CULICINE MOSQUITOES (*DIPTERA: CULICIDAE*) RECORDED FROM THE PROVINCE OF MOÇAMBIQUE (PORTUGUESE EAST AFRICA) AND THEIR RELATIONSHIP TO ARTHROPOD-BORNE VIRUSES

C. BROOKE WORTH and BOTHA DE MEILLON

Arthropod-born Virus Research Unit, South African Institute for Medical Research, Johannesburg

Separata dos ANAIS DO INSTITUTO DE MEDICINA TROPICAL, Volume XVII, N.os 1/2
Março/Junho de 1960

CULICINE MOSQUITOES (*DIPTERA: CULICIDAE*) RECORDED FROM THE PROVINCE OF MOÇAMBIQUE (PORTUGUESE EAST AFRICA) AND THEIR RELATIONSHIP TO ARTHROPOD-BORNE VIRUSES (1) (*)

C. BROOKE WORTH (2) and BOTHA DE MEILLON (3)

Arthropod-born Virus Research Unit, South African Institute for Medical Research, Johannesburg

INTRODUCTION

Edwards (1941) listed 22 species of culicine mosquitoes from the Province of Moçambique (Portuguese East Africa), deriving these records from the scanty literature and study of the few small collections available up to that time (Sant'Anna, 1905; Séguy, 1959). In the same year de Meillon and Rebêlo (1941) published additional records obtained incidentally during an anopheline survey of the country. This paper added 20 species to Edwards' list, bringing the known fauna to 42. Pereira (1946*a*, 1946*b*) during further work with anophelines

(*) Entregue para publicação em 21-3-960.

(1) The studies and observations on which this paper is based were financed jointly by the Institute for Medical Research of Moçambique, the Institute of Tropical Medicine (Portugal), the South African Institute for Medical Research, the Poliomyelitis Research Foundation, the South African Council for Scientific and Industrial Research and The Rockefeller Foundation.

(2) The Rockefeller Foundation.

(3) South African Institute for Medical Research.

was nevertheless able to contribute 21 new culicine records and subsequently (1958) yet another four. With the exception of a few problematical records which will be discussed under individual species, the hitherto published culicine fauna of Moçambique therefore stands at 67 species.

The present paper records the results of activities with culicine mosquitoes themselves in Moçambique during brief periods in 1957 and 1959, in connection with a program directed toward the elucidation of the distribution of arthropod-borne viruses in Southern Africa. Since a large part of the country was sampled and the total list of culicines from Moçambique is now brought to over 100, it would appear that the fauna must finally be fairly well disclosed. While further forms undoubtedly remain to be detected, particularly in the northern highlands and along the forested northwestern boundary, it is likely that the commonest species have all come under surveillance. Since it is among these prevalent forms that species of economic importance are most likely to be found, it seems timely to present a complete listing of culicine mosquitoes from Moçambique with the available data on their distribution and potential relationship to public health and animal husbandry.

The survey in 1957 was carried out from mid-July to mid-August with the two-fold purpose of collecting mosquitoes for identification and blood specimens for serological study. Culicine mosquitoes were collected at 25 localities within the Province. Unfortunately this was during the dry season, and since only a few hours were spent in collecting at each location, the samples of the fauna are far from exhaustive ones. However most of the previous culicine records from Moçambique were based on material collected south of the Save River, whereas 19 of the 25 collecting stations in the present survey were north of that boundary. Hence a great number of the records afford new distributional data.

Blood specimens were collected from resident human beings in 29 localities most of which were also sites of mosquito collecting. Results of serological studies of these specimens are presented elsewhere (Kokernot, Smithburn, Gandara *et al.*, 1960.

The work in 1959 represented an effort to collect large masses of culicine mosquitoes, for attempts to isolate viruses, at a few selected localites, again north of the Save River. Three weeks were spent at

Lumbo during March, while relatively brief periods — two days or less — were devoted to collecting at Namacurra, Quelimane and Nova Lusitania. Native boys were recruited to catch mosquitoes resting on vegetation or as they came to bite. The numbers of each species of mosquito obtained in this manner are indicated in parentheses in the following list, since they furnish clues to the relative abundance of the various members of the culicine fauna at that season.

De Meillon and Rebêlo (1941) and Pereira (1946*a*, 1946*b*) have published locality records in full for those species which they collected. These references will therefore not be repeated here. However all new locality records established during the activities in 1957 and 1959 are presented. In addition the known distribution of each species, based on all available information, is defined in accordance with the division of the Province into a few simple regions. These are:

1. Northern. North of the Zambeze River.
2. Intermediate. The Zambeze River which divides the country roughly into equal northern and southern parts.
3. Southern. South of the Zambeze River.
4. Coastal. Seacoasts and brackish estuaries.
5. Inland lowland. This includes localities from sea level up to 200 meters in elevation. Most of the southern half of the country falls into this category, while in the north this comprises a coastal strip of varying width. In addition it extends far inland along some of the rivers.
6. Highland. This region, above 200 meters in elevation, includes a large part of the interior of the northern half of the country, but a much smaller portion of the western part of the southern half.

Species recorded from the Province of Moçambique for the first time are preceded by an asterisk. The 1957 and 1959 records refer to collections made in the course of the work described in this paper. A few other records are derived from unpublished material kindly furnished by Pereira (1959) and from the identification of mosquitoes submitted sporadically by various individuals to the South African Institute for Medical Research, notably a collection made at Luabo by P. J. Usher in 1957.

The table and the following text present information relative to the known role of several mosquito species in carrying viruses in Moçambique or elsewhere in Africa. In addition the neutralizing anti-

bodies detected against these and some other viruses in sera of residents of Moçambique are indicated in the table. It will be seen that, with the exception of Bwamba fever, for which no mosquito vector has been demonstrated, a presumed vector species of mosquito has been locally found for all other viruses against which antibodies were detected. Conversely in the few cases in which antibodies were not found, a potential vector is nevertheless seen to be locally present. Hence there is no reason to doubt that additional types of virus could be introduced successfully into Moçambique from time to time.

CULICINE MOSQUITOES OF MOÇAMBIQUE

**Toxorhynchites brevipalpis* Theobald. One male from Luabo submitted by P. J. Usher. Intermediate: coastal.

Convention is followed in listing this species with true culicine mosquitoes.

**Uranotaenia pallidocephala* Theobald. 1957: Namacurra. Pereira (1959): Vila de João Belo. Northern: inland lowland. Southern: coastal.

Uranotaenia philonuxia Philip. Pereira (1946*a*, 1946*b*). Southern: coastal.

**Uranotaenia alboabdominalis* Theobald. 1957: Namacurra, Nametil, Montepuez, Palma. Northern: coastal, inland lowland, highland.

**Uranotaenia mayeri* Edwards. 1959: Lumbo (1 male). Northern: coastal.

This identification is based on the description of the male by Mattingly (1953).

**Uranotaenia bilineata* Theobald. 1957: Mueda, Espungabera. Northern: highland. Southern: highland.

Uranotaenia balfouri Theobald. Edwards (1941). De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*, 1958). 1957: Montepuez. Northern: highland. Southern: coastal, inland lowland.

Uranotaenia palmeirimi de Meillon and Rebêlo. De Meillon and Rebêlo (1941). Northern: coastal.

Through an error the type locality was omitted from the text originally describing this species. It was taken at Pebane in Quelimane District.

Uranotaenia hopkinsi Edwards. Pereira (1946*a*, 1946*b*). Southern: coastal, inland lowland.

