

MOSQUITO SPECIES ENCOUNTERED IN A FLOODED GRASSLAND DAMBO IN KENYA¹

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ABSTRACT. The larvae and pupae of mosquitoes found in a flooded dambo on a bushed grassland in Central Province, Kenya were monitored during the short rainy season. The densities of the immature stages of 8 species were recorded daily for a one month period. *Aedes cumminsii mediopunctatus*, *Ae. lineatopennis* and *Ae. sudanensis* were collected for 8, 9 and 18 days respectively and each disappeared after one generation. *Aedes lineatopennis* and the *Culex* spp. specimens were collected in much greater densities than in a forest dambo studied previously.

INTRODUCTION

Davies (1975) states that Rift Valley fever (RVF) virus is believed to be maintained in Kenya in forests or secondarily derived and natural grasslands of comparatively high rainfall and humidity (ecological zones II, III, Pratt et al. 1966). In these areas the mosquito fauna associated with temporary pools in dambos (Ackermann 1936) is being studied. Observations concerning the immature mosquito fauna of a dambo in a forest of the type commonly occurring in ecological zone II have been reported previously (Linthicum et al. 1983). This study follows the succession of mosquito species found in a grassland dambo in ecological zone III in Kenya.

MATERIALS AND METHODS

The dambo monitored in this study (Fig. 1) is located along the Kamiti River 7 km SE of Ruiru, Thika District, Central Province, Kenya (1°12'S, 37°E) at an elevation of 1500 m. This area is principally comprised of bushed grasslands. The dambo is sinuous in shape, measuring approximately 75 × 200 m. It exhibited the zonal differentiation described by Mackel (1974) and Linthicum et al. (1983) with the exception that the washbelt area on one side was much reduced by the presence of the river. The seepage zone was extensive and extended 20–30 m on either side of the longitudinal axis of the dambo. The emergent vegetation in the central area was primarily the sedge *Cyperus immensus* B. Clarke. The grass *Digitaria abyssinica* (A. Richard) Stapf predominated in the remainder of the dambo. The entire surface of the dambo remained in direct sunlight for ap-

proximately 12 hours each day and the water temperature at 1430 hr varied between 23–34°C.

Daily rainfall data were recorded during the short rains from October 1 to December 31, 1982 at a station 2 km NW of the study site. Rainfall data for previous years were obtained from the Kenya Meteorological Department. The degree of flooding (water level) in the dambo was recorded daily by measuring the water depth in mm at the lowest point in the seepage zone (the first area to flood). The flooding of dambos occurs infrequently and usually coincides with periods of unusually heavy rainfall.

Immature mosquitoes were sampled with a pint (0.47 liter) dipper daily from November 27 (the first day of flooding) to December 31, 1982. Twenty-five samples were taken by dipping at equal intervals along each of 2 lines transecting the dambo. The ends of the transecting lines always coincided with the margins of the standing water. All samples were transported to the laboratory where the larvae were separated by stage, counted and, when possible, reared to adults. To simplify sorting procedures, the larvae were separated into 2 groups consisting of (first and second) and (third and fourth) stages. The pupae were counted and reared to adults. Species identification was determined following the methods described by Linthicum et al. (1983). Each day the total number and stage of each *Aedes* collected was determined. The *Culex* larvae and pupae were grouped together each day and not sorted to species. Random samples, consisting of 10 specimens, of the *Culex* larvae were taken daily and reared to adult to determine relative abundance of the individual species.

RESULTS

The daily water level in the Kamiti dambo and daily rainfall for the area are illustrated in

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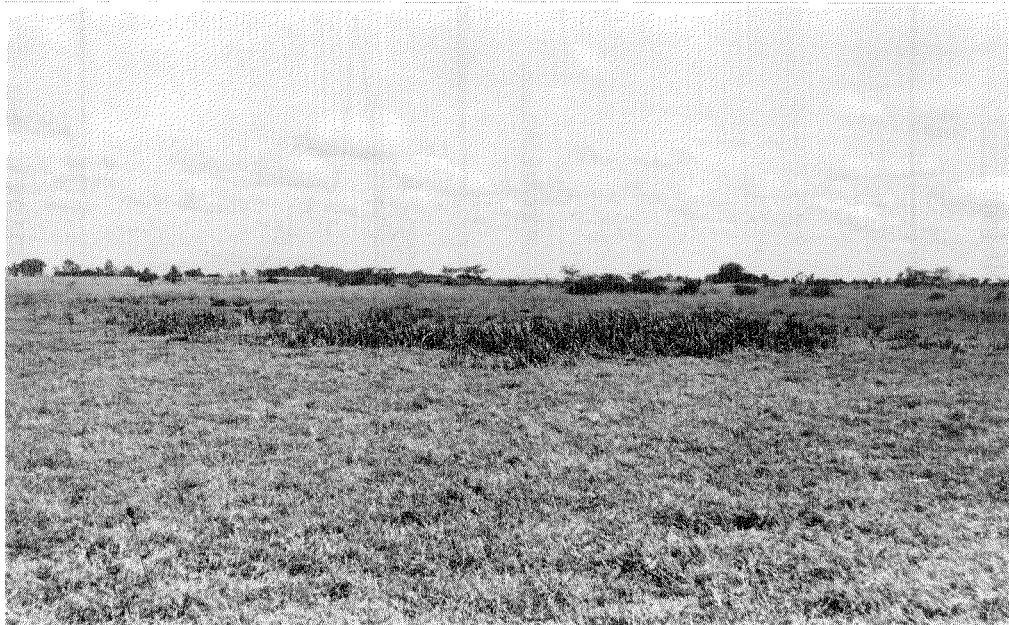


