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WORLD HEALTH
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ORIGINAL: FRENCH

The Secretary of the Expert Committee
on Malaria has the honour to present herewith a

NOTE ON MALARIA EPIDEMIOLOGY

IN FRENCH WEST AFRICA

(Section 1 - 3 of the Agenda)

by

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1. ANOPHELINE FAUNA OF FRENCH WEST AFRICA

The anopheles identified between 1 August 1948 and 31 March 1950 in the French West African territories are as follows, grouped by colonies:

HAUTE-VOLTAs/g Anopheles, series Myzorhynchus:A.coustaniA.coustani var. ziemannis/g Myzomyia, group Neomyzomyia:A.nili

HAUTE-VOLTA (continued)

s/g Myzomyia, group Myzomyia:

A.brunnipes
A.domicolus
A.flavicosta
A.funestus
A.hancocki
A.marshalli
A.rivulorum

s/g Myzomyia, group Pyretophorus:

A.gambiae

s/g Myzomyia, group Neocellia:

A.maculipalpis
A.pretoriensis
A.rufipes
A.rufipes var. ingrami

s/g Myzomyia, group Cellia

A.pharoensis
A.squamosus

IVORY COAST

A. Middle Coast (Zone of the wooded savannas).

s/g Anopheles, series Myzorhynchus:

A.coustani
A.coustani var. ziemanni

s/g Myzomyia, group Neomyzomyia:

A.cinctus
A.nili

s/g Myzomyia, group Myzomyia

A.brunnipes
A.domicolus
A.flavicosta
A.funestus
A.hancocki
A.rivulorum

s/g Myzomyia, group Pyretophorus:

A.gambiae

s/g Myzomyia, group Neocellia:

A.pretoriensis

A.rufipes

s/g Myzomyia, group Cellia:

A.pharoensis

A.squamosus

B. Lower Coast (Maritime and forest zones).

s/g Anopheles, series Myzorhynchus:

A.coustani

A.coustani var. ziemanni

A.obscurus

s/g Myzomyia, group Neomyzomyia:

A.cinctus

A.dureni

A.nili

A.rhodesiensis

s/g Myzomyia, group Myzomyia:

A.flavicosta

A.funestus

A.hancocki

A.leesoni

A.marshalli

A.rivulorum

s/g Myzomyia, group Pyretophorus:

A.gambiae

A.gambiae var. melas

s/g Myzomyia, group Neocellia:

A.rufipes

s/g Myzomyia, group Cellia:

A.pharoensis

A.squamosus

FRENCH GUINEA

s/g Anopheles, series Myzorhynchus:

A.coustani

A.coustani var. ziemanni

s/g Myzomyia, group Neomyzomyia:

A.nili

s/g Myzomyia, group Myzomyia:

A.brunnipes

A.funestus

A.marshalli

A.moucheti var. nigeriensis

s/g Myzomyia, group Pyretophorus:

A.gambiae

A.gambiae var. melas

s/g Myzomyia, group Neocellia:

A.rufipes

s/g Myzomyia, group Cellia:

A.pharoensis

A.squamosus

FRENCH SUDAN

s/g Anopheles, series Myzorhynchus:

A.coustani

A.coustani var. ziemanni

A.paludis

s/g Myzomyia, group Neomyzomyia:

A.nili

s/g Myzomyia, group Myzomyia:

A.domicolus

A.funestus

s/g Myzomyia, group Pyretophorus:

A.gambiae

s/g Myzomyia, group Neocellia:

A.rufipes
A.rufipes var. ingrami

s/g Myzomyia, group Cellia:

A.pharoensis
A.squamosus

SENEGAL, CASAMANCE, NIGER, DAHOMEY

Less known fauna, including:

A.coustani (Casamance)
A.paludis (Senegal)
A.nili (Dahomey)
A.funestus (Senegal, Casamance, Niger, Dahomey)
A.funestus var. dahomeensis nov. var. (Dahomey)
A.leesoni (Dahomey)
A.gambiae (Senegal, Casamance, Niger, Dahomey)
A.gambiae var. melas (Senegal, Casamance)
A.rufipes (Casamance)
A.pharoensis (Senegal, Casamance, Niger, Dahomey)
A.squamosus (Casamance)

This list of anopheline species in French West Africa is far from complete. More than 1,000 preparations of larvae (in particular from the Haute-Volta, Ivory Coast and Guinea) have still to be examined.

