THE HORIZONTAL DISTRIBUTION OF *AEDES* PUPAE AND THEIR SUBSEQUENT ADULTS WITHIN A FLOODED DAMBO IN KENYA: IMPLICATIONS FOR RIFT VALLEY FEVER VIRUS CONTROL[1]

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The environmental conditions that predispose Rift Valley fever (RVF) virus epizootics in Kenya are related to widespread and prolonged rainfall (Davies et al. 1985). Such excessive rainfall has been shown to cause flooding in shallow, streamless depressions at the headwaters of drainage systems (known as dambo formations in eastern and southern Africa) (Ackermann 1936, Mackel 1974, Linthicum et al. 1983) in RVF epizootic areas and to produce a hatch of *Aedes* species that could introduce the virus into susceptible animal or human hosts (Linthicum et al. 1985b). The species succession and population dynamics of immature mosquitoes in these habitats during the short rainy season (October–December) have been described (Linthicum et al. 1984). The dispersal and survival patterns of *Ae. mcintoshi* Huang [as *lineatopennis* (Ludlow)] were studied during a dry season (January–February) following artificial flooding of the above habitats (Linthicum et al. 1985a).

Efforts to limit RVF outbreaks by controlling potential vectors might most effectively be targeted at immature stages. However, information on the distribution within these dambo habitats of the immature stages of the various mosquito species is not available. To enhance efforts to control these vectors, detailed knowledge of the horizontal distribution of species within these habitats must be understood. The objectives of this study were to determine the relative horizontal distribution of *Aedes* pupae and their subsequent adults within specific regions of dambos.

The two dambos sampled in this study were in ecoclimatic zone II of Pratt et al. (1966), located southeast of Ruiru, Thika District, Central Province, Kenya (1°12'S, 37°E; 1,500 m). Figure 1 illustrates collection sites 1–6, 9, and 10 located near the Kamiti River in study area I. Two separate areas became flooded April 30, 1987. The area containing collection sites 1, 2, 3 and 4 was artificially flooded by pumping water from the Kamiti River. The area containing sites 5 and 6 was initially flooded by the overflow of the river and later maintained by pumping water from the river. Water depth in both areas ranged from 100 to 900 mm. Vegetation at sites 1, 2, 3 and 5 was composed of mixed species of grasses; however, the dominant species was *Digitaria abyssinica* (A. Richard) Stapf, from 0.3 to 1.0 m

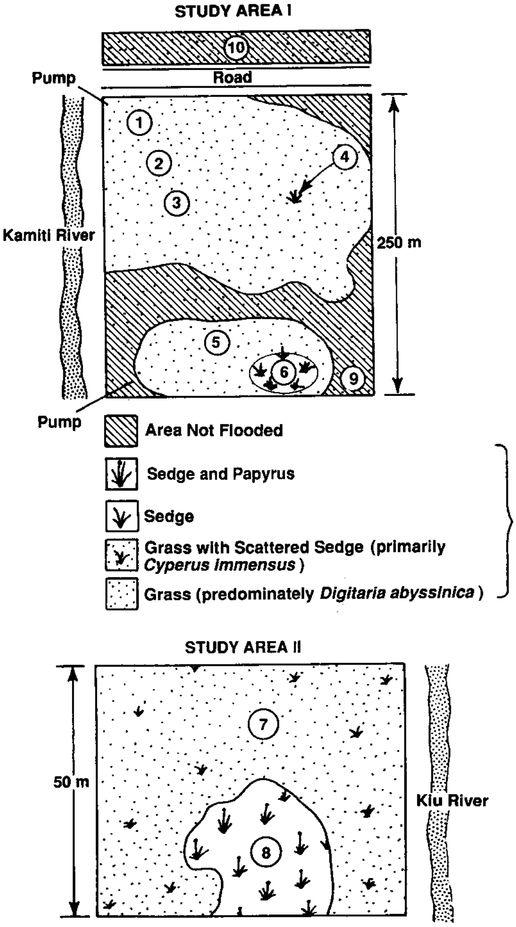

Fig. 1. Diagram of collection sites in study area I and study area II.