**Uranotaenia candidipes* Edwards. 1957: Namacurra, Mualama, Nametil, Montepuez, Mueda, Palma, Maua, Cuamba. Northern: coastal, inland lowland, highland.

**Uranotaenia mashonaensis* Theobald. 1957: Nametil, Maua, Cuamba. Northern: inland lowland, highland.

**Uranotaenia nigromaculata* Edwards. 1957: Namacurra. Northern: inland lowland.

**Uranotaenia fusca* Theobald. Pereira, 1959: Malema. Northern: highland. Based on larvae.

**Uranotaenia shillitonis* Edwards. Pereira, 1959: Nacaroa. Northern: inland lowland. Based on larvae.

Aedomyia africana Neveu-Lemaire. De Meillon and Rebêlo (1941). Northern: highland. Southern: inland lowland.

Aedomyia furfurea (Enderlein). Pereira (1946*a*, 1946*b*). Southern: coastal.

Ficalbia (Mimomyia) splendens (Theobald). Edwards (1941). De Meillon and Rebêlo (1941). Southern: inland lowland.

Ficalbia (Mimomyia) hispida (Theobald). Edwards (1941). 1957: Montepuez. Northern: highland.

Ficalbia (Mimomyia) lacustris Edwards. Pereira (1946*a*, 1946*b*). Southern: coastal.

Ficalbia (Mimomyia) mimomyiaformis (Newstead). De Meillon and Rebelo (1941). 1957: Namacurra, Palma, Cuamba, Mocímboa da Praia. 1959: Lumbo (1 specimen). Northern: coastal, inland lowland, highland. Intermediate: inland lowland (riverine). Southern: coastal, inland lowland.

Ficalbia (Mimomyia) plumosa (Theobald). De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). 1957: Mocímboa da Praia. Northern: coastal. Southern: coastal.

**Ficalbia (Etorleptomyia) mediolineata* (Theobald). 1957: Montepuez, Palma. 1959: Lumbo (1 male). Pereira, 1959: Lourenço Marques. Northern: coastal, highland. Southern: coastal.

Ficalbia (Ficalbia) uniformis (Theobald). De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). Northern: highland. Southern: coastal.

Ficalbia (Ficalbia) malfeyti (Newstead). Mattingly and Hamon (1955): Vila Cabral. Northern: highland.

First identified and recorded as *F. uniformis* by de Meillon and Rebêlo (1941). Some of these specimens were later found to be *F. malfeyti* and so recorded by Mattingly and Hamon.

Mansonia (Coquillettidia) metallica (Theobald) [1]. Pereira (1946*a*, 1946*b*). 1957: Vila de Sena, Maua. 1959: Lumbo (8), Namacurra (4). Northern: coastal, inland lowland, highland. Intermediate: inland lowland (riverine). Southern: coastal.

Mansonia (Coquillettidia) annetti (Theobald). This record is taken from Séguy (1930), who reports that Lesne collected the species at Beira (Southern: coastal). Although Edwards (1912) gave Uganda as part of the range of *M. annetti,* he later (1941, p. 95) restricted it to Nigeria and by implication rejected Séguy's record with the statement, «Records from other countries require confirmation.»

**Mansonia (Coquillettidia) maculipennis* (Theobald). 1957: Mualama, Nametil, Montepuez, Mocímboa do Rovuma, Palma. Northern: coastal, inland lowland, highland.

**Mansonia (Coquillettidia) cristata* (Theobald). 1957: Namacurra, Montepuez. Northern: inland lowland, highland.

**Mansonia (Coquillettidia) aurites* (Theobald). 1957: Namacurra, Mocímboa do Rovuma, Palma. Northern: coastal, inland lowland, highland.

Mansonia (Coquillettidia) chrysosoma (Edwards). Pereira (1946*a*, 1946*b*). 1957: Marromeu. 1959: Lumbo (1 specimen). Northern: coastal. Intermediate: coastal. Southern: coastal, inland lowland.

**Mansonia (Coquillettidia) aurea* (Edwards). 1957: Montepuez. Northern: highland.

**Mansonia (Coquillettidia) wahlbergi* (Edwards). Pereira, 1959: Lourenço Marques. Southern: coastal.

Mansonia (Coquillettidia) microannulata (Theobald). Pereira (1946*a*, 1946*b*). P. J. Usher: Luabo. Intermediate: coastal. Southern: coastal.

---

[1] Formerly *Taeniorhynchus.*

(*Mansonia (Coquillettidia) microannulata* var. *auripennis* (Edwards). Pereira, 1959: Lourenço Marques. Southern: coastal.

Mansonia (Mansonioides) africana (Theobald). Séguy (1930). Edwards (1941). Pereira (1946*a*, 1946*b*). Specimens at South African Institute for Medical Research: Fukwa, Chicualacuala. 1957: Marromeu, Vila de Sena. 1959: Lumbo (354), Namacurra (27), Quelimane (91), Nova Lusitania (1660). Northern: coastal, inland lowland. Intermediate: coastal, inland lowland (riverine). Southern: coastal, inland lowland.

This was the commonest mosquito at Nova Lusitania in April, 1959, representing 65 per cent of all culicines taken.

Mansonia (Mansonioides) uniformis (Theobald). Séguy (1930). Edwards (1941). De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). 1957: Marromeu, Vila de Sena, Nametil, Quissanga, Cuamba. 1959: Lumbo (310), Namacurra (18), Quelimane (202), Nova Lusitania (667). Northern: coastal, inland lowland, highland. Intermediate: coastal, inland lowland. Southern: coastal, inland lowland.

Both species of *Mansonioides* have been found carrying viruses infections for man in the Union of South Africa. Spondweni virus was originally isolated from *M. uniformis* in Tongaland, northern Natal (Kokernot, Smithburn, Muspratt and Hodgson, 1957) and has since been found in *M. africana* in the same region (McIntosh, Kokernot *et al.*, in preparation). Wesselsbron virus, first isolated from a dead sheep in Orange Free State (Weiss *et al.*, 1956) is now known also from *M. uniformis* (Kokernot, Smithburn, Paterson and de Meillon, in preparation) as well as from other mosquito hosts (see beyond) and from man (Smithburn *et al.*, 1957). Sindbis virus has recently been isolated from *M. africana* in Tongaland (Arthropod-borne Virus Research Unit, unpublished information). This virus is discussed beyond in connection with *Culex univittatus*.

The relative abundance and wide distribution of these two species in Portuguese East Africa should keep them under suspicion here. Their apparent absence or rarity in the highlands probably reflects only the fact that collections in 1957 were made during the dry season: at other times they may be present in significant numbers.

Aedes (Mucidus) scatophagoides (Theobald). Séguy (1930). Edwards (1941). 1957: Maxixe. Intermediate: inland lowland. Southern: coastal.

Aedes (Mucidus) (Karsch). Karsch (1887). Edwards (1941). Pereira (1946*b*). Southern: coastal.

Aedes (Mucidus) nigerrimus (Theobald). Sant'Anna (1905). Edwards (1941). Southern: coastal.

Aedes (Ochlerotatus) fryeri (Theobald). Pereira (1946*a*, 1946*b*). 1959: Lumbo (5). Northern: coastal. Southern: coastal.

Aedes (Stegomyia) aegypti (Linnaeus). Séguy (1930). Edwards (1941). De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). Specimens in collection of South African Institute for Medical Research: Inhaca Island. 1957: Maxixe. 1959: Lumbo (337), Namacurra (15), Nova Lusitania (1). Northern: coastal, inland lowland. Intermediate: inland lowland. Southern: coastal. Undoubtedly more widely distributed than the records indicate, although it seems to have an affinity for the coast (see de Meillon and Rebêlo, 1941).