Moreover, judging by a study of the inventories of fauna in foreign territories (British Gambia, Portuguese Guinea, Sierra Leone, Liberia, Gold Coast and Nigeria), it is probable that a certain number of species in addition to those already listed remain to be found in the French territories:

A.implexus
A.jebudensis
A.smithii
A.barberellus
A.freetownensis
A.hargreavesi
A.theileri var. brohieri
A.wellcomei

Certain observations may be made concerning the known fauna:

- distribution of gambiae, funestus and pharoensis throughout the whole territory
- extensive distribution of rufipes, which must be noted on account of its important role as a vector.

- presence of gambiae var. melas throughout the whole of the West African coast.
- presence in Guinea of moucheti var. nigeriensis, an important vector in Southern Nigeria.
- abnormal presence in the Lower Ivory Coast of dureni previously noted only in the Belgian Congo where it transmits malaria.

2. ANOPHELINE VECTORS OF MALARIA

Between 1 January 1949 and 31 March 1950 slightly over 8,000 anopheles were dissected and examined for sporozoites and oocysts.

The percentages of total infection are given in the following table:

TABLE NO. 1

HAUTE-VOLTA (except Bobo-Dioulasso), SUDAN, IVORY COAST

Species	Females Dissected	Females positive	% of total infestation
<u>gambiae</u>	2,810	320	11.38
<u>funestus</u>	2,892	296	10.23
<u>rufipes</u>	430	33	7.67
<u>nili</u>	17	1	5.88
<u>pharoensis</u>	90	4	4.44
<u>hancocki</u>	62	2	3.22
<u>flavicosta</u>	68	1	1.47
<u>brunnipes</u>	72	1	1.38
<u>domicolus</u>	283	3	1.06
<u>coustani</u>	7	0	0
<u>pretoriensis</u>	1	0	0

A.brunnipes and A.flavicosta were found infected with oocysts only. Their role in the transmission of malarial parasites must for the present be considered as nil or negligible.

A.domicolus, on the other hand, has been shown to be a possible vector. A.Sindou Subdivision of Banfora, Bobo-Dioulasso district one female out of 44 dissected was found with sporozoites (2.2%); its role however remains episodic.

I will therefore divide the African vectors into three categories:

1. The primary vectors:

A.gambiae

A.funestus

A.rufipes

2. The secondary vectors:

A.nili

A.pharoensis

3. The subsidiary vectors:

A.hancocki

A.domicolus

A.nili and A.pharoensis have often been noted by different workers as transmitters of malaria parasites. As regards A.rufipes, the circumstances are as follows:

In 1947 GELFAND, in Kano (Northern Nigeria) found that one female out of 19 dissected specimens contained sporozoites and concluded that A.rufipes was negligible as a local vector; he emphasized, however, that in the regions where this species abounded it was impossible to attach much value to the research carried out in Kano.

In February - March 1949, while making an anopheline survey trip in Haute-Volta, I was able to point out, at Dori,* that rufipes might constitute not one of the vectors but the vector of malaria in certain localities.

* Société de Pathologie Exotique, meeting of 4.12.1949

The anopheline fauna was composed of:

A.rufipes : 72.4% A.pharoensis : 11.4%
A.funestus : 3.4% A.gambiae : 1.4%

Dissections carried out gave the following results:

Species	Anopheles dissected		Sporozoites		Oocysts	
	Number	+ %	+ %	+ %		
<u>rufipes</u>	127	6 4.7	2 1.5	5 3.7		
<u>pharoensis</u>	64	1 1.5	0 0	1 1.5		
<u>funestus</u>	3	0 0	0 0	0 0		

I was at that time convinced that rufipes had only a local significance but I was later obliged to revise this opinion in view of the results of dissections which I carried out both at Bobo-Dioulasso and in other localities.

In fact, at Bobo-Dioulasso, where A.rufipes is not found very frequently, since, out of 2,947 anopheles captured between 1 January 1949 and 31 March 1950 the percentages of the various species represented were:

A.gambiae 80.82%
A.funestus..... 15.20%
A.rufipes 2.74%
A.nili..... 0.67%
A.domicolus.....)
A.pharoensis ...)
A.squamosus.....) 0.57%
A.pretoriensis..)