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[1] In conducting the research described in this report, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," as promulgated by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Animal Resources, National Research Council. The facilities are fully accredited by the American Association for Accreditation of Laboratory Animal Care.

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in height. Site 1 was restricted to a ditch adjacent to the road. The vegetation in the lowest area (site 6) was composed primarily of the sedge *Cyperus immensus* B. Clarke, 1.0–2.5 m in height. Site 4 was an area that contained both sedge and grasses. Sites 9, 10 were located in areas not flooded; however, they were sampled to determine if adults would leave the immediate vicinity of the emergence sites. The vegetation at these sites was predominantly *Digitaria abyssinica*. Study area II, shown diagrammatically in Fig. 1 and located 2.5 km southwest of area I along the Kiu River, was entirely inundated on April 30, 1987 from the river. Collection site 7 contained a mixture of both sedge and grass vegetation, and site 8 contained sedges and a species of papyrus.

Pupae were sampled daily between 0900–1000 hr on May 7–9 at sites 1–6 and on May 9–11 at sites 7 and 8 with a pint (0.47 liter) dipper, counted, and returned to the laboratory to rear to adults for species identification. The average number of pupae collected per dip at each site is illustrated in Fig. 2. From 25 to 100 dips were made at each site daily. Male and female data were combined. In study area I (Fig. 2), where more than 8,000 specimens were collected, site 3 had the highest density and site 6 had the lowest density of *Aedes* pupae. *Aedes mcintoshi* was the most common species collected, representing 90% (7,328/8,183) of all specimens. *Aedes circumluteolus* (Theobald) and *Ae. dentatus* (Theobald) represented 5.6% (462/8,183) and 4.7% (382/8,183) of the collection, respectively. *Aedes dentatus* represented 9.9 ± 0.6% (percent ± SE) (259/2,616) of the specimens collected at site 4, which was significantly higher than at the other sites (pairwise Chi square tests of hypotheses, $P < 0.01$) in area I. Only 0.2 ± 0.1% (3/1,838) of the collection at site 1 consisted of *Ae. dentatus*, significantly lower than for the other sites with grass vegetation ($P < 0.01$). No *Ae. dentatus* were collected at site 6. *Aedes cumminsii* (Theobald) represented only 0.05% (4/8,183) of the collection in area I. *Aedes circumluteolus*, *Ae. unidentatus* and *Ae. taylori* together represented <1% of the total collection in area I. The collection of 2 specimens of *Ae. taylori* (normally a tree hole species) in a ground pool probably represents an uncommon occurrence in this type of habitat.

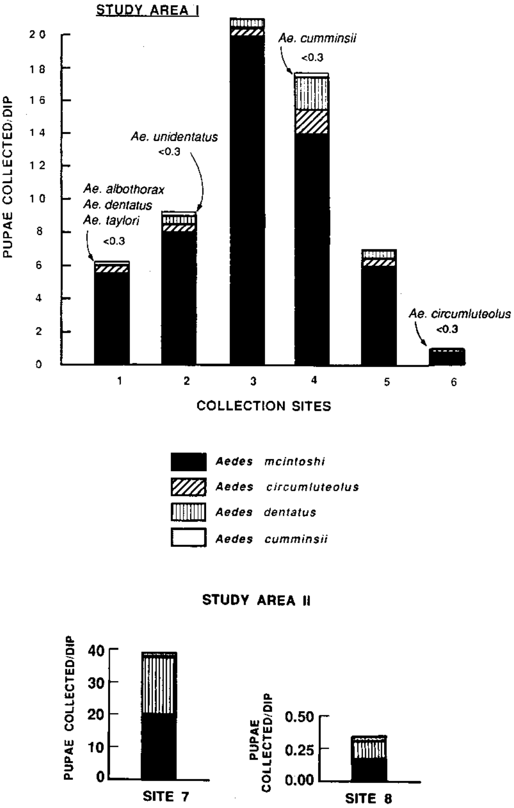

Fig. 2. Number of pupae of each species collected/dip at each collection site in study area I and study area II.

