

## CONCLUSIONS

Malaria control in tropical Africa is one of the foremost preoccupations of the health workers there. Much more than is the case with any other tropical endemic disease, this campaign needs to be conducted energetically and judiciously. It may be only ineffective—indeed, dangerous—without previous thorough knowledge of the biology of *Anopheles gambiae*, the principal vector of the disease.

The observations and experiments that we were able to make during our stay in French West Africa prompted us to clarify several aspects of the biology of the species which it is essential to know before involving money and resources in malaria-control measures.

As far as the possibility of controlling the early stages of the anopheline is concerned, we were able to show that the duration of the egg-adult cycle was very variable, and that, under optimum conditions of temperature and of proportion of organic matter in the breeding-place, the development of *gambiae* could be completed within seven days. This figure must be taken into account when arranging the time-table for spraying the breeding-places.

It was, however, the biology of the adults that we studied principally, because the present trend of the campaign against the anophelines tends to give an ever more important place to methods of killing the adults by spraying with residual insecticides (DDT, benzene hexachloride, chlordane, etc.).

One question arose: was it advisable to proceed with spraying during the dry season, the period during which *gambiae* seems to disappear? We have shown that, although the early stages do not survive for more than a few days, *gambiae* females are to be found, during the adverse season, in shelters where they live in a state of aestivation, able to feed, and ready to lay as soon as a certain degree of mean relative humidity is reached. These females ensure the survival of the species and its persistence during a season unsuitable for the development of the early stages, and their presence provides an explanation of the continuity of endemic malaria in the savanna regions of Africa. The malariologist must, therefore, in the localities where his services are required, search for the shelters where *gambiae* aestivates, so that insecticide spraying will eliminate this residual fauna and enable the pullulation of the populations

during the rainy season to be avoided. He will also have to know the seasonal variations of the anopheline fauna, since if the modifications which intervene during the course of the seasons are followed for too short a period, misleading estimates concerning the presence and density of *gambiae* may result.

One of the most interesting problems to resolve was that presented by the presence of populations of zoophilic *gambiae* in the Sahelian and Sudanese savanna zones. We were able to demonstrate the existence of such populations, which feed on the wild fauna or on herds of migrating cattle. They present a high maxillary index and develop preferably in waters with a high content of dissolved organic matter of vegetable origin, which slows down the egg-adult cycle. The populations of anthropophilic *gambiae*, on the contrary, have a low maxillary index, develop in waters which are poor in organic matter, and show a high degree of exophily.

The existence of these two populations seems to us to be comparable with the situation envisaged by Garnham<sup>128</sup> for *Anopheles pharoensis*, the vector of malaria in Egypt. Madwar<sup>241</sup> pointed out a sporozoite-rate of 1.4%, and Barber & Rice<sup>16</sup> one of 0.33%. This anopheline is essentially anthropophilic in that country; Barber & Rice found 97.5% of the females engorged with human blood in dwellings. In Uganda, the sporozoite-rate is 0.6%,<sup>136, 137</sup> in southern Nigeria, 0.07%, and in the Upper Volta, 1.2% (dissections made by the writer in 1948-50). On the other hand, *A. pharoensis* plays no part in the transmission of the haematozoa in northern Nigeria, Tanganyika, and Kenya where, principally zoophilic, it shows a maxillary index of 14.6.<sup>150</sup>

Exophily in anthropophilic *gambiae* populations may account for the setbacks recorded by several experimenters in combating the adults by house spraying. The repulsive effect of insecticides with a pyrethrum base has been pointed out by Swellengrebel & de Buck<sup>363</sup> for *A. maculipennis*, and by Senior White et al.<sup>400</sup> and Ribbands<sup>293</sup> for *A. minimus*. Following on the spectacular eradication of *gambiae* in Brazil (where we know that it lived in houses), numerous DDT campaigns were undertaken in Africa. Despite the demonstration, in the laboratory<sup>193</sup> and in native huts,<sup>238</sup> of a considerable mortality-rate in the *gambiae* treated with DDT, some serious rebuffs were recorded. Some publications then showed that the application of DDT (or, later, of benzene hexachloride) in dwellings alone did not prove efficacious in combating the pullulation of *gambiae*. Muirhead-Thomson<sup>260, 261</sup> pointed out that, in Nigeria, the application of DDT did not prevent the females from feeding in the huts and then going to outside shelters, even if the dosage applied was double the normal one.<sup>263, 265</sup> The same fact was established by Eddey<sup>108</sup> on the Gold Coast, and by Hocking<sup>169</sup> in Kenya.

Our observations have shown us the high percentages of *gambiae* found in shelters, and we think that a careful study of exophily will make it possible to envisage, in the not too distant future, if not the disappearance, at least a considerable diminution, of endemic malaria in Africa. There will also be the question of determining, for each region, the conditions under which zoophilic populations of *gambiae* can develop and maintain themselves ; these populations, owing to their ability to cross with anthropophilic populations and to feed on man, should the occasion arise, are a factor in the spread of malaria which must not be neglected.