The following table shows the dissections carried out:

TABLE NO.2

Species	Females dissected	Females positive	Percentage of total infestation
<u>gambiae</u>	1,271	111	8.5%
<u>funestus</u>	167	15	8.9%
<u>rufipes</u>	52	6	11.5%
<u>nili</u>	20	1	5.0%

For the period between 1 January 1950 and 31 March 1950 rufipes gave a sporozoite rate of:

16.6% (Bobo-dioulasso)

3.1% (Several localities of the Haute-Volta together)

whereas the A.gambiae and A.funestus showed infected salivary glands, respectively, in the following proportions:

12.0% (<u>gambiae</u>)	0 (<u>funestus</u>)
5.3%	10.7%

Finally, in a part of the Subdivision of Banfora (Bobo-Dioulasso district), where the extensive rice fields constitute larval breeding places, A.rufipes is the principal vector and the sporozoite rates varied as follows:

3.7%,	6.4%,	7.1%,	in the dry season;
14.8%,	16.9%,		at end of the rainy season

The extraordinary diversity of the breeding grounds of A.rufipes (the extensive grassy marshes and rice fields as well as banks of rivers or wells), its extremely exophilous character¹ and its flying abilities (4 kms. flight has been observed) make the fight against this vector extremely difficult and its eradication almost impossible.²

¹The ratio of rufipes captured in occupied dwellings to rufipes found in refuges (destroyed dwellings, hen houses, rabbit hutches, livestock sheds, holes in trees, etc.) is about 1 to 10.

²Length of development cycle: 13 to 21 days. Definitely anthropophilic maxillary rate of 12.6

We have been made sufficiently acquainted, by the works of numerous authors, with the role of A.gambiae and A.funestus in the transmission of malaria, but it would be a mistake to consider that A.gambiae is more dangerous than A.funestus. They are vectors of equal importance. Dissections carried out regularly since January 1949 in a certain number of localities in the Haute-Volta have shown that three patterns for the comparative seasonal variation of gambiae and funestus can be established, excluding other species, namely:

Two infrequent patterns:

- (a) prevalence of A.gambiae all the year;
- (b) prevalence of A.funestus all the year;

and one very general pattern:

- (c) seasonal inversion of the two species.

(a) Prevalence of gambiae all the year.

This prevalence, observed in the French Sudan and in some localities of the Haute-Volta (regions of the Sahel and Sudan open savannas) is probably due to the disappearance of breeding places during the dry season. During the rainy season the rains create favourable conditions for the development of A.gambiae, and this is followed, at the beginning of the dry season, by an increase in the number of funestus, but the percentage of this latter seldom, or only for a very short period, reaches or surpasses the percentage of gambiae.

The infection rate follows a similar curve but the funestus oocyst and sporozoite rate surpasses in the dry season that of the rainy season gambiae.

(b) Prevalence of A.funestus all the year.

This is fairly general in the forest and savanna regions where conditions are more or less stable; in most cases it is accompanied by high malaria endemicity and by a high funestus infection rate.

At the height of the rainy season A.gambiae shows a definite increase but it rarely surpasses the funestus or, if so, only for a very limited period.

(c) Seasonal inversion of A.gambiae and A.funestus.

This is the most frequently observed type of anopheline variation.

A.gambiae definitely predominates during the rainy months when the rains favour its development in the so-called "preferential" breeding places, but after the rains cease funestus becomes predominant and a high percentage of them is noted during the whole of the dry season. In this cycle of renewal of the fauna, funestus plays a bigger role as vector than gambiae, this latter taking precedence over funestus during only a relatively short period.

These patterns are closely linked not only to the meteorological conditions (rainfall, evaporation) but to the nature of the breeding places and to the variations in these during the course of the year. The malariologist who carries out a survey in a given locality must take these variations in the composition of the fauna into account, and he will be unable to draw valid conclusions which may serve in the control of the vectors unless the investigations cover a whole year.