In study area II (Fig. 2), the most common species were *Ae. mcintoshi* and *Ae. dentatus*, representing 51% (1,196/2,345) and 46% (1,083/2,345), respectively, while *Ae. cumminsii* comprised 3% (64/2,345). The number of pupae collected per dip at site 7 was more than 100-fold higher than at site 8. *Aedes albothorax* (Theobald), *Ae. circumluteolus*, *Ae. unidentatus* McIntosh and *Ae. taylori* Edwards were not found in area II.

Resting adults were collected with a mechanical aspirator (Davis and Gould 1973) starting 1–3 days after emergence in Area I (May 10–14, 1987) from vegetation at sites 3, 5, 6, 9 and 10 (Fig. 1). Sites 1, 2 and 4 were not sampled, since they were flooded and were considered to be duplicates of site 3. Sites 7 and 8 in Area II were not sampled because of logistical constraints. Collections were made for predetermined periods between 0800–0900 hr. *Aedes mcintoshi* was the predominant species collected (1,460 specimens). A summary of the number of adult *Ae. mcintoshi* collected per minute at different sites is shown in Fig. 3. Male and female data are combined. Overall males represented 29% of the collections. The majority of the adults were found resting at site 3, which correlated closely with the site that produced the largest number of pupae.

Very few of the *Aedes* pupae collected in the flooded dambos were from the central low lying area containing primarily sedge vegetation. This strongly suggests that areas with vegetation comprised of grass or a grass-sedge mixture were the most likely oviposition sites for gravid females. It was previously reported that *Ae. mcintoshi* (as *lineatopennis*) first stage larvae were not collected in a flooded dambo until the water flooded areas outside the central sedge area, suggesting that the eggs were located outside the area of sedge growth (Linthicum et al. 1984). *Aedes dentatus* exhibited a predisposition for areas with a mixture of grass and sedge vegetation although the mosquito species composition of the 2 study areas differed markedly. As evidenced by the resting collections, the majority of *Ae. mcintoshi* adults remained in the immediate vicinity of the flooded immature habitat (sites 3, 5, 6; Fig. 3) for at least 5 days post-emergence. Some adults were found in unflooded areas of the dambo (sites 9, 10; Fig. 3). Linthicum et al. (1985a) reported limited dispersal for *Ae. mcintoshi* (as *lineatopennis*) after emergence during a dry season artificial flooding experiment. Mark, release, recapture studies conducted over an expended period of time should be conducted to better assess the general pattern of dispersal of adults during a wet period.

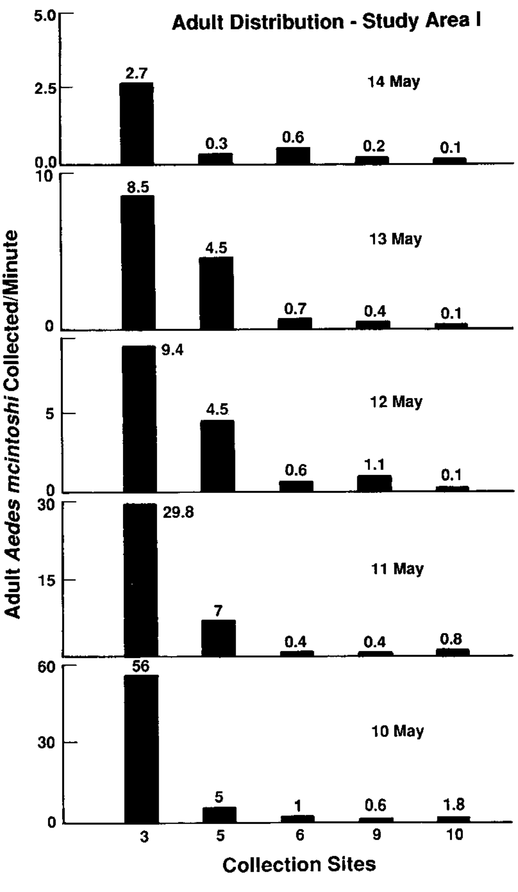

Fig. 3. Number of *Aedes mcintoshi* adults collected per minute at selected sites in study area I.