The classical vector of urban yellow fever and dengue, *A. aegypti* is present in sufficient numbers in Portuguese East Africa to support the spread of the causative viruses, should these be introduced. It is interesting to note that although neither of the dengue viruses has been isolated from mosquitoes in Africa, serologic evidence of their past activity in Moçambique has been obtained (table). Dengue 1 has similarly left its serological traces in human residents of neighboring Natal (Kokernot *et al.*, 1956). Information on *A. aegypti* as a host to yellow fever virus is fully summarized by Whitman (1951).

Chikungunya virus was first isolated from human patients in Tanganyika (Ross, 1956). Shortly thereafter the same virus was obtained from *Aedes aegypti, Culex fatigans* and bedbugs, although it appeared that *A. aegypti* was the primary vector (Lumsden, 1955). The virus has subsequently been isolated elsewhere, including the Union of South Africa (Gear and Reid, 1957). The finding of antibodies in residents of Moçambique was therefore not unexpected.

Aedes (Stegomyia) subargenteus Edwards. Pereira (1958). 1957: Vilanculos, Marromeu, Namacurra. 1959: Lumbo (32). Northern: coastal, inland lowland. Intermediate: coastal. Southern: coastal.

Aedes (Stegomyia) woodi Edwards. Pereira (1946*a*, 1946*b*). 1959: Lumbo (74), Namacurra (7), Quelimane (6), Nova Lusitania (12). Northern: coastal, inland lowland. Southern: coastal.

Aedes (Stegomyia) simpsoni (Theobald). De Meillon and Rebelo (1941). 1957: Zandamela, Vilanculos, Nova Lusitania, Marromeu,

TABLE — *Mosquitoes recorded in Moçambique, showing viruses which have been isolated from them in Africa. Also neutralizing antibodies against these and other viruses in sera of residents of Moçambique.*

	Chikungunya	Middelburg	Semliki Forest	Sindbis	H 336	Spondweni	Wesselsbron	West Nile	Yellow fever	Zika	Bunyamwera	Germiston	AR 136	Pongola	Rift Valley fever	Simbu	Witwatersrand	Unknown, Moçambique	Dengue 1	Dengue 2	Bwamba fever
Mansonia (*Mansonioides*) *africana* (Theobald)				X		X															(Suspected to be mosquito-borne but not yet proved)
Mansonia (*Mansonioides*) *uniformis* (Theobald)						X	X														
Aedes (*Stegomyia*) *aegypti* (Linnaeus)	X								X										X	X	
Aedes (*Stegomyia*) *simpsoni* (Theobald)									X												
Aedes (*Stegomyia*) *africanus* (Theobald)									X	X									(Virus not isolated from mosquitoes in Africa)	(Virus not isolated from mosquitoes in Africa)	
Aedes (*Aedimorphus*) *argenteopunctatus* (Theobald			X																		
Aedes (*Aedimorphus*) *albocephalus* (Theobald)		X																			
Aedes (*Aedimorphus*) *cumminsi* ssp. *mediopunctatus* (Theobald)						X															
Aedes (*Neomelaniconion*) *circumluteolus* (Theobald)		X				X	X				X		X	X	X	X					
Aedes (*Skusea*) *pembaensis* Theobald																		X			
Culex (*Neoculex*) *rubinotus* Theobald					X							X					X				
Culex (*Culex*) *sitiens* Wiedemann (group)																		X			
Culex (*Culex*) *theileri* Theobald															X						
Culex (*Culex*) *univittatus* Theobald				X			X	X													
Culex (*Culex*) *fatigans* Wiedemann	X																				
Culex (*Culex*) *antennatus* (Becker)								X													
Neutralizing antibodies found in human sera in Moçambique (1957)	X		X	X	X	X	X	X		X	X			X	X				X	X	X

Mocímboa do Rovuma. 1959: Lumbo (269), Namacurra (27). Northern: coastal, inland lowland, highland. Intermediate: coastal. Southern: coastal.

This species is implicated as an intermediary between the monkey-to-monkey and man-to-man cycles of yellow fever in endemic areas of Central Africa (Taylor, 1951). Its abundance in the Province of Moçambique, in view of the prevalence of several species of wild primates, might assist in the establishment of an enzootic cycle, should the virus be introduced.

Aedes (Stegomyia) metallicus (Edwards). Séguy (1930). Edwards (1941). 1959: Lumbo (18). Northern: coastal. Intermediate: inland lowland (riverine).

**Aedes (Stegomyia) calceatus* Edwards. 1959: Lumbo (2). Northern: coastal.

**Aedes (Stegomyia) heischi* van Someren, 1959: Lumbo (5). Northern: coastal.

One of these specimens has been examined by Mattingly. A minor variation consists in the fifth hind tarsal segment being almost entirely pale with a small black area at the tip.

Aedes (Stegomyia) africanus (Theobald). Howard (1912), referred to in Mattingly (1952). «Unnamed localities.» This is a record which Edwards (1941) apparently chose not to recognize.

This species is important in Central Africa in maintaining the monkey-to-monkey cycle of yellow fever in the forest canopy (Taylor, 1951). Since the presence of *A. africanus* in Moçambique is open to some question, it is perhaps significant that yellow fever is also apparently absent. On the other hand Zika virus was originally obtained from both monkeys and *A. africanus* in Uganda (Dick *et al.*, 1952), and a low incidence of Zika neutralizing antibodies has been found in human residents of Moçambique (Kokernot, Smithburn, Gandara *et al.*, 1960). However it is possible that Zika virus may be carried by other species of mosquito in addition to *A. africanus*.

Aedes (Stegomyia) vittatus (Bigot). Edwards (1941). De Meillon and Rebêlo (1941). 1959: Lumbo (1 specimen). Northern: coastal, inland lowland.

Aedes (Aedimorphus) marshalli (Theobald). Pereira (1958). *Based on larvae. Southern: coastal.*

**Aedes (Aedimorphus) capensis* Edwards. 1957: Maua. Northern: highland.

Aedes (Aedimorphus) argenteopunctatus (Theobald). Pereira (1946*a*, 1946*b*). 1957: Zandamela, Maxixe, Vilanculos, Mualama, Quissanga, Mocímboa da Praia, 1959: Lumbo (145), Namacurra (97). Northern: coastal, inland lowland. Southern: coastal, inland lowland.

Semliki Forest virus was isolated from *A. argenteopunctatus* collected at Namacurra in 1959 (McIntosh, Worth and Kokernot, to be published). It is consequently significant to note that the mosquito is a fairly abundant form, widely distributed along the coast and in the adjacent inland lowlands. This is the first time that *A. argenteopunctatus* has been incriminated as a virus carrier.

Semliki Forest virus was first isolated from *Aedes (Aedimorphus) abnormalis* (Theobald) in Uganda (Smithburn and Haddow, 1944). Although the virus is infectious for human beings, it is not known to produce overt illness.

**Aedes (Aedimorphus) domesticus* (Theobald). 1959: Lumbo (1 specimen). Northern: coastal.

**Aedes (Aedimorphus) filicis* Ingram and de Meillon. 1959: Lumbo (2). Northern: coastal.

Aedes (Aedimorphus) albocephalus (Theobald). Pereira (1946*a*, 1946*b*). 1957: Lourenço Marques, Zandamela, Maxixe, Vilanculos, Maua, Mocímboa da Praia, 1959: Lumbo (2180). Namacurra (7), Quelimane (3), Nova Lusitania (3). Northern: coastal, inland lowland, highland. Southern: coastal, inland lowland.