Fig. 1. The Kamiti dambo, Ruiru, Kenya on November 15, 1982.

Fig. 2. During the 29 rainy days that occurred during the study period an unusually high precipitation of 436.5 mm fell on the Kamiti dambo. The previous 20 year mean annual rainfall for the area was 488.2 mm. The first standing water in the dambo was observed on November 27 when the level was 160 mm. Between November 27 and December 6 the water level rose to a depth of 605 mm. The water level gradually declined thereafter until December 16 when the level dropped rapidly. On December 31 there was no standing water in the dambo. The water appeared cloudy and brown during and immediately following periods of rainfall. At other times the water was only slightly to moderately turbid.

A total of 29,573 larvae and pupae were collected and separated according to developmental stage between November 28, the first day after flooding (day one), and December 27 (day 29). The mosquito species identified were: *Aedes (Aedimorphus) cumminsii mediopunctatus* (Theobald), *Ae. (Mucidus) sudanensis* (Theobald), *Ae. (Neomelaniconion) lineatopennis* (Ludlow), *Culex (Culex) antennatus* (Becker), *Cx. (Cux.) pipiens* Linnaeus, *Cx. (Cux.) theileri* Theobald, *Cx. (Cux.) zombaensis* Theobald and *Cx. (Lutzia) tigripes* De Grandpre and De Char-moy. Table 1 lists the total numbers of mos-

quitoes collected. The 3 *Aedes* spp. represented 19.1% of the total collection and 87% of these specimens were *Ae. lineatopennis*. *Culex pipiens* was found in all samples and it represented 54.6% of the individuals in the sample collections. *Culex zombaensis* was found in all but 4 samples and it represented 28.6% of the total collection. *Culex antennatus*, *theileri* and *tigripes* represented 12.2%, 2.9% and 1.7% respectively of the sample collections. Figure 3 illustrates the daily total of immatures collected for each of the 3 *Aedes* spp. and for the *Culex* spp. *Aedes cumminsii mediopunctatus* was first collected on day one and last collected on day 8, with greatest numbers occurring on days 2 and 3. Small numbers of *Ae. sudanensis* were collected on days 1-18. *Aedes lineatopennis* was first collected on day 5 and last collected on day 13, with largest numbers collected on days 6-8. After the *Aedes* larvae disappeared they were not collected again during the study period. The first *Culex* specimens were collected on day 7 and numbers increased to a maximum on days 11 and 12. After this time their numbers declined but still remained numerous until day 22. The last *Culex* specimens were collected on December 27 (day 30). Figure 4 illustrates for each of the 3 *Aedes* spp. and the *Culex* spp. the mean number of individuals of each devel-