Rift Valley fever virus has been isolated from 4 of the *Aedes* species [*circumluteolus* (Weinbren et al. 1957), *cumminsii* (Saluzzo et al. 1984), *dentatus* (McIntosh 1972) and *mcintoshi* (McIntosh 1972)] discussed here; however only *Ae. mcintoshi* has been implicated in RVF vertical transmission. Mosquito control efforts to limit RVF epizootics must consider the location and distribution of vector species. In the areas examined in this study, limited flooding of dambo habitats, where only low lying sedge areas are flooded, may have little impact on RVF epizootics. Efforts to control mosquitoes under these conditions may not be necessary. Flooding of entire dambos could initiate RVF activity where *Ae. mcintoshi* is present; however, flooding of only isolated dambos might be of little epizootic significance if adult dispersal is limited. The dispersal patterns of secondary *Culex* and *Anopheles* vectors must also be examined to fully assess the threat of RVF epizootics when dambos are flooded.

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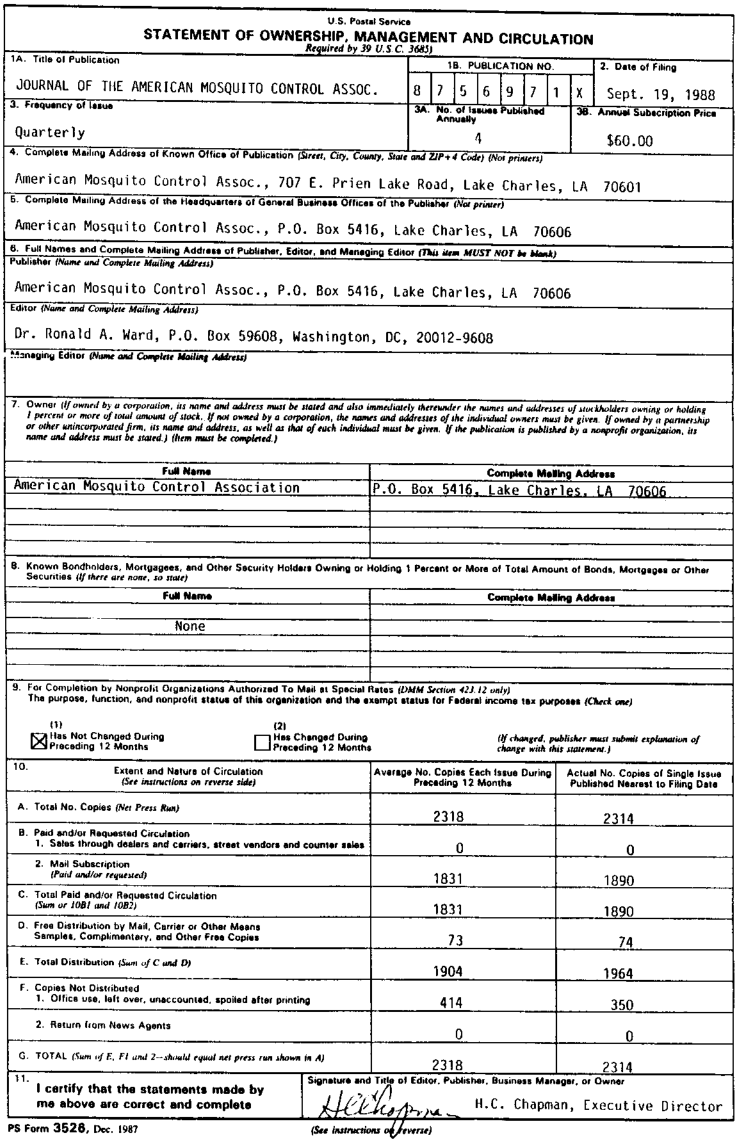

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