A species with wide distribution which nevertheless is most abundant at or near the coast. At Lumbo in March, 1959, it was the second most common mosquito, accounting for 13 per cent of all culicines taken. Of 25 samples of engorged blood from *A. albocephalus* collected at Lumbo and tested by the precipitin reaction, 24 were of human origin, the other one from a goat. No viruses were recovered from this mosquito, although in the Union of South Africa it has been found as a virus carrier. Hence in view of its high populations at various times and places in Portuguese East Africa, as well as its feeding habits, it should be kept in mind as having potential economic significance.

In Tongaland, northern Natal, *A. albocephalus* and *A. circumluteolus* have both been found carrying Middelburg virus (Arthropod-

borne Virus Research Unit, unpublished information). This virus was first isolated in the eastern Cape Province from *Aedes (Ochlerotatus) caballus* (Theobald) and *Neomelaniconion* spp. mosquitoes (Kokernot, de Meillon *et al.*, 1957), during an epizootic of Wesselsbron virus infection among sheep. Middelburg virus infection apparently produces only a mild febrile illness in lambs and is not known to be accompanied by clinical symptoms in human beings. The absence of neutralizing antibodies in human sera collected during the 1957 survey is no guarantee that the virus will not appear in Moçambique sooner or later.

Aedes (Aedimorphus) leesoni Edwards. De Meillon and Rebelo (1941). Southern: inland lowland.

Aedes (Aedimorphus) dalzieli (Theobald). Howard (1912). Edwards (1941). Southern: coastal. Edwards' (1941, p. 184) citation of Lomagundi should probably be referred to Southern Rhodesia.

Aedes (Aedimorphus) quasiunivittatus (Theobald). Edwards (1941). No locality cited. A specimen in the collection at the South African Institute for Medical Research bears an identification label in Edwards' hand writing and is probably the one on which he based his reference to Moçambique. It was collected by B. de Meillon in February, 1938, at Lourenço Marques. Southern: coastal.

Aedes (Aedimorphus) cumminsi ssp. *mediopunctatus* (Theobald). Pereira (1946*a*, 1946*b*). Southern: coastal.

Apparently not common, but has on one occasion been found carrying Spondweni virus in northern Natal, close to the southern boundary of Portuguese East Africa (McIntosh, Kokernot *et al.*, in preparation).

**Aedes (Aedimorphus) bevisi* (Edwards). Pereira (1959): Lourenço Marques. Southern: coastal.

**Aedes (Aedimorphus) hirsutus* (Theobald). 1957: Guija. Southern: inland lowland.

Aedes (Aedimorphus) fowleri (d'Emmerez de Charmoy). De Meillon and Rebêlo (1941). 1959: Lumbo (14). Northern: coastal, inland lowland.

Aedes (Aedimorphus) durbanensis (Theobald). Theobald (1910) (as *Grabhamia ocellata*). Pereira (1946*a*, 1946*b*). 1957: Lourenço Marques, Guija, Zandamela, Maxixe, Vilanculos, Mambone. 1959: Lumbo (5). Northern: coastal. Southern: coastal, inland lowland.

Aedes (Aedimorphus) ochraceus (Theobald). De Meillon and Rebêlo (1941). Southern: inland lowland.

**Aedes (Neomelaniconion)* (1) *lineatopennis* (Ludlow). 1957: Nova Lusitania. 1959: Quelimane (1 specimen). Northern: coastal. Southern: coastal.

Aedes (Neomelaniconion) circumluteolus (Theobald). Pereira (1946*a*, 1946*b*). 1957: Lourenço Marques, Guija, Zandamela, Marromeu, Moçímboa do Rovuma, Maua. 1959: Lumbo (118), Namacurra (109), Quelimane (4), Nova Lusitania (193). Northern: coastal, inland lowland, highland. Intermediate: coastal. Southern: coastal, inland lowland.

This species has been found as the most abundant culicine, as well as the one most frequently carrying viruses, in northern Natal adjacent to the boundary of Portuguese East Africa. There is no doubt that it must appear in the same role on the opposite bank of the Maputa River, at a place such as Catuane. While it does not seem to occupy such a prominent position in the mosquito fauna in more northern portions of the country, its generally widespread distribution should keep it on the list of suspects.

The table shows that *A. circumluteolus* has been found carrying eight different viruses. It is a remarkable and unexplained fact that all of these isolations have been made in Tongaland, northern Natal, where the species was detected as a virus carrier for the first time. *Aedes circumluteolus* extends into Uganda, Sudan and the Belgian Congo (Edwards, 1941) but has not hitherto been suspected as a virus carrier (Smithburn and de Meillon, 1957).

Of the eight types of virus, Middelburg, Spondweni and Wesselsbron have already been mentioned in connection with other mosquitoes listed in the foregoing pages. Pongola (Kokernot, Smithburn, Weinbren and de Meillon, 1957), Simbu (Weinbren *et al.*, 1957) and AR 136 (Arthropod-borne Virus Research Unit, unpublished information) viruses were recognized for the first time in Tongaland. The latter two have not been found elsewhere. However, neutralizing antibodies to Pongola virus were found abundantly in the Moçambique survey in 1957 and may indicate that it is widespread. This agent is related to Bwamba fever virus.

---

(1) Formerly *Banksinella*.

Rift Valley fever virus is a recognized pathogen, particularly of sheep, although it causes an acute febrile illness also in man. First isolated from sheep in East Africa in 1930 (Daubney *et al.*, 1931), it has since caused widespread epizootics in the Union of South Africa where the virus was isolated from *A. caballus* and *C. theileri* (Gear *et al.*, 1955). Its subsequent isolation from *A. circumluteolus* in Tongaland (Kokernot, Heymann *et al.*, 1957) and evidence of neutralizing antibodies in human sera from Moçambique in 1957 (Kokernot, Smithburn, Gandara *et al.*, 1960), are therefore not entirely unexpected.

Bunyamwera virus, detected in *A. circumluteolus* from Tongaland (Kokernot, Heymann *et al.*, 1957), was originally discovered in Uganda in a mixed pool of *Aedes* mosquitoes (Smithburn *et al.*, 1946). It has also been isolated in Tongaland from a febrile human being (Kokernot *et al.*, 1958). The virus seems to be rather widespread as judged by distantly separated virus isolations and antibody studies, the latter including positive results with human sera tested in the 1957 Moçambique survey (Kokernot, Smithburn, Gandara *et al.*, 1960).

Aedes (Neomelaniconion) palpalis var. *maculicosta* Edwards. Pereira (1958). Identification of this West African form is based on larvae only. Southern: coastal.

Aedes (Diceromyia) adersi (Edwards). Pereira (1958). Based on larvae. Specimen from Inhaca Island in South African Institute for Medical Research (de Meillon, 1947). Southern: coastal.

**Aedes (Diceromyia) fascipalpis* (Edwards). 1959: Lumbo (1 specimen). Northern: coastal.

**Aedes (Pseudarmigeres)* (1) *natalensis* Edwards. 1959: Lumbo (1 specimen), Namacurra (10). Northern: coastal, inland lowland.

Aedes (Skusea) pembaensis Theobald. Edwards (1941). 1957: Maxixe, Vilanculos, Mambone, Quissanga, Mocímboa da Praia. 1959: Lumbo (9868), Quelimane (30). Northern: coastal. Southern: coastal.