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## **ANNEXES**

## ANNEX 1

### GEOGRAPHICAL DISTRIBUTION OF *A. GAMBIAE*

The Ethiopian geographical region is—with the exception of the desert regions, high altitudes, and the part of South Africa comprising the southern Transvaal, the Orange Free State, Basutoland, and a large part of the Cape Province—entirely colonized by *A. gambiae*. The distribution range of this species extends from north of Dakar on the west, to the north of the Anglo-Egyptian Sudan and to Eritrea in the east, and as far as Natal in the south. Its presence has been recorded in the islands of the Indian Ocean, the Gulf of Guinea, and the Atlantic Ocean.

The references by Séguy<sup>342</sup> to the discovery of exceptional specimens outside the Ethiopian region (one in Algeria and one in Macedonia) relate, without doubt, to the transport of these *gambiae* by the sea-route. One could not, in any case, include *gambiae* in the list of palaeo-arctic anopheles, nor make it a neotropical species on account of its accidental presence in Brazil.

It seems that the presence of *gambiae* (*arabiensis*) at Aden<sup>275</sup> may also be due to sea transport between East Africa and Aden. Although the southern part of Arabia may be included within the Ethiopian region, it seems probable that the discovery of *gambiae* there was accidental; indeed, although Patton<sup>275</sup> mentioned *A. arabiensis*, *A. azriki* (*turkhudi*), *A. d'thali*, and *A. jehafi* (*cinereus*) as representatives of the Ethiopian fauna, Christophers & Chand,<sup>63</sup> on the contrary, referred to *A. d'thali* and *A. adenensis* only; Leeson,<sup>212</sup> for his part, has identified only *A. adenensis*, *A. coustani*, *A. multicolor*, and *A. cinereus* among the oriental species along the Persian Gulf.

Information of two kinds is given below: on the one hand, a list of the most interesting publications concerning *A. gambiae* in the various regions of its range; on the other, details of the place and date of the captures and determinations made by the author.

#### FRENCH AFRICA

##### French West Africa

###### Dahomey

- Cotonou : Le Moal, 1906<sup>223</sup> ; Bauvallet, 1928<sup>21</sup>
- Djougou : Holstein, 5/1949
- Dompago : Holstein, 10/1949
- Kandi : Holstein, 5/1950
- Kouandé : Holstein, 7/1949
- Natitingou : Holstein, 11/1948
- Ouidah : Le Moal, 1906<sup>223</sup>
- Porto Novo : Le Moal, 1906<sup>223</sup> ; Bernet, 1948<sup>28</sup> ; Huttel, 1950<sup>181</sup>
- Tanguieta : Holstein, 7/1949

###### Guinea

- Beyla : Holstein, 8/1949
- Boffa : Holstein, 10/1949
- Conakry : Laveran, 1904<sup>206</sup> ; Le Moal, 1905<sup>223, 224</sup> ; Leger & Baury, 1922<sup>221</sup> ; Holstein, 10/1949

Dalaba : Holstein, 7/1949  
 Dubreka : Holstein, 10/1949  
 Gouecké : Holstein, 7/1949  
 Guéckédou : Holstein, 9/1949  
 Kankan : Joyeux, 1915 <sup>190</sup> ; Holstein, 10/1949  
 Kindia : Leger & Baurry, 1922 <sup>221</sup>  
 Kissidougou : Holstein, 9/1949  
 Kouroussa : Joyeux, 1915 <sup>190</sup>  
 Labé : Holstein, 4/1949  
 Macenta : Holstein, 10/1949  
 Mamou : Holstein, 4/1949  
 N'Zérékoré : Holstein, 11/1948  
 Pita : Holstein, 8/1949  
 Samoé : Holstein, 7/1949  
 Telimélé : Holstein, 8/1949  
 Youkounkoun : Holstein, 8/1949

### Ivory Coast

Abengourou : Holstein, 3/1949  
 Abidjan : Le Moal, 1906 <sup>223</sup> ; Bernet, 1948 <sup>28</sup> ; Holstein, 12/1948  
 Adzopé : Holstein, 3/1949  
 Agboville : Holstein, 3/1949  
 Agnibilékrou : Holstein, 3/1949  
 Aniassué : Holstein, 3/1949  
 Assinié : Blanchard & Dyé, 1904 <sup>36</sup>  
 Azaguié : Holstein, 12/1948  
 Bingerville : Holstein, 12/1948  
 Bondoukou : Holstein, 3/1949  
 Bouaflé : Holstein, 7/1949  
 Bouaké : Bernet, 1948 <sup>28</sup>  
 Bouna : Holstein, 3/1949  
 Daloa : Holstein, 11/1948  
 Danané : Holstein, 11/1948  
 Dimbokro : Holstein, 10/1948  
 Duékoué : Holstein, 8/1949  
 Ferkessédougou : Holstein, 4/1950  
 Gagnoa : Holstein, 7/1949  
 Grand Bassam : Blanchard & Dyé, 1904 <sup>36</sup> ; Le Moal, 1906 <sup>223</sup> ; Bernet, 1948 <sup>28</sup> ;  
 Holstein, 12/1948  
 Grand Lahou : Le Moal, 1906 <sup>223</sup>  
 Guiglo : Holstein, 8/1949  
 Man : Holstein, 11/1948  
 Odienné : Holstein, 12/1948  
 Ouangolodougou : Holstein, 4/1950  
 Port-Bouet : Bernet, 1948 <sup>28</sup>  
 Sassandra : Bernet, 1948 <sup>28</sup>  
 Séguéla : Holstein, 11/1948  
 Téhini : Holstein, 3/1949  
 Touba : Holstein, 7/1949  
 Toulépleu : Holstein, 8/1949  
 Toumodi : Bernet, 1948 <sup>28</sup>  
 Vavoua : Holstein, 7/1949