The gambiae and funestus infection rates are very variable. A few are given here in order to show their approximate range:

A.gambiae (sporozoite rate):

%	
2.2	GAOUA, Haute-Volta (March),
2.6	ABENGOUROU, Ivory Coast (March),
3.2	MOPTI, Sudan (June),
5.0	TIOGO, Haute-Volta (February),
6.6	KOUMBIA, Haute-Volta (July),
12.9	DARSALAMY, Haute-Volta (June),
16.6	KOUMI, Haute-Volta (April),
17.5	KOUA, Haute-Volta (July),
38.2	SAKABY, Haute-Volta (August).

A.funestus (sporozoite rate):

3.2	KOUMBIA, Haute-Volta (July),
3.6	YABASSO, Haute-Volta (October),
4.7	NIONO, Sudan (May),
6.6	SEGU, Sudan (May)
7.6	OUMGADOU, Haute-Volta (November),
9.6	TENKODOGO, Haute-Volta (December),

A. funestus (sporozoite rate)

(continued)

	%
12.1	KELESSO, Haute-Volta (December),
12.5	ABENGOUROU, Ivory Coast (March),
14.3	YAKALA, Haute-Volta (December),
19.2	KOUA, Haute-Volta (January),
30.0	SAKABY, Haute-Volta (January).

3. MALARIA

Malaria is endemic in the Bobo-Dioulasso district and its intensity decreases only slightly during the dry season, a period during which transmission decreases considerably even though it may not cease altogether.

Since May 1949 the Bobo-Dioulasso district has been systematically surveyed, and malaria investigations have included a survey of anopheline fauna, fixing of the anopheline infection rates and survey of breeding places in addition to establishment of spleen and parasite rates. As far as possible, only children in the population groups which escape medical supervision, i.e. those who do not attend either government or mission schools, are seen and examined for malarial purposes.

From material already supplied by surveys, the following figures may be given; they probably differ very little from the final figures compiled when the work is terminated.

The spleen rate is about 40%; average enlarged spleen = 0.65%.

The spleen enlargements are as follows:

Spleen 1 (palpable under edge of costal arch)	-	54%
Spleen 2 (between the edge of costal arch and level of umbilicus)	-	30%
Spleen 3 (beneath the level of the umbilicus)	-	16%

Percentages vary, of course, from one locality to another but it is very rarely that spleens 2 or 3 are more frequent than spleens 1.

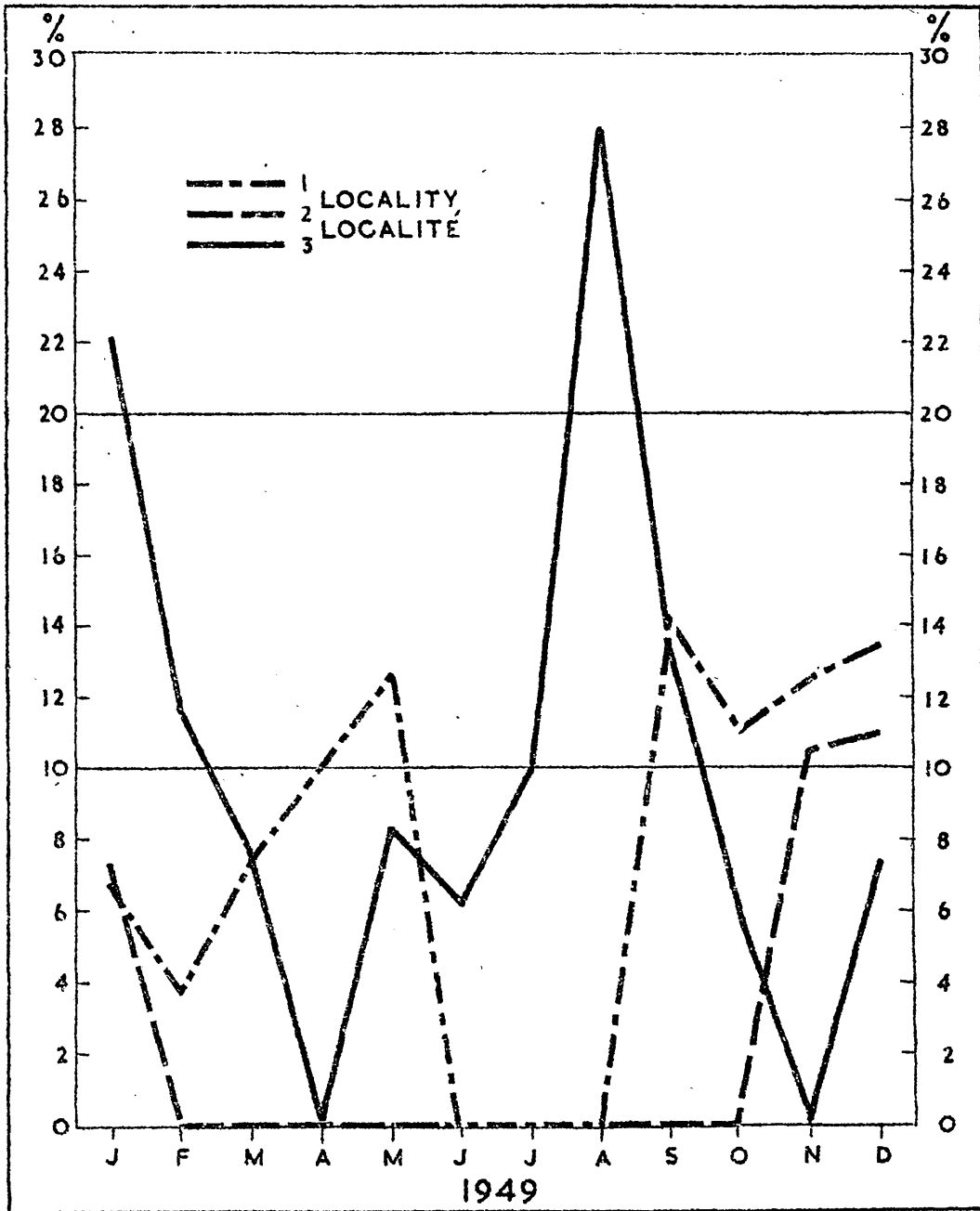
The malaria parasites involved are:

P.falciparum (90 to 95%)

P.vivax and P.malariae (5 to 10%)

The parasite rate is about 40% and the gametocyte rate about 9%, but these may be much higher and attain respectively, 80% and 25%.

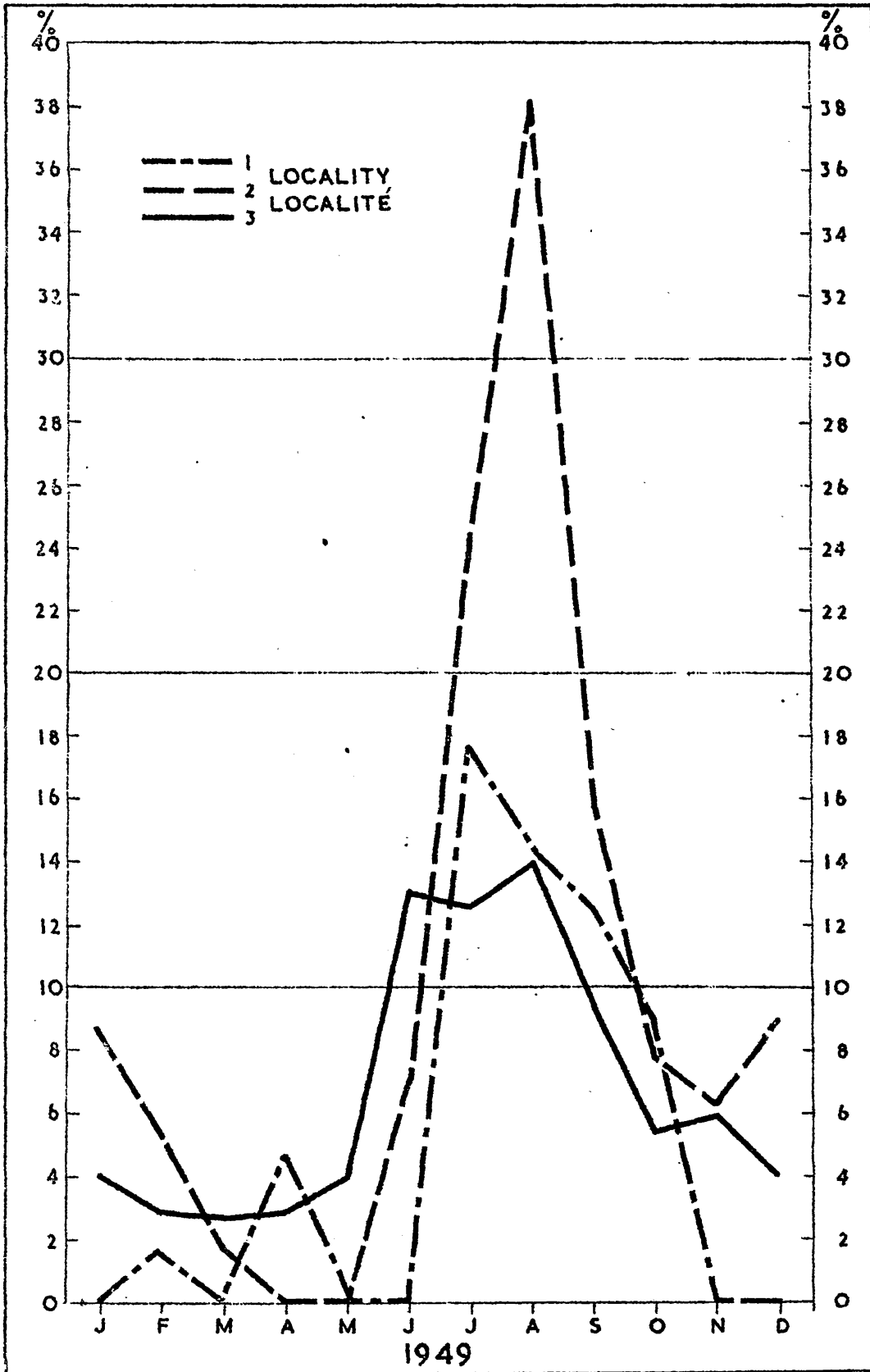
VARIATIONS IN THE SPOROZOITE INDEX OF A. FUNESTUS
 VARIATIONS DE L'INDEX SPOROZOITIQUE DE A. FUNESTUS