At Lumbo in March, 1959, this was by far the most abundant mosquito, accounting for over 60 per cent of all culicines taken. Eight strains of a hitherto unknown and as yet unidentified virus were recovered from this species. This is the first time that *A. pembaensis* has been found carrying viruses.

(1) Formerly *Dunnius*.

Apparently the larvae of this species usually inhabit a saline environment, for not only are all the records of its occurrence in Portuguese East Africa coastal, but at Lumbo it was shown that the density of adults decreased rapidly when collections were made as little as two or three miles inland. Precipitin tests on engorged blood contained in more than 50 *A. pembaensis* taken at Lumbo disclosed that the mosquitoes had without exception fed on man. The species was a nuisance in camp, biting freely even in daytime.

Initial studies with the virus isolated from *A. pembaensis* indicate little if any evidence of neutralizing antibodies in the sera of human donors of all ages residing at Lumbo in the vicinity where the mosquitoes were collected. These apparently contradictory findings, (1) virus and human blood in the mosquitoes but (2) no evidence of neutralizing antibodies in human sera from the same locality, can not be reconciled on the basis of the limited evidence presently available.

If *A. pembaensis* is shown eventually to serve as a vehicle for infecting man with pathogenic viruses, the public health problem thus recognized will have a limited distribution along the seacoast and tidal estuaries.

**Eretmapodites subsimplicipes* Edwards, 1957: Vilanculos, Mocímboa do Rovuma. 1959: Lumbo (5). Northern: coastal, highland. Southern: coastal.

Eretmapodites quinquevittatus Theobald. De Meillon and Rebelo (1941). 1957: Vilanculos, Mambone, Mualama, Maua, Mocímboa da Praia. 1959: Lumbo (37), Namacurra (2). Northern: coastal, inland lowland, highland. Southern: coastal.

Culex (Lutzia) tigripes Grandpré and Charmoy. Edwards (1941). De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). Luabo (P. J. Usher collection). 1957: Lourenço Marques, Guija, Nova Lusitania, Namacurra, Nametil, Montepuez, Palma, Maua, Cuamba. 1959: Lumbo (6). Northern: coastal, inland lowland, highland. Intermediate: coastal. Southern: coastal, inland lowland.

Culex (Neoculex?) pulchrithorax Edwards. Inclusion of this species from «Mozambique» in Edwards' table (1941, p. 481) is almost certainly an error, since the same table fails to list it from Natal and Transvaal where (p. 255) it is said to occur.

Culex (Neoculex) rubinotus Theobald. Pereira (1946*a*, 1946*b*). Southern: coastal.

Within the past few years *C. rubinotus* has been detected carrying three different types of virus in the Union of South Africa. Of these, H 336 (Smithburn *et al.*, 1959) is of particular interest in view of the detection of neutralizing antibodies against it in residents of Moçambique (Kokernot, Smithburn, Gandara *et al.*, 1960). It is closely related to Uganda S virus, originally isolated from a mixed *Aedes* pool in Uganda (Dick and Haddow, 1952). H 336 virus was originally isolated from a naturally infected human being.

Germiston virus (Kokernot *et al.*, 1960) has serological affinities with Bunyamwera virus. Although neutralizing antibodies against Germiston virus were not found in a small number of tests on sera obtained in the 1957 survey in Moçambique, it may be regarded as a potentially important intruder on the basis of two cases of overt illness contracted by laboratory personnel working with this agent (Kokernot *et al.*, *loc. cit.*).

The third virus from *C. rubinotus*, designated as Witwatersrand virus, appears to be unrelated to other agents (McIntosh, Kokernot and Paterson, in preparation).

Culex (Neoculex) rima Theobald. Pereira (1946*a*, 1946*b*). 1957: Namacurra. Northern: inland lowland. Southern: coastal.

Culex (Neoculex) insignis (Carter). Edwards (1941). Luabo (P. J. Usher collection). 1957: Mambone, Montepuez, Mueda, Palma, Maua. 1959: Lumbo (5), Namacurra (23), Nova Lusitania (1). Northern: coastal, inland lowland, highland. Intermediate: coastal. Southern: coastal.

**Culex (Neoculex) sunyaniensis* Edwards. 1957: Mocímboa da Praia. Northern: coastal.

Culex (Neoculex) horridus Edwards. Pereira (1946*a*, 1946*b*). 1957: Nova Lusitania. 1959: Lumbo (6), Namacurra (1). Northern: coastal, inland lowland. Southern: coastal.

Culex (Culiciomyia) nebulosus Theobald. Pereira (1946*a*, 1946*b*). 1957: Nametil, Mocímboa do Rovuma, Espungabera, 1959: Lumbo (2). Northern: coastal, inland lowland, highland. Southern: coastal, inland lowland, highland.

Culex (Mochthogenes) inconspicuosus (Theobald). De Meillon

and Rebêlo (1941). 1957: Cuamba. Northern: highland. Southern: highland.

Culex (Culex) poicilipes (Theobald). De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). Luabo (P. J, Usher collection). 1957: Guija, Cuamba. 1959: Lumbo (9), Nova Lusitania (2). Northern: coastal, highland. Intermediate: inland lowland (riverine), coastal. Southern: coastal, inland lowland.

Culex (Culex) bitaeniorhynchus Giles. De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). Luabo (P. J. Usher collection). Intermediate: coastal. Southern: inland lowland, highland.

Culex (Culex) ethiopicus Edwards. De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). 1957: Guija. Southern: coastal, inland lowland, highland.

**Culex (Culex) aurantapex* Edwards. 1957: Namacurra. Pereira (1959): Lourenço Marques, Vila de João Belo. Northern: inland lowland. Southern: coastal.

Culex (Culex) annulioris Theobald. De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). Luabo (P. J. Usher collection). 1957: Mualama, Nametil, Montepuez, Mocímboa do Rovuma, Quissanga, Cuamba, Mocímboa da Praia. 1959: Lumbo (20), Namacurra (9). Northern: coastal, inland lowland, highland. Intermediate: coastal. Southern: coastal, inland lowland.

Culex (Culex) annulioris ssp. *major* Edwards. Pereira (1946*a*, 1946*b*). Southern: coastal.

**Culex (Culex) sitiens* Wiedemann. 1957: Lourenço Marques, Mambone, Palma, Mocímboa da Praia. 1959: Lumbo (156). Northern: coastal. Southern: coastal.

A virus was recovered from mosquitoes ascribed to this species collected at Lumbo in 1959. However owing to the difficulty of making accurate field diagnoses of the various species of *Culex* with ringed proboscides, it is necessary to attribute this virus to this section of the genus rather than to a specific entity. The virus has not yet been identified and the public health implications are consequently unknown. It is nevertheless significant that this group of culicines generally favors the coastal districts and adjacent lowlands.

Culex (Culex) thalassius Theobald. Sant'Anna (1905). Edwards (1941). Pereira (1946*a*, 1946*b*). 1957: Lourenço Marques, Mambone, Marromeu. 1959: Lumbo (981), Namacurra (2), Quelimane (3), Nova

Lusitania (10). Northern: coastal, inland lowland. Intermediate: coastal. Southern: coastal.

The large number of specimens from Lumbo in 1959 may include some admixture of other species of *Culex* with ringed proboscides.

Culex (Culex) tritaeniorhynchus Giles. Pereira (1946*a*, 1946*b*). Luabo (P. J. Usher collection). 1959: Lumbo (674), Namacurra (5), Nova Lusitania (5). Northern: coastal, inland lowland. Intermediate: coastal. Southern: coastal.

