in July-September and
17% of cases of "Malaria" in October-December occurred
in children under 10 years of age)

Just what proportion of each age-group falls ill with malaria is highly controversial. Congenital malaria, as is to be expected in a zone where the infection is holoendemic (Wilson et al., 1950) is certainly a rarity in Nigerians in south-western Nigeria and for the first three months of life most infants in that area remain clear of malaria parasites (Bruce-Chwatt, 1952). Thereafter, they are increasingly liable to infection until by the age of 12 months few are malaria-free. In his analysis of those infections in infants, Bruce-Chwatt showed that just over 50% of the infected babies suffered manifest loss of physical well-being as shown by a falling weight curve. In north-western Nigeria, the almost absolute freedom from infection found in the south in very young infants is not found during the period of maximum transmission. In July and August in villages where mosquitoes are present in great numbers, 76% of infants were found to be infected before they had lived for three months. In southern Nigeria there is considerable evidence suggesting that infants are born with a degree of passive immunity; in north-western Nigeria this is doubtful. In that latter area, it seems that the prevalence of the risk of infection during the rains is able to establish malaria parasitaemia almost at birth. The contrast is shown in Table 10.

Table 10
Incidence of parasitaemia in infants in north-western
and south-western Nigeria

Age	South-western Nigeria		North-western Nigeria	
1, 2 and 3 months	6/138	4.3%	13/37	35.2%
4, 5 and 6 months	35/109	32.0%	36/62	58.0%
7, 8 and 9 months	52/75	69.2%	52/67	77.6%
10, 11 and 12 months	34/39	87.1%	27/32	84.4%

The African pre-school child is at maximum vulnerability, being exposed not only to the intercurrent infections that are common at this age but also to nutritional disturbance and deficiencies (Williams, 1940). The incidence of malaria is at its peak in this group and the high parasite densities that prevail indicate a relative inability to cope with the infection. Insufficient evidence exists to disentangle the specific part played by malaria in this age-group. It is probable that in addition to those who are frankly ill with that disease there is a large number who harbour malaria parasites in apparent tolerance but are yet not able to achieve full fitness. Inability to establish a perfect blood picture, inability to achieve an optimum annual weight gain and manifest signs of defective nutrition are all especially marked throughout Nigeria during the ages when malaria is at its greatest incidence. That the Northerner suffers disablement to a greater degree than does his southern compatriot is suggested by the more frequent occurrence of liver enlargement in the north-western community. This is shown in Table 11. However, the need for further work on the complex interaction of diet and infection is underlined when that table is compared with Table 12 which shows the average percentages of haemoglobin found in different age-groups in south-western and north-western Nigeria. The comparison shows that by the latter measure the Northerner is not always at a disadvantage.

Table 11
Incidence of palpable hepatomegaly at different ages
in representative south-western and north-western
Nigerian communities

Age-group	South-western		North-western	
	Infants	0/10	0.0%	0/68
1 and 2	2/12	16.7%	30/71	42.2%
3 and 4	9/25	36.0%	23/38	60.6%
5, 6 and 7	3/37	8.1%	21/66	31.8%
8, 9 and 10	1/21	4.8%	3/33	9.0%
11 to 16	-	-	1/21	4.8%
16 and over	3/117	2.6%	-	-

Table 12
Average percentage haemoglobin, as found in field investigations
of representative rural communities in south-western
and north-western Nigeria

Age-group	South-western	North-western
Infants	70.0%	65.0%
1 and 2	67.5%	75.0%
3 and 4	72.5%	75.0%
5, 6 and 7	72.5%	85.0%
8, 9 and 10	70.0%	87.5%
11 to 16	77.5%	87.5%
16 and over	82.5%	85.0%

(As determined from Talquist Scales)

Over and above nutritional and infective factors, the effect of genetic influences must be considered, in particular the possible influence on malarial morbidity of the sickle-cell trait (Allison, 1954). In western Sokoto, this trait is found in 18-20% of the population. It can occur more often in south-western Nigeria. For instance, at Egga an overall incidence of 32.2% has been found, whereas the incidence in a Lagos school was only 18.5%. The tentative stage reached in Nigerian researches on this subject preclude dogmatism, but it can be asserted that the influence, if any, of the trait on the incidence of malaria must be confined to an effect on the density of parasitaemia rather than on the parasite rate.