**Mauritania**

- Boghé : Sautet, Ranque, Vuillet & Vuillet, 1948<sup>331</sup>  
 Gara-Sabo : Couvy, 1924 (quoted by Sénevet<sup>344</sup> and by Séguy<sup>342</sup>)  
 Kaédi : Couvy, 1924 (quoted by Sénevet<sup>344</sup>); Sautet, Ranque, Vuillet & Vuillet, 1948<sup>331</sup>  
 Koundel : Sautet, Ranque, Vuillet & Vuillet, 1948<sup>331</sup>  
 Krika : Sautet, Ranque, Vuillet & Vuillet, 1948<sup>331</sup>  
 Mouït : Sautet, Ranque, Vuillet & Vuillet, 1948<sup>331</sup>  
 Sélibaly : Couvy, 1924 (quoted by Sénevet<sup>344</sup>)

**Niger**

- Dosso : Holstein, 12/1948  
 Niamey : Bernet, 1949<sup>28</sup>; Holstein, 5/1949  
 Say : Holstein, 10/1948

**Senegal**

- Bignona : Holstein, 10/1948  
 Dakar : Le Moal, 1906<sup>228</sup>; Thiroux & d'Anfreville, 1908<sup>373</sup>; A. Leger, 1919<sup>219</sup>;  
 Noc, 1920<sup>271</sup>; M. Leger, 1925<sup>220</sup>; Kartman, Newcomb, Campau & Morrison;  
 1947<sup>192</sup>; Bernet, 1948<sup>27</sup>; Le Gouas, 1949<sup>222</sup>; Holstein, 10/1949  
 Goré : Le Moal, 1906<sup>223</sup>; Bernet, 1948<sup>28</sup>  
 Kaolack : Thiroux & d'Anfreville, 1908<sup>373</sup>  
 Kolda : Holstein, 2/1949  
 Matam : Sautet, Ranque, Vuillet & Vuillet, 1948<sup>331</sup>  
 M'Bour : Jonchère (quoted by Gellie, 1947<sup>134</sup>); Holstein, 12/1948  
 Podor : Thiroux & d'Anfreville, 1908<sup>373</sup>  
 Rufisque : Le Moal, 1906<sup>223</sup>; Bernet, 1948<sup>28</sup>  
 St. Louis : Thiroux & d'Anfreville, 1908<sup>373</sup>; Bourret & Dufougeré, 1912<sup>40</sup>  
 Sedhiou : Holstein, 8/1949  
 Sor : Thiroux & d'Anfreville, 1908<sup>269</sup>; Bourret & Dufougeré, 1912<sup>40</sup>  
 Tambacounda : Holstein, 11/1949  
 Ziguinchor : Holstein, 7/1949

**Sudan**

- Joyeux, Sicé & Sautet, 1937-8<sup>181</sup>  
 Ansongo : Sautet & Marneffe, 1943<sup>330</sup>  
 Bafoulabé : Sautet & Marneffe, 1943<sup>330</sup>  
 Baguineda : Sautet, 1942<sup>327</sup>; Sautet & Marneffe, 1943<sup>330</sup>  
 Bamako : Le Moal, 1906<sup>223</sup>; Thiroux & d'Anfreville, 1908<sup>373</sup>; Sénevet & Ethès,  
 1939<sup>345</sup>; Sautet, 1942<sup>327</sup>; Marneffe, Ranque & Sautet, 1943<sup>243</sup>; Sautet &  
 Marneffe, 1943<sup>330</sup>; Bernet, 1948<sup>28</sup>; Holstein, 10/1948  
 Bandiagara : Sautet, 1942<sup>327</sup>; Sautet & Marneffe, 1943<sup>330</sup>; Holstein, 6/1949  
 Boky-Wéré : Holstein, 11/1952  
 Bougouni : Holstein, 8/1949  
 Dia : Holstein, 1/1953  
 Dia-bozo : Holstein, 2/1953  
 Diafarabé : Holstein, 2/1953  
 Diré : Sautet & Marneffe, 1943<sup>330</sup>  
 Djenné : Holstein, 5/1949  
 Douna : Holstein, 6/1949  
 El Oualadji : Sautet & Marneffe, 1943<sup>330</sup>