The large number of specimens from Lumbo in 1959 may, as in the case of *C. thalassius*, not be a pure sample. Both these species exhibited their maximum abundance from one to three or four miles inland from the edge of the bay, their populations thus forming a band adjoining the marginal *A. pembaensis* population.

Culex (Culex) duttoni Theobald. De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). 1957: Guija, Nametil, Montepuez, Palma, Mungari. Northern: coastal, inland lowland, highland. Southern: coastal, inland lowland, highland.

**Culex (Culex) argenteopunctatus* (Ventrillon). Pereira (1959): Maruppa. Northern: highland.

This record probably refers to *C. (C.) argenteopunctatus* ssp. *kingi* (Theobald).

Culex (Culex) theileri Theobald. Pereira (1946*a*, 1946*b*). Southern: inland lowland.

The association of *C. theileri* with epizootics of Rift Valley fever among sheep in the Union of South Africa (Gear *et al.*, 1955) has already been noted in the discussion of *A. circumluteolus*. The apparent scarcity of *C. theileri* in Moçambique is therefore significant.

Culex (Culex) univittatus Theobald. Edwards (1941). De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). 1957: Lourenço Marques, Guija, Zandamela, Mambone, Marromeu, Vila de Sena, Mocímboa do Rovuma, Maua, Cuamba, Tete, Mungari. 1959: Lumbo (358), Namacurra (67), Nova Lusitania (15). Northern: coastal, inland lowland, highland. Intermediate: coastal, inland lowland. Southern: coastal, inland lowland, highland.

This widespread and fairly abundant mosquito is likely to be a virus carrier in Moçambique in view of its known activities elsewhere in Africa. In the Union of South Africa it has been found carrying

Wesselsbron virus along with other mosquitoes already discussed (Kokernot, Smithburn, Paterson and de Meillon, in preparation).

Sindbis virus, originally detected in the Nile delta of Egypt, was isolated in that region from *Culex* mosquitoes that in all likelihood were *C. univittatus* (Taylor *et al.*, 1955). Later the virus was recovered from *C. univittatus* near Johannesburg in the Union of South Africa (Weinbren *et al.*, 1956) and more recently from the same species in Tongaland, northern Natal (Kokernot, Smithburn, Paterson and de Meillon, in preparation). Neutralizing antibodies against this virus were detected in human sera in the 1957 Moçambique survey, but the agent is not known to cause overt disease in man or domestic animals.

Sindbis virus was isolated near Johannesburg also from two mixed pools of mosquitoes, one containing 4 *Culex pipiens* and/or *fatigans*, 2 *C. theileri* and 13 *C. univittatus;* the other, 2 *C. tigripes* and 1 *C. annulioris* without any *C. univittatus* (Weibren *et al., loc. cit.)*. It is therefore evident that additional species have a biological relationship to this virus.

West Nile virus infection, on the other hand, may result in an acute febrile illness resembling dengue. The virus was first isolated from a human case in Uganda (Smithburn *et al.*, 1940). Subsequently, it has been recovered from *C. univittatus* and *C. antennatus* in Egypt (Taylor *et al.*, 1956) and from *C. univittatus* in Tongaland, northern Natal (Arthropod-borne Virus Research Unit, unpublished information). Neutralizing antibodies in human sera from Moçambique (Kokernot, Smithburn, Gandara *et al.*, 1960) suggest that *C. univittatus* may be concerned in transmitting West Nile virus in this country.

Culex (Culex) simpsoni Theobald. De Meillon and Rebêlo (1941. Pereira (1946*a*, 1946*b*). 1957: Montepuez, Chicoa, Mocímboa da Praia. 1959: Lumbo (22). Northern: coastal, highland. Intermediate: highland. Southern: coastal, inland lowland, highland.

Culex (Culex) pipiens Linnaeus. Pereira (1946*a*, 1946*b*). 1957: Marromeu. Intermediate: coastal. Southern: coastal, inland lowland.

Culex (Culex) fatigans Wiedemann. Séguy (1930). Edwards (1941). De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). 1957: Nova Lusitania, Nametil, Palma. Northern: coastal, inland lowland. Intermediate: inland lowland. Southern: coastal, inland lowland.

In the discussion of *A. aegypti* it has already been stated that the role of *C. fatigans* in the transmission of Chikungunya virus may be only a minor one (Lumsden, 1955).

Culex (Culex) zombaensis Theobald. Edwards (1941). Pereira (1946*a*, 1946*b*). Southern: coastal, inland lowland.

**Culex (Culex) trifilatus* Edwards. 1957: Espungabera. Southern: highland.

**Culex (Culex) vansomereni* Edwards. Pereira (1959): Macaloge. Northern: highland. Based on larvae.

Culex (Culex) antennatus (Becker). Edwards (1941). Pereira (1946*a*, 1946*b*). 1957: Guija, Marromeu. 1959: Nova Lusitania (3). Intermediate: coastal. Southern: coastal, inland lowland.

In the discussion of *C. univittatus* it was pointed out that West Nile virus has been recovered from *C. antennatus* in Egypt (Taylor *et al.*, 1956). However these authors felt that *C. antennatus* was the less important of the two vectors in that region. On the basis of distribution records and apparent relative abundance of the two species in Moçambique, it would seem likely that *C. antennatus* would also be of only secondary significance here.

Culex (Culex) decens Theobald. De Meillon and Rebêlo (1941). Pereira (1946*a*, 1946*b*). 1957: Maua, Cuamba. 1959: Lumbo (7). Northern: coastal, highland. Intermediate: inland lowland (riverine). Southern: coastal, inland lowland.

**Culex (Culex) trifoliatus* Edwards. 1957: Namacurra, Mualama, Mocímboa do Rovuma, Maua, Cuamba. Northern: inland lowland, highland.

Culex (Culex) perfuscus Edwards. This species was originally reported by de Meillon and Rebêlo (1941) from both Tete and Cuamba, but later de Meillon (1947) corrected the identification of the Tete specimens to *C. telesilla*. 1959: Lumbo (1 specimen). Northern: coastal, highland.

Culex (Culex) telesilla de Meillon and Lavoipierre. De Meillon (1947): Tete. Intermediate: inland lowland (riverine).

Culex (Culex) guiarti Blanchard. De Meillon and Rebelo (1941). Pereira (1946*a*, 1946*b*). 1957: Zandamela, Vilanculos, Namacurra, Mocímboa do Rovuma, Maua, Mocímboa da Praia. Northern: coastal, inland lowland, highland. Southern: coastal, highland.

Culex (Culex) weschei Edwards. Pereira (1946*a*, 1946*b*). 1957: Mocímboa da Praia. Northern: coastal. Southern: coastal.

DISCUSSION

Although information on the distribution of the various mosquitoes from the Province of Moçambique is far from complete, the available records already reveal that some of the species have distinct tendencies to being found in definite regions, north or south, or with respect to the seacoast, interior lowlands and highlands. Species that show this kind of selective distribution will enter into cycles of disease transmission on a zonal or geographical basis. A knowledge of their presence and relative abundance in various localities will therefore be helpful in epidemiological and epizootiological studies.

The fact that viruses were successfully isolated from mosquitoes in Portuguese East Africa during the brief initial attempt in 1959 is indicative of the broad field awaiting further investigation in this country. Serological studies of human sera collected throughout the Province in 1957 (Kokernot, Smithburn, Gandara *et al.*, 1960) show that many kinds of virus have been active among the indigenous population at various places and times. These viruses may show renewed activity occasionally, while there is always the possibility of new viruses being introduced. A knowledge of the part played by widely ranging mosquito species in viral transmission in other parts of Africa is an aid in directing attention to potential transmitters in Moçambique. In addition, some Moçambique species, not incriminated elsewhere, may be disclosed as transmitting vehicles in this country owing to specialized local ecological conditions.

