

***Aedes (Stegomyia) bromeliae* (Diptera: Culicidae), THE YELLOW FEVER VIRUS VECTOR IN EAST AFRICA¹**

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Abstract. The *Aedes (Stegomyia) simpsoni* complex in the Afrotropical Region comprises at least 3 species (*Ae. simpsoni*, *Ae. lilii*, and *Ae. bromeliae*). The species from which Mahaffy, Haddow, and others isolated yellow fever virus, and which is the most common and widespread man-biting member of the *simpsoni* complex, is *Ae. bromeliae*, not *Ae. simpsoni*. *Aedes simpsoni* is apparently restricted to southern Africa, where it is also a man-biting species; however, it is not known to be involved in the transmission of arboviruses. *Aedes lilii* occurs in eastern and western Africa but is less prevalent than *Ae. bromeliae*, and no females have been recorded as biting man. Literature references to *Ae. simpsoni* are reviewed, and those applying to *Ae. bromeliae* are given. Distribution, immature habitats, and biting preferences of all 3 species in eastern and southern Africa are presented. *Aedes bromeliae* is reported from South Africa for the first time.

During the 1940s researchers in Uganda incriminated *Aedes (Stegomyia) simpsoni* (Theobald) as one of the primary vectors of yellow fever virus among primates, including man, in East Africa. Since then, the major medical and public health texts treating African arboviral vectors have listed *Ae. simpsoni* as a primary vector of yellow fever virus in Africa, thus prompting considerable attention. In this regard, Gerberg & Hartberg (1975) listed 137 bibliographic references to *Ae. simpsoni*. Recently, Huang (1979) reported that what was previously called *Ae. (Stg.) simpsoni* in the Afrotropical Region is a complex of at least 3 species: *Ae. simpsoni*, *Ae. lilii* (Theobald), and *Ae. bromeliae* (Theobald). Characters for separating the *simpsoni* complex from other Afrotropical *Aedes (Stegomyia)* and for distinguishing females of these 3 species were presented by Huang (1979) and Huang & Ward (1982).

Currently, several investigators are actively en-

gaged in studies involving members of the *simpsoni* complex, but some investigators are unaware of the recent taxonomic changes that alter the species and vector concepts and species distributions.

The purpose of this paper is to reconfirm and expand the earlier report on the *simpsoni* complex (Huang 1979), and to clarify and incriminate *Ae. bromeliae*, not *Ae. simpsoni*, as the yellow fever virus vector in East Africa. In addition, many literature references to *Ae. simpsoni* are listed in light of current knowledge of the 3 members of the complex. It is hoped that this paper will enable entomologists, epidemiologists, ecologists, virologists, and other field workers to correctly identify the species on which they are working.

MATERIALS AND METHODS

This study is based on specimens collected or otherwise acquired by the Medical Entomology Project (MEP) and the Systematics of *Aedes* Mosquitoes Project (SAMP), Department of Entomology, National Museum of Natural History, Smithsonian Institution, and on specimens that were borrowed from major museums, institutions, and individuals mentioned in the Acknowledgments section.

Information on distribution, immature habitats, and biting preferences presented in this paper is based entirely on specimens that I have examined.

RESULTS AND DISCUSSION

Distribution. *Aedes bromeliae* is a common species throughout most of the Afrotropical Region. It occurs in southeastern Sudan in the north; to southwestern Ethiopia, Uganda, Kenya, and Tanzania in the east; through Malawi and Zimbabwe to South Africa in the south; through Zaire and Congo to Angola in the southwestern corner; and through the Central African Republic to western Africa. It is reported here for the first time from