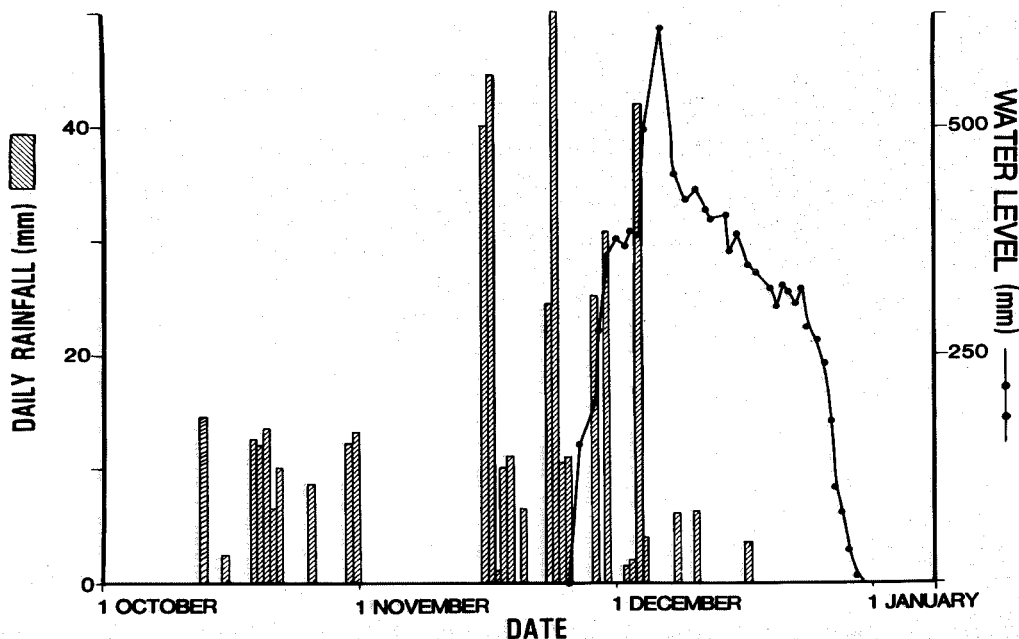


Fig. 2. Daily rainfall in mm (histogram) and water level in mm (solid line) at the Kamiti dambo, Ruiru, Kenya from October 1, 1982 to January 1, 1983.

Table 1. The number of specimens collected by species and life stage at the Kamiti dambo, Ruiru, Kenya from November 28 to December 27, 1982, by dipping.

Species	Larval stage		Pupae	Total
	1st-2nd	3rd-4th		
<i>Aedes cumminsii</i>	405	161	42	608 (2.1%)
<i>Ae. sudanensis</i>	100	32	16	148 (0.5%)
<i>Ae. lineatopennis</i>	2811	1579	507	4897 (16.5%)
<i>Culex</i> spp.	14607	7226	2087	23920 (80.9%)

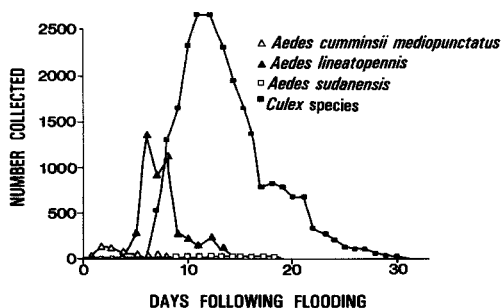


Fig. 3. Daily total of specimens collected by dipping from the Kamiti dambo, Ruiru, Kenya from November 28 to December 27, 1982.

opmental stage collected per dip on each collection day following the presence of standing water. The time from first hatch to first pupae was 6 days for *Ae. cumminsii mediopunctatus* and *lineatopennis*, and 9 days for *sudanensis*.

DISCUSSION

Rift Valley fever virus has been isolated from 6 of the 8 species of mosquitoes collected in this grassland dambo. *Aedes lineatopennis* has been found infected in Kenya (Davies and Highton 1980), South Africa (McIntosh et al. 1980, McIntosh and Jupp 1981) and Zimbabwe (McIntosh 1972). *Culex pipiens* was found infected during a 1977 epizootic in Egypt (Meegan 1979, Hoogstraal et al. 1979) and