SUMMARY AND CONCLUSIONS

1. A survey of the literature pertaining to mosquitoes of Portuguese East Africa has disclosed records of 67 culicine species. Recent field work, in 1957 and 1959, plus access to other information, bring the known fauna to over 100. It is believed that the commonest mosquitoes in this country have now been recorded.

2. Locality records for the various species in the Province have been used as a basis for defining specific distributions in a few major subdivisions: north of

the Zambeze River, the Zambeze River, south of the Zambeze; and coastal, inland lowlands up to 200 meters elevation, and interior highlands above 200 meters.

3. Viruses were obtained from three species of mosquito in Moçambique in 1959. These species were not known hitherto as virus carriers. In addition, a number of species are cited as known virus carriers in adjacent countries. The extent of the public health problem for which each species of mosquito might be responsible has been roughly appraised in terms of its abundance and distribution.

RESUMO

1. O cômputo da bibliografia referente aos mosquitos da África Oriental Portuguesa revelou a existência de 67 espécies de *Culicini*. Prospecções recentes, realizadas em 1957 e em 1959 e outras fontes de informação elevaram as espécies conhecidas a mais de 100. Crê-se que os mosquitos mais vulgares nesta província estão já todos assinalados.

2. As taxas locais de incidência referentes às diversas espécies existentes na província foram utilizadas como base para se estabelecerem distribuições específicas nas seguintes regiões: ao norte do Zambeze; junto ao Zambeze; ao sul do Zambeze; na zona costeira; nas zonas interiores até 200 m de altitude e nas zonas interiores acima de 200 m.

3. Foram obtidos vírus de 3 espécies de mosquitos em Moçambique, em 1959. Estas espécies não eram até agora conhecidas como vectores de vírus. São citadas, além dessas, algumas espécies que são vectores conhecidos de vírus nos territórios vizinhos. Foi sumàriamente apreciado o problema de saúde pública resultante de cada espécie de mosquito poder ser incriminada, em relação à sua abundância e distribuição.

RÉSUMÉ

1. Le dépouillement de la bibliographie relative aux moustiques de l'Afrique Orientale Portugaise a permis de dénombrer l'existence de 67 espèces de *Culicini*. Grâce à de récentes prospections effectués en 1957 et en 1959 et à l'utilisation d'autres sources de renseignements, on connaît actuellement plus de cent espèces. On pense que les moustiques les plus communs de cette Province ont tous été signalés.

2. Les taux locaux d'incidence relatifs aux diverses espèces existant dans la Province ont servi de base à l'établissement des répartitions spécifiques entre les régions suivantes: nord du Zambèze, près du Zambèze, sud du Zambèze, zone côtière, zone intérieure au-dessous de 200 m et zone intérieure au-dessus de 200 m.

3. On a obtenu des virus de trois espèces de moustiques au Mozambique en 1959. Ces espèces n'étaient pas encore reconnues comme porteuses de virus. On cite, outre celles-ci, quelques espèces qui sont, dans les territoires voisins, reconnues comme porteuses de virus. On a sommairement recherché ensuite l'incidence de chaque espèce de moustique sur la santé publique par rapport à son abondance et à sa distribution.

BIBLIOGRAPHY

A. *Mosquitoes: distribution, taxonomy, etc.*

DE MEILLON, B. — J. Ent. Soc. S. Afr., *10:* 108, 1947.

DE MEILLON, B. and REBÊLO, A. — Culicini (Diptera, Nematocera) from the Colony of Moçambique. — «Moçambique», Documentario trimestral, N.º 27: 69-77, 1941.

EDWARDS, F. W. — Bul. Ent. Res., p. 253, 1912.

EDWARDS, F. W. — Mosquitoes of the Ethiopian Region. III. Culicine Adults and Pupae. — Brit. Mus. (Nat. Hist.), London, pp. 499, 1941.

HOWARD, C. W. — Bul. Ent. Soc., *3:* 211-218, 1912.

KARSCH — Ent. Nachr., p. 25, 1887.

MATTINGLY, P. F. — Bul. Brit. Mus. (Nat. Hist.) Ent., *2,* n.º 5, p. 252, 1952.

MATTINGLY, P. F. — Rev. Zool. Bot. Afr., *47:* 317, 1953.

MATTINGLY, P. F. and HAMON, J. — Ann. Parasit. hum. comp., *30:* 488-96, 1955.

PEREIRA, M. DE C. — Culicídeos da Província do Sul do Save (África Oriental Portuguesa). — Anais do Instituto de Medicina Tropical, *3:* 341-364, 1946*a*.

PEREIRA, M. DE C. — Culicini (Diptera, Nematocera) da Colónia de Moçambique. — Anais do Instituto de Medicina Tropical, *3:* 367-372, 1946*b*.

PEREIRA, M. DE C. — Culicídeos de Moçambique (Ilha da Inhaca). — Sociedade de Estudos da Província de Moçambique, *112:* 65-79, 1958.

PEREIRA, M. DE C. — Personal correspondence. 1959.

SANT'ANNA, J. F. — We have been unable to trace this publication. However the Instituto de Medicina Tropical in Lisboa has kindly sent us photocopies of two papers by Sant'Anna which have been used in preparing the present review of Moçambique mosquitoes. These are: Arch. Hyg. e Path. Exot., *2:* 65, 1909, and Arch. Hyg. e Path. Exot., *3:* 155, 1912. (1905).

SÉGUY, E. — Contribution à l'étude de la faune du Mozambique. Voyage de M. P. Lesne. 1928-1929. — Bul. Nat. Hist. Paris (2), II, pp. 645-656, 1930.

SÉGUY, E. — Personal communication. 1959. Professor Séguy has kindly informed us that specimens collected in Moçambique in 1905 by M. G. Vasse are in the general collection of the Paris Museum. These specimens were known to Edwards and may have been studied by him. At any rate Edwards' 1941 list incorporated Vasse's collection as well as those mentioned eleswhere in the present review such as the collections of Sant'Anna and of Lesne.

THEOBALD, F. V. — A monograph of the Culicidae. — V. Brit. Mus. (Nat. Hist.), London, 1910.

B. *Viruses: isolation, serology, etc.*

DAUBNEY, R., HUDSON, J. R. and GARNHAM, P. C. C. — Enzootic hepatitis or Rift Valley fever. An undescribed virus disease of sheep, cattle and man from East Africa. — J. Path. and Bact., *34:* 545-579, 1931.

DICK, G. W. A. and HADDOW, A. J. — Uganda S virus. A hitherto unrecorded virus isolated from mosquitoes in Uganda. — Trans. Roy. Soc. Trop. Med. and Hyg., *46:* 600-618, 1952.

DICK, G. W. A., KITCHEN, S. F. and HADDOW, A. J. — Zika virus. I. Isolations and serological specificity. — Trans. Roy. Soc. Trop. Med. and Hyg., *46:* 509-520, 1952.

GEAR, J., DE MEILLON, B., LE ROUX, A. F., KOFSKY, R., ROSE INNES, R., STEYN, J. J., OLIFF, W. D. and SCHULZ, K. H. — Rift Valley fever in South Africa. A study of the 1953 outbreak in the Orange Free State, with special reference to the vectors and possible reservoir hosts. — S. Afr. Med. J., *29:* 514-518, 1955.