WHO 5254

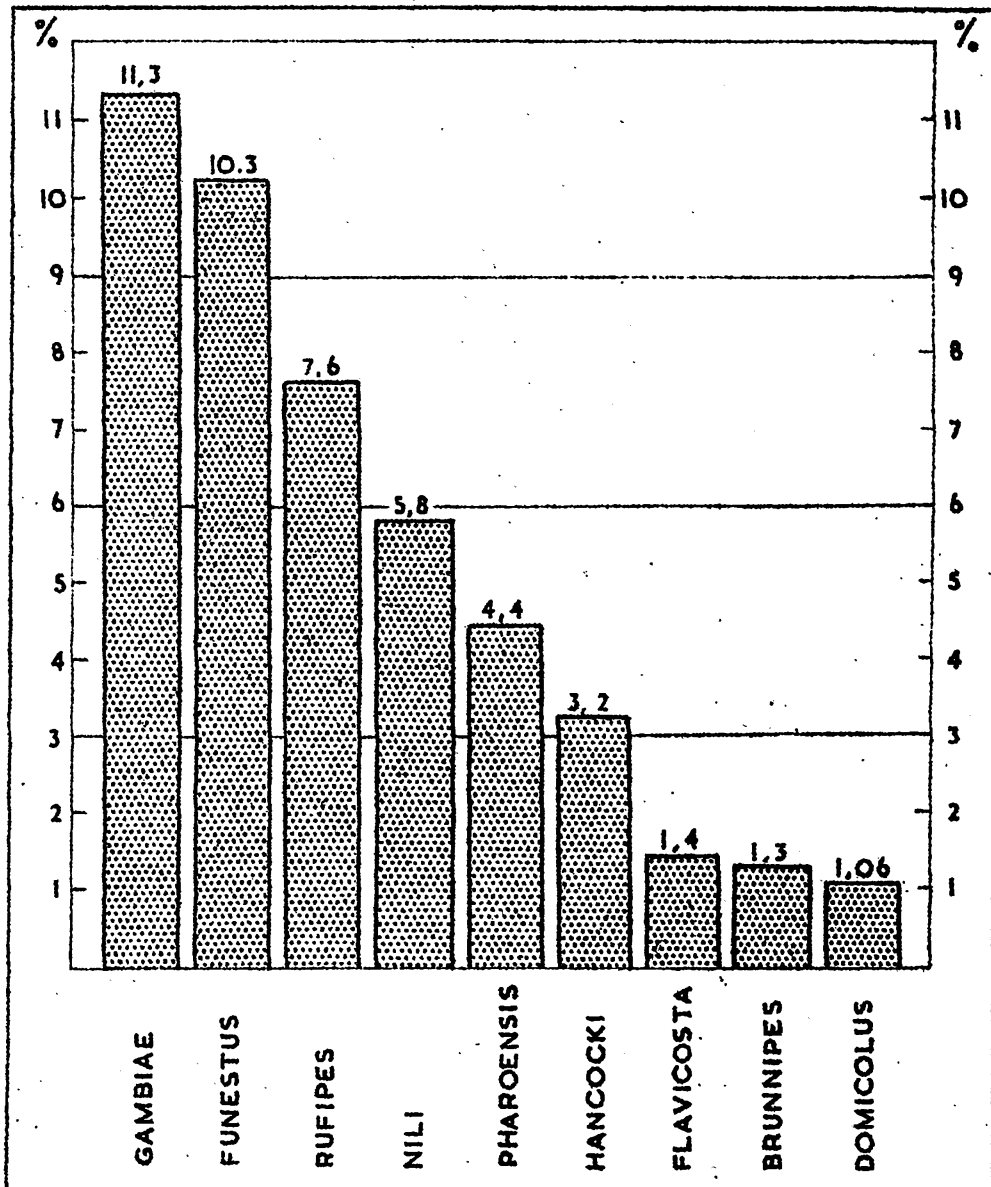
	1	2	3	4	5	6	7
SENEGAL							
CASAMANCE							
SOUDAN FRANÇAIS							
NIGER							
DAHOMY							
HAUTE-VOLTA							
MOYENNE CÔTE D'IVOIRE							
BASSE CÔTE D'IVOIRE							
GUINÉE FRANÇAISE							
TERRITOIRES ÉTRANGERS : FOREIGN TERRITORIES							
GAMBIE							
SIERRA LEONE							
LIBERIA							
GOLD COAST							
NIGERIA							
1 s/g ANOPHELES, ser. MYZORHYNCHUS							
2 " " ser. CHRISTYA							
3 s/g MYZOMYIA, groupe NEOMYZOMYIA							
4 " " groupe MYZOMYIA							
5 s/g MYZOMYIA, groupe PYRETOPHORUS							
6 " " groupe NEOCELLIA							
7 " " groupe CELLIA							
COUSTANI							
COUSTANI VAR. ZIEMANNI							
OBSCURUS							
PALUDIS							
IMPLEXUS							
CINCTUS							
DURENI							
JEBUDENSIS							
NILI							
RHODESIENSIS							
SMITHI							
BARBERELLUS							
BRUNNIPES							