By school-age the effect of malaria on Nigerian morbidity seems to be slight. A protracted survey carried out in Lagos (Archibald and Bruce-Chwatt, in print) on a group of children attending a primary school there showed that protracted suppression of malaria resulted in a slightly better annual weight-gain than occurred in controls exposed to the normal malaria hazard of that town. This suppression did not affect absences and did not improve a generally defective blood-picture. A similar investigation carried out at Accra did show an improved attendance record for the suppressed group (Colbourne, 1955). The effect of malaria on this group in northern Nigeria has still to be determined.

All that has hitherto been said about the difficulty of assessing the amount of ill-health attributable to malaria applies with especial force to the effect of the infection on adults. A static population in an area of holoendemic malaria is largely immune to the local strains of the infection by adult life. However, Nigerians are not a static people and they certainly contract seasonal illnesses which are commonly diagnosed as "malaria".

These are usually of transient nature and rarely of great severity. The Argungu records in Table 9 show that there is a steep seasonal increase in ill-health in that area at the very time when effort is needed for farming. No seasonal increase of similar proportion is found in the south-west. That increase, especially when it is considered in association with the absence of the malaria-free period in young infants (the occurrence of which is attributed to their having been transitorily

protected by immunity transmitted from their mothers) suggests that resistance to the disease is defective in northern Nigerian adults.

5. EFFECT ON THE SELECTION OF A PILOT CONTROL AREA

The especial need for malaria control in north-western Nigeria is underlined by the points made in the previous paragraphs. The early infection of infants, the association of liver enlargement with the incidence of malaria, the seasonal increase of illness attributed to this disease and the suggested defective adult resistance all point to a clamant problem. That anopheline infectivity was concentrated to the limited wet season gave hope that a corresponding concentration of control measures might achieve interruption of transmission. Such led to the choice of north-western Nigeria as the site for the first major control project to be sponsored in that country, the Western Sokoto Malaria Control Pilot Project.

6. SUMMARY AND CONCLUSIONS

An attempt has been made to describe the comparative epidemiology of malaria in representative communities of South-western and north-western Nigeria.

Basic differences of these communities are tabulated.

The climates of the two areas are contrasted and their influence on the seasonal densities and infectivities of the local vectors, A. gambiae and A. funestus are shown.

The occurrence of malaria in holoendemic proportions in both areas is demonstrated and the effect of malaria in this incidence on local mortality is examined. It is shown that pre-pubertal mortality is higher in the north-west than in the south-west of Nigeria, and evidence that the influence of malaria on this mortality mainly affects the pre-school groups is recapitulated.

The difficulty of determining the influence of malaria on morbidity is stressed. The occurrence of a pronounced seasonal rise in North-western Nigeria over the general percentage of 6-9% which is the overall figure of malaria diagnosed in cases attending hospitals and dispensaries throughout Nigeria is shown. That a disproportionate number of the cases making up this seasonal incidence occur in those under ten years of age is mentioned.

That a malaria-free period from birth till the third month which is a feature of the epidemiology of malaria in south-western Nigeria does not occur in the north-west of that country is demonstrated.

The complicating interrelationship of genetics, infections and malnutrition on the pre-school child is stated and the particular influence of malaria in preventing the achievement of full fitness by such children is discussed. The varying incidence of different indices of impaired well-being from area to area are illustrated. That insufficient information is available in Nigeria to justify dogmatic conclusions on the possible influence of the sickle-cell trait on the epidemiology of malaria is mentioned.

Evidence that the schoolchild in south-western Nigeria may be but little disturbed by the presence in his circulation of malaria parasites is touched on, but it is stated that the effect of the infection on this age-group in the north has yet to be elucidated.

The conclusion that there may be a defective resistance to the infection in Northern Nigerian adults is postulated.

These considerations determined the choice of Western Sokoto as the site for the first extensive Malaria Control Pilot Project in Nigeria.

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