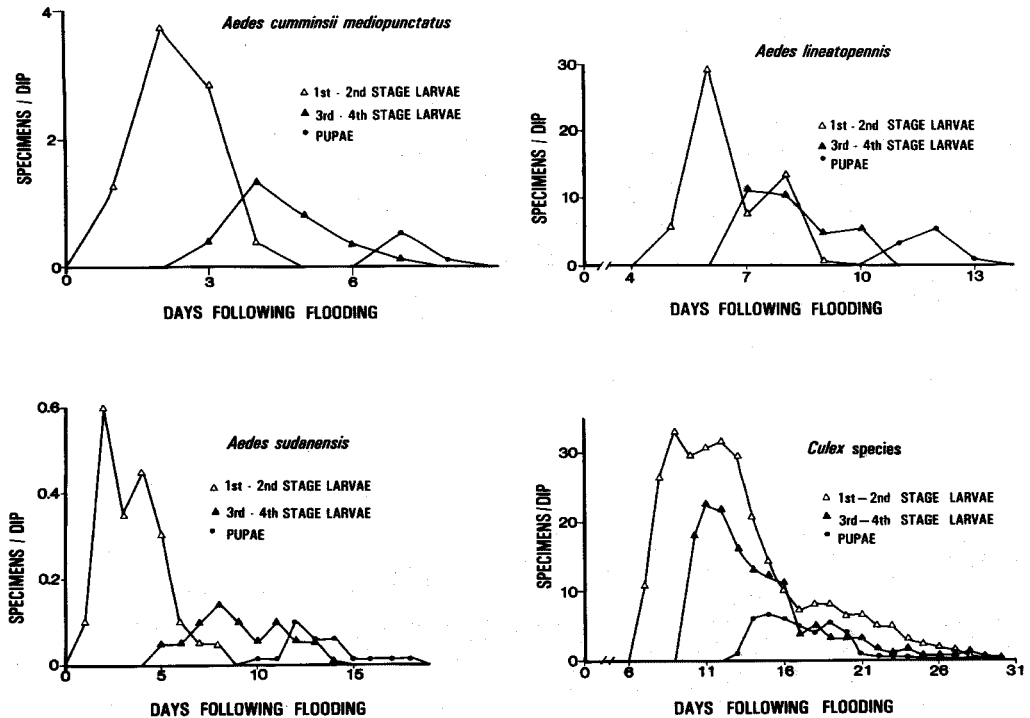


Fig. 4. Mean number of specimens collected per dip in the Kamiti dambo, Ruiru, Kenya from November 28 to December 27, 1982 for the developmental stages of *Aedes cumminsi mediopunctatus*, *sudanensis*, *lineatopennis* and *Culex* species.

Culex theileri has been found infected in South Africa (Gear et al. 1955, McIntosh 1972, McIntosh et al. 1980, McIntosh and Jupp 1981). McIntosh et al. (1983) made 7 isolations of RVF from *Cx. zombaensis* during an outbreak in the coastal region of Natal Province, South Africa in 1981. Virus has recently been isolated in Kenya from *Ae. cumminsi mediopunctatus* and *Cx. antennatus* (Linthicum, Davies, Kairo and Bailey 1983, unpublished data). The study of the breeding habits of these and other species of mosquitoes may be important to understand better the ecology of RVF.

The rainfall during the study period almost equalled the yearly mean total for the area and there was a sufficiently high water table to produce standing water in the dambo. This may be of importance as RVF epizootics are known to coincide with periods of heavy rainfall which flood low lying areas (Schulz 1951, Davies 1975, McIntosh and Jupp 1981). RVF did not occur although the short period of flooding of this grassland dambo produced large numbers of potential vectors.

Aedes cumminsi mediopunctatus, *sudanensis* and *lineatopennis* larvae were collected after the dambo was flooded. The eggs of *Ae. cumminsi mediopunctatus* and *sudanensis* must have been flooded immediately as larvae were found on day one and maximum numbers were collected on day 2. Figure 2 shows that by day 4 the water depth had more than doubled since the first day of flooding. This increase coincided with the first collections of *Ae. lineatopennis* on day 5 and suggests that its eggs were located in areas not flooded until the water level reached 380 mm at the lowest point in the seepage zone. Each of the *Aedes* spp. disappeared after a single generation. The period from first hatch to first pupae for *Ae. cumminsi mediopunctatus* and *sudanensis* was 2 and 9 days respectively less than that reported for the same species in a forest dambo (Linthicum et al. 1983). The same period for *Ae. lineatopennis* required 1 more day than that reported in the forest dambo. In comparison with the forest dambo the grassland dambo was more exposed to direct sunlight, the water temperature was higher and

was located at a 200 m lower elevation. The number of specimens of *Ae. cumminsii medipunctatus* and *sudanensis* collected per dip was less than one-half the number collected per dip in a flooded forest dambo (Linthicum et al. 1983). However, the number of specimens of *Ae. lineatopennis* collected per dip was more than twice the number collected per dip in the forest dambo. The number of *Culex* spp. collected per dip was almost ten fold the number collected per dip in the forest dambo. Although *Culex (Cux.) quasisguarti* Theobald and *Cx. theileri* were found in the forest dambo in approximately equal numbers, *Cx. quasisguarti* was absent from the grassland dambo and *Cx. theileri* represented only 2.9% of the *Culex* collected. These species were replaced by *Cx. pipiens* and *zombaensis* which together represented 83.2% of the sample *Culex* collections. The decline in numbers of *Culex* spp. collected in the grassland dambo correspond to a lowering of the water level (Fig. 2) starting at day 17 and a dramatic drop after day 25.

The 3 *Aedes* spp. described in this study were found in very large numbers only in association with the flooded dambo situations. Immatures have been collected in a variety of other habitats but in comparatively small numbers (Hopkins 1952, Linthicum et al. unpublished data). Light trap and dipping collections conducted in the same area in Kenya between 1981 and 1983 show that small numbers of the 3 *Aedes* spp. were collected during each rainy season when temporary ground pools (other than the dambo formations) are flooded, and that large numbers were collected only when the dambos flooded (Linthicum et al., unpublished data). These collections also indicate that the 5 *Culex* spp. are collected in small numbers year-round with much higher numbers collected during the rainy seasons, particularly when the dambos flooded. The only ecological change that increases the surface area of the standing water in this area and produces the conditions necessary for large numbers of mosquitoes to be produced is the flooding of the dambos.

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