- Gao : Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup>  
 Gembé : Sautet & Marneffe, 1943<sup>330</sup>  
 Goundam : Sautet & Marneffe, 1943<sup>330</sup>  
 Kayes : Neveu-Lemaire, 1906<sup>267</sup> ; Thiroux & d'Anfreville, 1908<sup>373</sup> ; Bouffard, 1909<sup>38</sup> ;  
 Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup>  
 Ké-Macina : Holstein, 5/1949  
 Kokry : Sautet, 1942<sup>327</sup> ; Marneffe, Ranque & Sautet, 1943<sup>243</sup> ; Sautet & Marneffe,  
 1943<sup>330</sup> ; Holstein, 5/1949  
 Komora : Holstein, 1/1953  
 Koulikoro : Bouffard, 1909<sup>38</sup> ; Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup>  
 Koulouba : Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup>  
 Kouoro : Holstein, 11/1951  
 Koutiala : Holstein, 5/1949  
 Markala : Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup> ; Holstein, 5/1949  
 Monimpébougou : Holstein, 2/1953  
 Mopti : Marneffe, Ranque & Sautet, 1943<sup>243</sup> ; Sautet & Marneffe, 1943<sup>330</sup> ;  
 Holstein, 6/1949  
 Nara : Holstein, 5/1949  
 Niafouké : Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup>  
 Niono : Marneffe, Ranque & Sautet, 1943<sup>243</sup> ; Sautet & Marneffe, 1943<sup>330</sup> ; Holstein,  
 5/1949  
 Nioro : Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup>  
 San : Holstein, 6/1949  
 Sanga : Holstein, 6/1949  
 Sansanding : Holstein, 5/1949  
 Sarro : Holstein, 2/1953  
 Say : Holstein, 2/1953  
 Ségou : Bouffard, 1909<sup>38</sup> ; Sénevet & Ethès, 1939<sup>345</sup> ; Sautet, 1942<sup>327</sup> ; Sautet &  
 Marneffe, 1943<sup>330</sup> ; Holstein, 5/1949  
 Sikasso : Sautet, 1942<sup>327</sup> ; Sautet & Marneffe, 1943<sup>330</sup> ; Holstein, 10/1948  
 Sokolo : Holstein, 5/1949  
 Tenenkou : Holstein, 2/1953  
 Tilenbeya : Holstein, 2/1953  
 Tombouctou : Sautet & Marneffe, 1943<sup>330</sup>  
 Tonga : Sautet & Marneffe, 1943<sup>330</sup>  
 Toukoto : Neveu-Lemaire, 1906<sup>267</sup> ; Sautet, 1942<sup>327</sup>

### Upper Volta

- Banfora : Holstein, 2/1949  
 Batié : Holstein, 3/1949  
 Bobo-Dioulasso : Vilain, 1949<sup>392</sup>  
 Boromo : Holstein, 2/1949  
 Dédougou : Holstein, 6/1949  
 Diébougou : Holstein, 3/1949  
 Dori : Holstein, 2/1949  
 Fada-N'Gourma : Bernet, 1949<sup>28</sup>  
 Gaoua : Holstein, 10/1948  
 Houndé : Holstein, 2/1949  
 Kampti : Holstein, 3/1949  
 Kaya : Holstein, 2/1949  
 Koudougou : Bernet, 1948<sup>28</sup>  
 Koupéla : Holstein, 12/1949

Léo : Holstein, 3/1949  
 Nouna : Holstein, 10/1948  
 Ouagadougou : Legendre, 1927<sup>218</sup>; Le Gac, Seite & Combescot de Marsaguet, 1945<sup>218</sup>; Holstein, 2/1949  
 Ouahigouya : Holstein, 6/1949  
 Pabré : Holstein, 8/1949  
 Po : Holstein, 12/1949  
 Tenkodogo : Holstein, 12/1949  
 Tiogo : Holstein, 11/1948  
 Tougan : Holstein, 10/1948  
 Yakala : Holstein, 12/1949  
 Yako : Holstein, 6/1949

#### French Equatorial Africa

##### Gabon

Fernan Vaz, Mayoumba, Mouila, N'Dendé, Port Gentil, Tchibanga :  
 Galliard, 1932<sup>122</sup>

##### Middle Congo

Bacongo : Fiasson, 1943<sup>118</sup>  
 Brazzaville : Sicé & Vaucel, 1928<sup>352</sup>; Vaucel & Saleun, 1933<sup>391</sup>  
 Poto-Poto : Fiasson, 1943<sup>118</sup>

##### Oubangui Chari

Ombella-M'Poko district : Ledentu, 1942<sup>209</sup>

##### Tchad

Bouillez, 1916,<sup>89</sup> found only *A. funestus*, but *A. gambiae* must be considered as a probable species. Grjebine, 1951,<sup>148</sup> noted it at Fort Lamy.

#### French Cameroons

Rageau & Adam, 1951<sup>283</sup>  
 Douala, Yaoundé, and environs : Vaucel & Campourcy, 1943<sup>890</sup>

#### Comoro Islands

Anjouan, Grande-Comore, Mayotte, Mohéli : Lavergne, 1950<sup>207</sup>

#### Madagascar

Legendre, 1918<sup>217</sup>  
 Ambatofotsy : Doucet, 1951<sup>99</sup>  
 Ambatolampy, Ambohimahasoa, Antsirabe, Ihosy, Joffreville, Tamatave :  
 Bagster Wilson, 1947<sup>404</sup>  
 Ambatondrazaka, Ambilobe, Ambositra, Ankazobe, Betroka, Marovoay, Moramanga,  
 Morondava, Tsihombe, Vatomandry : Monier, 1937<sup>257</sup>  
 Andrialana, Imanombo, Mananjary, Nosy Bé : Dyé, 1904<sup>107</sup>  
 Ankavandra : Paulian (quoted by Doucet, 1951<sup>99</sup>)  
 Arivonimano : Doucet, 1951<sup>99</sup>  
 Bekily : Paulian (quoted by Doucet, 1951<sup>99</sup>)