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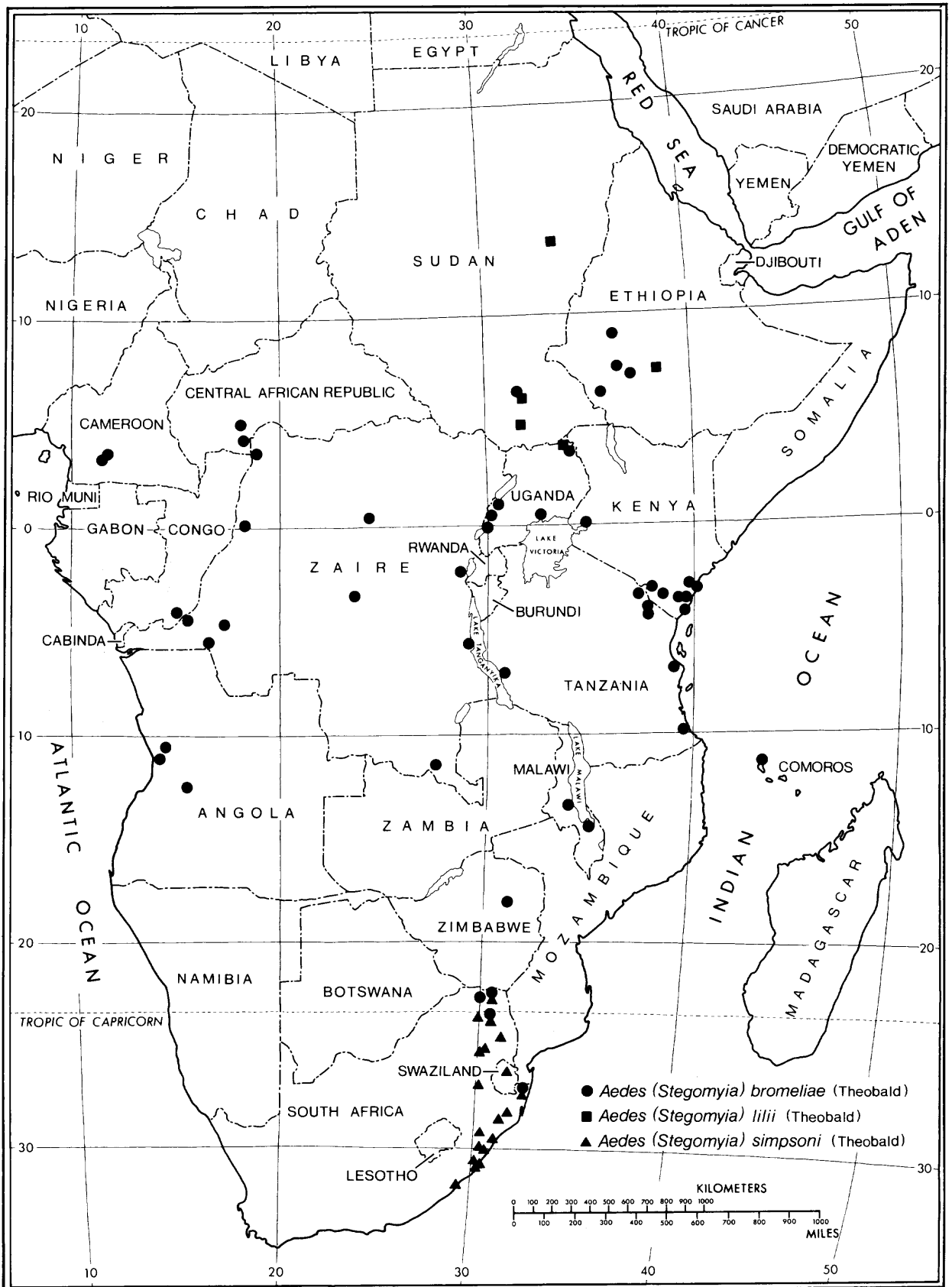


TABLE 1. Distribution of the species of the *Aedes simpsoni* complex in eastern and southern Africa.

COUNTRIES*	No. <i>Ae. bromeliae</i>	No. <i>Ae. lilii</i>	No. <i>Ae. simpsoni</i>
Sudan	1	4	0
Ethiopia	5	4	0
Uganda	82	12	0
Kenya	107	0	0
Tanzania	15	0	0
Malawi	13	0	0
Zimbabwe	2	0	0
South Africa	179	0	201
Swaziland	0	0	1
Total	404	20	202

* Countries from which specimens were available for examination.

South Africa, where it has been collected from northeastern Transvaal and from the northeastern corner of Natal (Fig. 1).

Aedes lilii occurs across Africa but is less common than *Ae. bromeliae*. In eastern Africa it has been found from southeastern Sudan in the west, to western Ethiopia in the east, and to northern Uganda in the south. It is not known from South Africa (Fig. 1).