GEAR, J. and REID, F. P. — The occurrence of a dengue-like fever in the northeastern Transvaal. I. Clinical features and isolation of virus. — S. Afr. Med. J., *31:* 253-257, 1957.

KOKERNOT, R. H., SMITHBURN, K. C. and WEINBREN, M. P. — Neutralizing antibodies to arthropod-borne viruses in human beings and animals in the Union of South Africa. — J. Immunol., *77:* 313-323, 1956.

KOKERNOT, R. H., DE MEILLON, B., PATERSON, H. E., HEYMANN, C. S. and SMITHBURN, K. C. — Middelburg virus, a hitherto unknown agent isolated from *Aedes* mosquitoes during an epizootic in sheep in the eastern Cape Province. — S. Afr. J. Med. Sci., *22:* 145-153, 1957.

KOKERNOT, R. H., HEYMANN, C. S., MUSPRATT, J. and WOLSTENHOLME, B. — Studies on arthropod-borne viruses of Tongaland. V. Isolation of Bunyamwera and Rift Valley fever viruses from mosquitoes. — S. Afr. J. Med. Sci., *22:* 71-80, 1957.

KOKERNOT, R. H., SMITHBURN, K. C., MUSPRATT, J. and HODGSON, B. — Studies on arthropod-borne viruses of Tongaland. VIII. Spondweni virus, an agent previously unknown, isolated from *Taeniorhynchus (Mansonioides) uniformis* Theo. — S. Afr. J. Med. Sci., *22:* 103-112, 1957.

KOKERNOT, R. H., SMITHBURN, K. C., WEINBREN, M. P. and DE MEILLON, B. — Studies on arthropod-borne viruses of Tongaland. VI. Isolation of Pongola virus from *Aedes (Banksinella) circumluteolus* Theo. — S. Afr. J. Med. Sci., *22:* 81-92, 1957.

KOKERNOT, R. H. SMITHBURN, K. C., DE MEILLON, B. and PATERSON, H. E. — Isolation of Bunyamwera virus from a naturally infected human being and further isolations from *Aedes (Banksinella) circumluteolus* Theo. — Am. J. Trop. Med. and Hyg., *7:* 579-584, 1958.

KOKERNOT, R. H., SMITHBURN, K. C., PATERSON, H. E. and MCINTOSH, B. M. — Isolation of Germiston virus, a hitherto unknown agent, from culicine mosquitoes, and a report of infection in two laboratory workers. — Am. J. Trop. Med. and Hyg., *9:* 62-69, 1960.

KOKERNOT, R. H., SMITHBURN, K. C., GANDARA, A., MCINTOSH, B. M. and HEYMANN, C. S. — Neutralization tests with sera from residents of Moçambique against selected arthropod-borne viruses isolated in Africa. — Anais do Instituto de Medicina Tropical, *17:* 1960.

KOKERNOT, R. H., SMITHBURN, K. C., PATERSON, H. E. and DE MEILLON, B. — Further isolations of Wesselsbron virus from mosquitoes. In preparation.

LUMSDEN, W. H. R. — An epidemic of virus disease in Southern Province, Tanganyika Territory in 1952-53. II. General description and epidemiology. — Trans. Roy. Soc. Trop. Med. and Hyg., *49*: 33-57, 1955.

MCINTOSH, B. M., KOKERNOT, R. H., PATERSON, H. E. and DE MEILLON, B. — Isolation of Spondweni virus from four species of culicine mosquitoes and a report of two laboratory infections with the viruses. In preparation.

MCINTOSH, B. M., WORTH, C. B., and KOKERNOT, R. H. — Isolation of Semliki Forest virus from *Aedes (Aedimorphus) argenteopunctatus* (Theobald) mosquitoes collected in Portuguese East Africa. — Trans. Roy. Soc. Trop. Med. and Hyg., to be published.

MCINTOSH, B. M., KOKERNOT, R. H. and PATERSON, H. E. — Witwatersrand virus: an apparently new virus isolated from culicine mosquitoes. In preparation.

ROSS, R. W. — The Newala epidemic. III. The virus: isolation, pathogenic properties and relationship to the epidemic. — J. Hyg., *54:* 177-191, 1956.

SMITHBURN, K. C., HUGHES, T. P., BURKE, A. W. and PAUL, J. H. — A neurotropic virus isolated from the blood of a native of Uganda. — Am. J. Trop. Med., *20:* 471-492, 1940.

SMITHBURN, K. C. and HADDOW, A. J. — Semliki Forest virus. I. Isolation and pathogenic properties. — J. Immunol., *49:* 141-157, 1944.

SMITHBURN, K. C., HADDOW, A. J. and MAHAFFY, A. F. — A neurotropic virus isolated from *Aedes* mosquitoes caught in the Semliki Forest. — Am. J. Trop. Med., *26:* 189-208, 1946.

SMITHBURN, K. C. and DE MEILLON, B. — Studies on arthropod-borne viruses of Tongaland. I. The expedition of April-May, 1955. — S. Afr. J. Med. Sci., *22:* 41-46, 1957.

SMITHBURN, K. C., KOKERNOT, R. H., WEINBREN, M. P. and DE MEILLON, B. — Studies on arthropod-borne viruses of Tongaland. IX. Isolation of Wesselsbron virus from a naturally infected human being and from *Aedes (Banksinella) circumluteolus* Theo. — S. Afr. J. Med. Sci., *22:* 113-120, 1957.

SMITHBURN, K. C., PATERSON, H. E., HEYMANN, C. S. and WINTER, P. A. D. — An agent related to Uganda S virus from man and mosquitoes in South Africa. — S. Afr. Med. J., *33:* 959-962, 1959.

TAYLOR, R. M. — Epidemiology. *In* Strode, G. K., Editor, Yellow Fever. McGraw-Hill, New York — Toronto — London. pp. 710, 1951.

TAYLOR, R. M., HURLBUT, H. S., WORK, T. H., KINGSTON, J. R. and FROTHINGHAM, T. E. — Sindbis virus: a newly recognized arthropod-transmitted virus. — Am. J. Trop. Med. and Hyg., *4:* 844-862, 1955.

TAYLOR, R. M., WORK, T. H., HURLBUT, H. S., and RIZK, F. — A study of the ecology of West Nile virus in Egypt. — Am. J. Trop. Med. and Hyg., *5:* 579-620, 1956.

WEINBREN, M. P., KOKERNOT, R. H. and SMITHBURN, K. C. — Strains of Sindbis-like virus isolated from culicine mosquitoes in the Union of South Africa. I. Isolation and properties. — S. Afr. Med. J., *30:* 631-636, 1956.

WEINBREN, M. P., HEYMANN, C. S., KOKERNOT, R. H. and PATERSON, H. E. — Studies on arthropod-borne viruses of Tongaland. VII. Simbu virus, a hitherto unknown agent isolated from *Aedes (Banksinella) circumluteolus* Theo. — S. Afr. J. Med. Sci., *22:* 93-102, 1957.

WEISS, K. E., HAIG, D. A. and ALEXANDER, R. A. — Wesselsbron virus — a virus not previously described associated with abortion in domestic animals. — Onderstepoort J. Vet. Res., *27:* 183-195, 1956.

WHITMAN, L. — The arthropod vectors of yellow fever. *In* Strode, G. K., Editor, Yellow Fever. McGraw-Hill, New York — Toronto — London. pp. 710, 1951.

Imprensa Portuguesa ★ Rua Formosa, 108-116 ★ Porto