Diego-Suarez : Billet, 1904 (quoted by Sénevet <sup>344</sup>) ; Dyé, 1904 <sup>107</sup> ; Monier, 1937 <sup>257</sup> ; Bagster Wilson, 1947 <sup>404</sup>  
 Fianarantsoa : Billet, 1904 (quoted by Sénevet <sup>344</sup>) ; Monier, 1937 <sup>257</sup> ; Bagster Wilson, 1947 <sup>404</sup>  
 Ivato : Monier, 1937 <sup>257</sup> ; Bagster Wilson, 1947 <sup>404</sup>  
 Lake Alaotra region : Doucet, 1949 <sup>47</sup>  
 Maevatanana : Dyé, 1904 <sup>107</sup> ; Monier, 1937 <sup>257</sup>  
 Mahatsinjo : Monier, 1937 <sup>257</sup> ; Doucet, 1951 <sup>99</sup>  
 Majunga : Monier, 1937 <sup>257</sup> ; Bagster Wilson, 1947 <sup>404</sup>  
 Miandrivazo : Paulian (quoted by Doucet, 1951 <sup>99</sup>)  
 Onilahy : Paulian (quoted by Doucet, 1951 <sup>99</sup>)  
 Tananarive : Monier, 1937 <sup>257</sup> ; Bagster Wilson, 1947 <sup>404</sup> ; Doucet, 1951 <sup>98</sup>  
 Tulear : Monier, 1937 <sup>257</sup> ; Bagster Wilson, 1947 <sup>404</sup>  
 Vangaindrano : Doucet, 1951 <sup>99</sup>

### Réunion

St. Paul : Blanchard, 1902 <sup>34</sup> ; Vassal, 1907 <sup>389</sup> ; Hamon & Dufour, 1951 <sup>155</sup>

### Somaliland coast

Djibouti : Theobald, 1910 (quoted by Sénevet <sup>344</sup>)

### French Togoland

Aledjo : Holstein, 10/1949  
 Lomé : Bernet, 1948 <sup>28</sup>  
 Sansanné-Mango : Holstein, 8/1949

## OTHER TERRITORIES IN THE ETHIOPIAN REGION

### Anglo-Egyptian Sudan

Lewis, 1942 <sup>225</sup>, 1947 <sup>228</sup> (southern Sudan), 1948 <sup>229</sup> (White Nile) ; Abbott, 1948 <sup>1</sup> (Darfur Province).

### Angola

De Mesquita, 1942 <sup>255</sup> ; E. Gonçalves Ferreira (quoted by Cambournac, 1950 <sup>57</sup>)

### Arabia

Patton, 1905 <sup>275</sup>

### Bechuanaland

Cambournac, 1950 <sup>57</sup>

### Belgian Congo

Newstead, Dutton & Todd, 1907 <sup>268</sup> ; Bequaert, 1930 <sup>25</sup> ; Duren, 1938 <sup>103</sup> ; Schwetz, 1944 <sup>385</sup> (Lakes Albert and Kivu) ; Schwetz, Baumann & Fort, 1948 <sup>389</sup> (Ruanda Urundi) ; Mattingly, 1949 <sup>249</sup> (Ruanda Urundi) ; Lambrecht, 1952 <sup>208</sup>

### British Somaliland

Glasgow & MacInnes, 1943 <sup>143</sup> ; Van Someren, 1943 <sup>387</sup>

**Cape Verde Islands**

Da Cruz Ferreira, 1945<sup>117</sup>; de Meira, Simões & Nogueira, 1947<sup>251</sup>

**Eritrea**

Corradetti, 1939<sup>69</sup>; Giaquinto-Mira, 1950<sup>135</sup>; Mara, 1950<sup>242</sup>

**Ethiopia**

Corradetti, 1938<sup>66, 67, 68</sup>, 1939<sup>70</sup> (Dankali country); 1939<sup>71</sup> (page 153) (Semien), 1939<sup>71</sup> (page 207) (Uollo-Jeggiu region); Brambilla, 1940-1<sup>44, 45</sup>; Melville, Bagster Wilson, Glasgow & Hocking, 1945<sup>252</sup> (Rift Valley and regions of the north-west and south-east); Corradetti & Archetti, 1946<sup>72</sup> (southern Ethiopia); Giaquinto-Mira, 1950<sup>135</sup>

**Gambia**

Dutton, 1903<sup>105</sup>

**Gold Coast**

Macfie, 1920<sup>234</sup>; Pomeroy, 1931<sup>282</sup>

**Italian Somaliland**

Bartolucci, 1932<sup>20</sup>; Mattei, 1932<sup>246</sup>; Bagster Wilson & Notley, 1943<sup>406</sup>; Giaquinto-Mira, 1950<sup>135</sup>

**Kenya**

Symes, 1928<sup>365</sup>, 1930<sup>366</sup>, 1940-1<sup>368</sup>; Garnham, 1929<sup>126</sup>; Kauntze & Symes, 1933<sup>184</sup> (Taveta Reserve to the south-west of Kilimandjaro); Bagster Wilson, 1936<sup>401, 402</sup>; Heisch, 1947<sup>161</sup> (Ethiopian frontier), 1948<sup>162</sup> (Garsen, on the Tana)