DOMICOLUS							
FREETOWNENSIS							
FLAVICOSTA							
FUNESTUS							
FUNESTUS VAR. DAHOMEENSIS							
HANCOCKI							
HARGREAVESI							
LEESONI							
MARSHALLI							
MOUCHETI VAR. NIGERIENSIS							
RIVULORUM							
THEILERI VAR. BROHIERI							
WELLCOMEI							
GAMBIAE							
GAMBIAE VAR. MELAS							
MACULIPALPIS							
PRETORIENSIS							
RUFIPES							
RUFIPES VAR. INGRAMI							
PHAROENSIS							
SQUAMOSUS							

VARIATIONS IN THE SPOROZOITE INDEX OF A. GAMBIAE
 VARIATIONS DE L'INDEX SPOROZOITIQUE DE A. GAMBIAE



PERCENTAGE OF TOTAL INFESTATION BY MALARIA HEMATOZOA
OF ANOPHELES IN F.W.A.

POURCENTAGE D'INFESTATION TOTALE, PAR LES HEMATOZOAIRES
DU PALUDISME, DES ANOPHELES D'A.O.F.



WHO 5257

TYPICAL SEASONAL ALTERNATION OF A. GAMBIAE AND A. FUNESTUS
 TYPE D'ALTERNANCE SAISONNIÈRE D'A. GAMBIAE ET A. FUNESTUS