Aedes simpsoni is apparently confined to southern Africa. It is currently known from northern and eastern Transvaal in the north, to eastern Natal in the east, to eastern Cape Province in South Africa, and from Swaziland (Fig. 1).

Specimens examined

A total of 1,004 adult specimens (497♂, 507♀) of the *Aedes simpsoni* complex was examined from 24 countries in the Afrotropical Region. Of these, 761 specimens (76%) are *Ae. bromeliae*; 40 specimens (4%) are *Ae. lilii*; and 203 specimens (20%) are *Ae. simpsoni*.

A total of 626 specimens (281♂, 345♀, with 114♂ and 5♀ genitalia preparations) of the *simpsoni* complex was examined from eastern and southern Africa.

Aedes bromeliae Theobald, 1911 (type-locality: Kampala, Uganda)

SUDAN: Upper Nile Prov: Bor. ETHIOPIA: Kefa Prov: Maji; Sidamo Prov: Jimma Area, Gojeb Riv; Welega Prov: Lekempt. UGANDA: Kingdom of Buganda: Kampala; Kingdom of Toro: Kilembe, Semliki Forest, Bwamba, Toro; Karamoja Dist: Kaabong. KENYA: Nyanza Region: Kisumu; Coast Region: Mombasa, Taveta, Malindi, Sagala Hill, Teita Hills, Kombeni, Mazeras. TANZANIA: Mtwara Region: Lindi; Kilimanjaro Region: Gonja, Gonja-Same, Moshi; Tabora Region: Mpanda; Coast Region: Dar es Salaam, Mbgala. MALAWI: Fort Johnston Dist: Fort Johnston; Salima Dist: Chitala Dist. ZIMBABWE: Masho-

TABLE 2. Immature habitats of the species of the *Aedes simpsoni* complex in eastern and southern Africa.

<i>Aedes</i>	PLANT AXILS	TREE HOLES	BAM-BOO POTS	BAM-BOO STUMPS	FALL-EN PLANT PARTS	ARTI-	TOTAL
						FI-CON-TERS	NO. COLLECTIONS
<i>bromeliae</i>	7*	14	12	1	1	2	37
<i>lilii</i>	1**	0	0	0	0	0	1
<i>simpsoni</i>	5***	1	10	2	0	2	20

* Banana, *Colocasia*, pineapple, and taro.

** *Sansevieria*.

*** Banana and taro.

naland South Prov: Salisbury. SOUTH AFRICA: Transvaal: Tzaneen, Thengwe, Makonde, Tshandana; Natal: Ndumu, Fontana Pan.

Aedes lilii Theobald, 1910 (type-locality: Bor, Sudan)

SUDAN: Upper Nile Prov: Bor; Equatoria Prov: Juba; Blue Nile Prov: Sennar. ETHIOPIA: Shewa: Langana. UGANDA: Karamoja Dist: Kaabong.

Aedes simpsoni Theobald, 1905 (type-locality: Nelspruit, South Africa; Gerberg 1972)

SOUTH AFRICA: Transvaal: Magoeba's kloof, New Agatha, White River Dist, Sycamore, Bushbuck Ridge, Randburg, Tzaneen, Nelspruit, Johannesburg, Makonde, Thengwe; Natal: Margate, Amanzimtoti, Durban Coast, St. Winifreds, Port Shepstone, Drakensberg, Eshowe, Ndumu, Fontana Pan, Oslobeach; Cape Prov: Port St. Johns. SWAZILAND: Stegi.

In eastern Africa, 245 adults (84♂, 161♀) of the *simpsoni* complex were examined from Sudan, Ethiopia, Uganda, Kenya, Tanzania, Malawi, and Zimbabwe. Ninety-two percent of the specimens (225 adults: 78♂, 147♀) are *Ae. bromeliae*, and 8% (20 adults: 6♂, 14♀) are *Ae. lilii*. No specimens of *Ae. simpsoni* were found from eastern Africa. In southern Africa, 381 adults (197♂, 184♀) of the *simpsoni* complex were examined from South Africa and Swaziland. Forty-seven percent of the specimens (178 adults: 106♂, 72♀) are *Ae. bromeliae*, and 53% (203 adults: 91♂, 112♀) are *Ae. simpsoni*. No specimens of *Ae. lilii* have been found in southern Africa. More detailed information on the distribution of the *simpsoni* complex in eastern and southern Africa is summarized in Table 1.