**Liberia**

Bequaert, 1930<sup>25</sup>; Barber, Rice & Brown, 1932<sup>17</sup>; Briscoe, 1948<sup>46</sup>; Young & Johnson, 1949<sup>410</sup>

**Mauritius**

Balfour, 1922<sup>10</sup>; MacGregor, 1924<sup>236</sup>; Kirk, 1934<sup>198</sup>; Gebert, 1936<sup>132</sup>; Jepson, Moutia & Courtois, 1947<sup>187</sup>

**Mozambique**

De Meillon, 1938<sup>88</sup>, 1941<sup>89</sup>; Rebelo, 1946<sup>288</sup>; Soeiro, 1950<sup>354</sup>

**Nigeria**

Annett, Dutton & Elliott, 1902<sup>8</sup>; Johnson, 1919<sup>188</sup>; Taylor, 1930<sup>370</sup>; Anderson, 1931<sup>9</sup>; Barber & Olinger, 1931<sup>13</sup>; Brown, 1947<sup>47</sup>; Bruce-Chwatt, 1947<sup>50</sup>, 1951<sup>54</sup>; Muirhead-Thomson, 1948<sup>262</sup>; Mattingly, 1949<sup>250</sup>

**Northern Rhodesia**

De Meillon, 1937<sup>86</sup>; Bagster Wilson, 1946<sup>403</sup>; Pielou, 1947<sup>277</sup>; Robinson, 1948<sup>288</sup>

**Nyasaland**

Lamborn, 1925<sup>202</sup>; Bagster Wilson, 1946<sup>403</sup>

**St. Thomas**

Edwards, 1934 <sup>109</sup>

**Seychelles**

Hermitte, 1931 <sup>164</sup> (Aldabra)

**Sierra Leone**

Stephens & Christophers, 1900 <sup>358</sup>; Blacklock & Evans, 1926 <sup>31</sup>; Gordon, Hicks, Davey & Watson, 1932 <sup>144</sup>; Tredre, 1946 <sup>380</sup>

**Southern Rhodesia**

Leeson, 1931 <sup>211</sup>

**South-West Africa**

De Meillon, 1951 <sup>91</sup>

**Spanish Guinea**

Gil Collado, 1936 <sup>140</sup> (Fernando Poo)

**Swaziland**

Cambournac, 1950 <sup>57</sup>

**Tanganyika**

Watson (quoted by Mackay, 1938 <sup>239</sup>); Scott, 1938 <sup>341</sup>; Bagster Wilson, 1936 <sup>401, 402</sup>, 1946 <sup>403</sup>; Bagster Wilson & Wilson, 1940 <sup>407</sup>

**Uganda**

Hancock, 1930 <sup>156</sup>, 1934 <sup>157</sup>; Gibbins, 1932 <sup>136</sup>, 1933 <sup>137</sup>; Hopkins, 1933 <sup>177</sup>; Haddow, 1945 <sup>152</sup>; Haddow, Gillett & Highton, 1947 <sup>154</sup>

**Union of South Africa**

Hill & Haydon, 1905 <sup>166</sup>; Ingram & De Meillon, 1927 <sup>152</sup>; Bedford, 1928 <sup>23</sup>; Swellengrebel, Annecke & De Meillon, 1931 <sup>362</sup>; De Meillon, 1934 <sup>82</sup>; Cambournac, 1950 <sup>57</sup>

**Zanzibar**

Aders, 1917 <sup>3</sup>, 1920 <sup>4</sup>; McCarthy, 1941 <sup>232</sup>

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## ANNEX 2

**SPOROZOITE-RATES OF A. GAMBIAE IN VARIOUS REGIONS  
OF AFRICA AND IN BRAZIL**

Region	Date of observation	Sporozoite-rate %	Authors
Anglo-Egyptian Sudan		1.1	Bedford <sup>24</sup>
Belgian Congo		7.1	Duren <sup>103</sup>
Boma	1938-1939	8.9 (mean)	Nicolay <sup>269</sup>
Elisabethville and environs	1944	4.6	} Vincke <sup>393</sup>
	1945	3.5	
	1946	5.0	
Leopoldville		1.07-10.9	Duren <sup>102</sup>
Mosso-Sud	1952	7.5	Lambrecht <sup>203</sup>
Stanleyville		3.0	Schwetz et al. <sup>340</sup>
Yalingimba		3.8	Davidson <sup>75</sup>
Cape Verde Islands	August-Sept. 1943	5.82	Da Cruz Ferreira <sup>117</sup>
French Cameroons			
Messa	April 1942	33.3	} Vaucel & Campourcy <sup>390</sup>
Yaoundé	1940-1941	18.5 (mean)	
	October 1941	35.2	
	Jan.-May 1942	26.6	
Gambia		2.8	Dutton <sup>105</sup>
Gold Coast		7.4	Taylor <sup>370</sup>
Kenya			
Digio	September 1931	17.64	Symes <sup>367</sup>
High plateaux (1,950-2,250 m (6,400-7,400 feet))		1.3	Garnham <sup>129</sup>
Kisumu	1932-1937	4 (mean)	Garnham <sup>127</sup>
Mombasa	August 1936- December 1937	3.1 (mean)	Wiseman et al. <sup>408</sup>
Mwatate	February 1930	18.96	Symes <sup>367</sup>
Nairobi	1926-1938	0.2-1 (mean)	Symes <sup>368</sup>

Region	Date of observation	Sporozoite-rate %	Authors
Taveta	May 1926- January 1938	0.6-4.6 (mean 1.05)	Kaunze & Symes <sup>194</sup>
		0.72-6.25	Symes <sup>367</sup>
Liberia		3.5	Barber et al. <sup>17</sup>
Madagascar	1935-1937	0.2	Monier <sup>257</sup>
Arrachart	1943-1944	1.6	} Bagster Wilson <sup>404</sup>
Tamatave	1943	7.1	
Mozambique			
Quelimane		5.0	Rebello <sup>288</sup>
Nigeria		0-20.0 (mean 5.89)	Bruce-Chwatt <sup>54</sup>
Ibadan	1946-1948	13.1	} Barber & Olinger <sup>15</sup>
Lagos		6.6	
Yaba		0.5-5.2	Bruce-Chwatt <sup>53</sup>
		4.6	Barber & Olinger <sup>15</sup>
Sierra Leone			
Freetown		8.0	} Gordon et al. <sup>144</sup>
Kissy		11.2	
Tanganyika			
Usa	Annual mean	3.6-5.7	Bagster Wilson & Wilson <sup>407</sup>
Uganda			
Jinja		17.8	} Gibbins <sup>136</sup>
Kampala		18.6	
Mbale		24.2	
Union of South Africa			
Transvaal		7.4-9.9	Cambournac <sup>57</sup>
		11.0	Swellengrebel et al. <sup>362</sup>
Zanzibar	1937	2.55-6.24	McCarthy <sup>232</sup>
Brazil			
Cumbe	Jan.-April 1940	5.6	Causey et al. <sup>80</sup>
Natal	May 1930	1.6	Causey et al. <sup>82</sup>
São Gonçalo	July-Aug. 1931	30.2	Davis <sup>77</sup>
Taipú		28.2	De Souza Pinto <sup>280</sup>

ANNEX 3

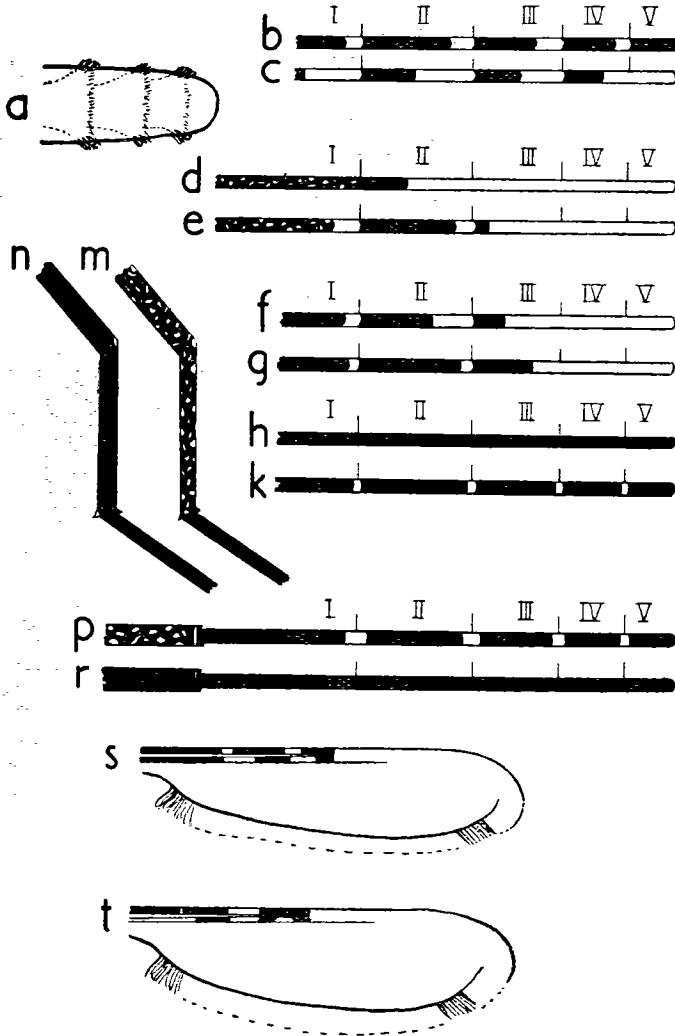
KEY TO THE IDENTIFICATION OF THE COMMON ANOPHELES  
IN FRENCH WEST AFRICA

Adults (Males and Females)

(see fig. 21)