Based on collection data, *Ae. bromeliae* has been found at the widest range of elevations, i.e., from below 166 m (500 ft) to 1,666 m (5,000 ft). *Aedes lilii* has been collected between 566 m (1,700 ft) and 1,666 m (5,000 ft) and *Aedes simpsoni* from below 166 m (500 ft) to 1,266 m (3,800 ft).

The specimens from Bwamba, Uganda, with la-

bel data: 1942, A.J. Haddow; 1946, A.J. Haddow; 1944, Van Someren; and 1945, Van Someren, were probably the same as those examined by Mahaffy et al. (1942) and Smithburn & Haddow (1946).

Bionomics

The immature stages of *Ae. bromeliae* have been collected from the following: tree holes in Uganda, Kenya, Malawi, and South Africa; bamboo pots placed on a tree about 1 m above ground level in Kenya and South Africa; leaf axils of pineapple and *Colocasia* in Uganda, banana in Tanzania, and taro in South Africa; a fallen plant part (spathe) in Kenya; a bamboo stump in South Africa; and artificial containers (old sink, tire) in South Africa. Females of this species have been taken while biting man in Bwamba, Uganda; in Jimma Area, Ethiopia; in Ganda, Kenya; and in Botambi, Central African Republic.

Larvae of *Ae. lili* have been collected from axils of *Sansevieria* (Liliaceae) in Uganda. Females of this species are not known to bite man.

Immature stages of *Ae. simpsoni* have been collected in South Africa from the following: a tree hole (*Ficus*); bamboo pots placed on a tree about 1 m above ground level; leaf axils of banana and taro; bamboo stumps; and artificial containers (old sink, tire). Females of this species have been taken while biting man in Transvaal (Tzaneen, Nelspruit, Johannesburg). More detailed information on the habitats of immature *simpsoni* complex mosquitoes in eastern and southern Africa is given in Table 2.

Preferred oviposition sites for *Ae. bromeliae* were tree holes, bamboo pots, and leaf axils, while artificial containers, bamboo stumps, and fallen plant parts were less commonly used. There is little doubt that *Ae. bromeliae* is the most adaptable of all 3 species in the *simpsoni* complex.

Preferred oviposition sites for *Ae. simpsoni* were bamboo pots and leaf axils, while bamboo stumps, artificial containers, and tree holes were less commonly used. This species is also highly adaptable.

Little is known about the oviposition sites of *Ae. lili*. In eastern Africa, immatures of *Ae. lili* have only been collected in *Sansevieria* axils. *Aedes lili* may be more specific in its oviposition preferences than the other 2 species.

CONCLUSIONS

Based on available collection data, the species from which Mahaffy et al. (1942) and Smithburn & Haddow (1946) isolated yellow fever virus was not *Aedes simpsoni*, as this species does not occur in Uganda and East Africa. Currently, there are only

2 species in the *simpsoni* complex that occur in Uganda, *Ae. lili* and *Ae. bromeliae*. As there are no man-biting records for *Ae. lili*, this species is considered to have little or no importance as a vector of yellow fever virus in Uganda. *Aedes bromeliae*, on the other hand, is a common, widespread, and ecologically diverse species; more important, it is the common man-biting member of the *simpsoni* complex in Bwamba, Uganda, and in East Africa. Thus it seems certain that *Ae. bromeliae* is the vector of yellow fever virus in East Africa.

Based on specimen data, *Ae. simpsoni* does not occur in eastern Africa, and *Ae. lili* is not recorded as man-biting; thus the following references to *Ae. simpsoni* probably apply to *Ae. bromeliae*: Gibbins (1942), Mahaffy et al. (1942), Haddow (1945a,b, 1948, 1950, 1968), Smithburn & Haddow (1946), Mahaffy (1949), Gillett (1951, 1955, 1969a,b,c, 1972a,b), Teesdale (1957), McClelland (1961), Serrie (1963), Mukwaya (1967, 1974, 1977), Hudson (1970), Metselaar et al. (1970), Mouchet (1970), Hartberg & Gerberg (1971), Mukwaya et al. (1971), Gillett & Van Someren (1972), Hartberg (1972), McCrae (1972), Parker et al. (1972), and Tonn et al. (1973).

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