- |  |                        |
|--|------------------------|
| 1. Abdominal segments with lateral tufts of scales (a) . . . . .   | 2                      |
| Abdominal segments without lateral tufts of scales . . . . .   | 3                      |
| 2. Last segment of posterior tarsus entirely dark (b) . . . . .  | <i>A. squamosus</i>    |
| Last segment of posterior tarsus entirely pale (c) . . . . .   | <i>A. pharoensis</i>   |
| 3. Posterior tarsus with at least the last two segments entirely pale<br>(d, e, f, g) . . . . .                    | 4                      |
| Posterior tarsus with all the segments black (h) or with pale rings<br>at the joints (k) . . . . .                 | 7                      |
| 4. Femora and tibiae with pale spots (m) . . . . .   | 5                      |
| Femora and tibiae uniform in colour (n) . . . . .  | 6                      |
| 5. Last three segments of the posterior tarsus completely pale (d) .   | <i>A. maculipalpis</i> |
| Last two segments only of the posterior tarsus completely pale (e)   | <i>A. pretoriensis</i> |
| 6. Third segment of the posterior tarsus with a black band less than<br>half the size of the segment (f) . . . . . | <i>A. coustani</i>     |
| Third segment of the posterior tarsus with a black band more<br>than half the size of the segment (g) . . . . .    | <i>A. rufipes</i>      |
| 7. Anterior tarsus with pale rings at the joints (p) . . . . .   | <i>A. gambiae</i>      |
| Anterior tarsus without pale rings at the joints (r) . . . . .   | 8                      |
| 8. Base of the first vein dark (s) . . . . .   | <i>A. nili</i>         |
| Base of the first vein pale (t) . . . . .  | <i>A. funestus</i>     |

**FIG. 21. MORPHOLOGICAL CHARACTERS FOR THE IDENTIFICATION OF  
A. GAMBIAE ADULTS**

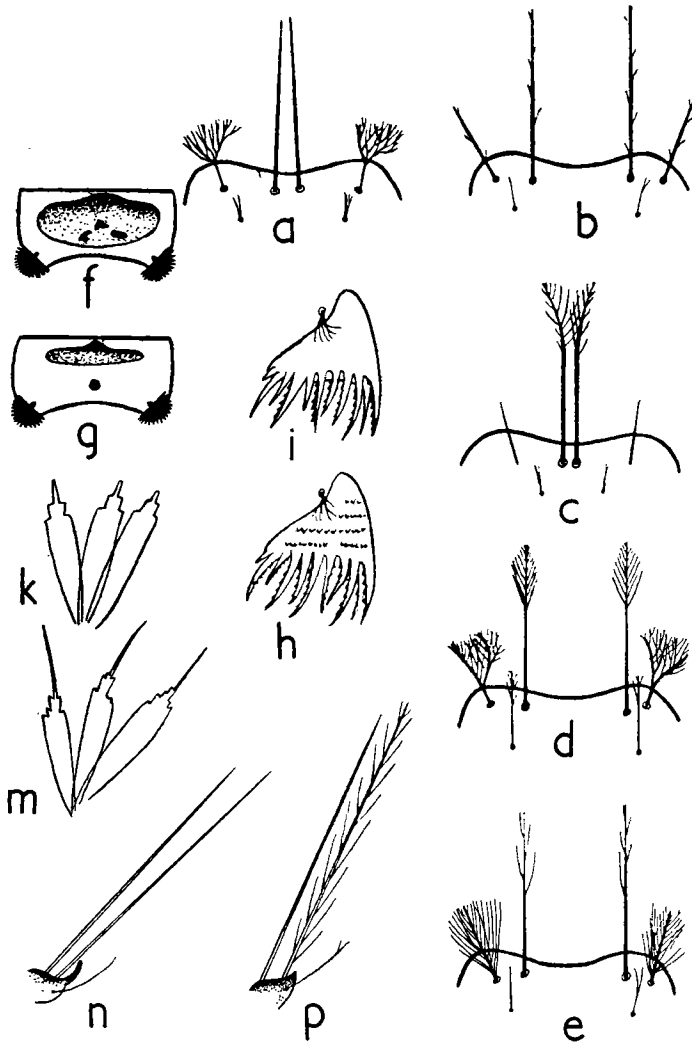


## Larvae in the IVth Instar

(see fig. 22)

1. Inner clypeal bristles contiguous (a, c) . . . . .	2
Inner clypeal bristles clearly separated (b, d, e) . . . . .	3
2. Inner clypeal bristles branched at the tip (c) . . . . .	<i>A. nili</i>
Inner clypeal bristles simple (a) . . . . .	<i>A. coustani</i>
3. External clypeal bristles in the form of a tuft (d, e) . . . . .	4
External clypeal bristles simple or bearing some fine branches (b)	5
4. Tuft very thick, from 20 to 45 branches (d) . . . . .	<i>A. pharoensis</i>
Tuft less thick, from 8 to 20 branches (e) . . . . .	<i>A. squamosus</i>
5. Abdominal plates very broad, covering almost the whole segment (f)	<i>A. funestus</i>
Abdominal plates narrower (g) . . . . .	6
6. Comb of segment VIII covered with spicules (h) . . . . .	<i>A. maculipalpis</i>
Comb of segment VIII not covered with spicules (i) . . . . .	7
7. Palmate abdominal bristles without a filiform prolongation (k) .	<i>A. rufipes</i>
Palmate abdominal bristles with a filiform prolongation (m) . .	8
8. Both mesothoracic bristles simple (n) . . . . .	<i>A. gambiae</i>
One mesothoracic bristle simple, one plumose (p) . . . . .	<i>A. pretoriensis</i>

FIG. 22. MORPHOLOGICAL CHARACTERS FOR THE IDENTIFICATION OF  
A. GAMBIAE LARVAE





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