PRETREATMENT OF FLOODWATER *AEDES* HABITATS (DAMBOS) IN KENYA WITH A SUSTAINED-RELEASE FORMULATION OF METHOPRENE

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ABSTRACT. Effectiveness of sustained-release Altosid® pellets (4% AI methoprene) against floodwater mosquitoes in dambos treated at 5, 3, and 1 wk before and 1 day after flooding was determined. Only 2% of *Aedes* pupae (primarily *Aedes mcintoshi*) survived to adults in an area treated 5 wk preflood, and no adult mosquitoes emerged from an area treated 1 day after flooding. In contrast, 12 and 16% of *Aedes* pupae successfully survived to the adult stage in areas pretreated 3 and 1 wk, respectively, preflood. The effectiveness of the Altosid declined against *Culex* spp. (primarily *Cx. antennatus*) collected from dambos 15–31 days after flooding. The potential for using preflood treatment with methoprene to control *Aedes* vectors of Rift Valley fever virus in endemic areas is discussed.

Outbreaks of Rift Valley fever (RVF) in Kenya occur after flooding of ground-pool habitats (dambos) containing drought-resistant eggs of transovarially infected *Aedes* spp. mosquitoes (Ackermann 1936). After emergence, these infected vectors introduce the virus into susceptible animal hosts (Linthicum et al. 1985). Control of *Aedes* spp. emergence in flooded dambos may effectively interrupt the natural enzootic cycle of RVF virus in endemic areas of Kenya. The application methods to dambos in eastern and southern Africa during the rainy season is made difficult because flooding leaves some areas virtually inaccessible by ground.

The efficacy of a sustained-release formulation of methoprene, as Altosid® pellets, against ground-pool breeding *Aedes* and *Culex* mosquito species in Kenya was demonstrated previously (Linthicum et al. 1989). If a methoprene formulation placed in dambos before the rainy season could retain effectiveness during later flooding, it could be applied in areas that become inaccessible during the rainy seasons. The objective of this study was to determine the effectiveness of a sustained-release Altosid formulation (4% AI methoprene, Zoecon Corp.) against floodwater mosquitoes breeding in dambos pretreated up to 5 wk preflood.

The study site was located approximately 11 km SSE of Ruiru, Thika District, Central Province, Kenya (1°12′S; 36°59′E; 1,500 m altitude). The study was conducted from October to December 1989 at a dambo system on the north bank of the Kamiti River during a period when rainfall was only moderate, permitting ground access to the area. Five separate treatment areas, 100 m^2 each, within the dambo system were formed by constructing trenched barriers lined with polyurethane sheets the day of flooding to restrict water flow in or out of these areas. The Altosid pellets used in this study had been held in their shipping container for 12 months after receipt. The pellets were applied by hand at a rate of 5.6 kg/ha (0.22 kg AI/ha) to 3 areas at 5, 3 and 1 wk preflood. Two areas were treated one day after flooding, one with the full treatment dosage and another with half of the full treatment dosage. The treatment sites were similar in terms of plant species [primarily sedge, *Cyperus immensus* (C. B. Clarke) and stargrass, *Digitaria abyssinica* (A. Richard) Stapf], species distribution and density, and topography to the remainder of the flooded dambo that served as the control area. Study areas were flooded by pumping water from the Kamiti River and maintained at a constant water depth of approximately 0.3 m throughout the sampling period.

Pupae were collected by making ca. 100 dips (0.47 liter dipper) 7 days after flooding, and daily thereafter from each site, counted and placed in 0.03 m^3 wire mesh cages partially submerged in ca. 0.1 m of water within the corresponding collection site. The number of pupae collected at each site is shown in Table 1. To determine treatment effectiveness on pupal survival for different species, adults that emerged into the cages were collected with battery powered hand-held aspirators, identified and counted daily. Multiple chi-square tests of mortality were performed (SAS/STAT 1988).

In the emergence cages in the control area, *Aedes mcintoshi* Huang was the most common *Aedes* spp. collected, representing 53% of the total *Aedes* spp.; followed by *Ae. dentatus* (Theobald) (34%), *Ae. cumminsii* (Theobald) (10%) and *Ae. circumluteolus* (Theobald) (3%). A single *Ae. sudanensis* (Theobald) was collected. More than 99% (299/300) of the pupae collected in the control area successfully emerged.

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Table 1. Efficacy of Altosid® pellets (4% AI methoprene) against *Aedes* spp. pupae in areas pretreated up to 5 weeks before flooding.

Area	Percent mortality (number dying/total number sampled) of pupae collected 7–14 days after flooding[1] *Aedes* spp.
Treated 5 wk before flooding	98 (2,058/2,100) a
Treated 3 wk before flooding	88 (1,843/2,100) b
Treated 1 wk before flooding	94 (1,604/1,707) c
Treated 1 day after flooding (one-half dose)	93 (205/220) b, c
Treated 1 day after flooding	100 (151/151) a, c
Control	<1 (1/300) d

[1] Percents within a column followed by different letters are significantly different ($P < 0.001$); multiple comparison chi-square test.

The percent mortality of *Aedes* pupae collected in the treatment sites is shown in Table 1. A high Altosid application rate of 5.6 kg/ha applied 1 day after flooding prevented any *Aedes* emergence (from 7 to 14 days after flooding) whereas half the treatment rate applied at the same time reduced adult *Aedes* emergence by 93% compared to the control. The 98% reduction of adult emergence for *Aedes* in the area treated 5 wk preflood was not statistically different from that from the area treated 1 day after flooding (100% control). Altosid pellets reduced *Aedes* spp. emergence by 88 and 94% in areas treated 3 and 1 wk preflood, respectively. Differences in the rates of water percolation through the soil in separate treatment areas may account for some dilution of Altosid in some of the treatment rates and explain why the applications in areas treated 3 and 1 wk before flooding controlled fewer mosquitoes than in the test area treated 5 wk before flooding. Compared with *Aedes* in the control area, all treatments resulted in statistically significant ($P < 0.001$) mosquito mortality.

Altosid pellets controlled the *Culex* spp. emergence (91%) 15–31 days after flooding in the area treated 5 wk preflood, and was similar in efficacy to that found in the half dosage area treated 1 day after flooding, which controlled 85% of *Culex* spp. pupae. In the areas treated 3 and 1 wk preflood and 1 day after flooding, Altosid pellets controlled 53, 63 and 66% of *Culex* spp. pupal emergence, respectively. *Culex antennatus* (Becker) was the most common *Culex* spp. collected, representing 54% of the total *Culex* collection; followed by *Cx. zombaensis* Theobald (25%), *Cx. pipiens* Linn. (15%) and *Cx. tigripes* De Grandpre and De Charmoy (6%).

The residual activity of Altosid pellets in controlling *Culex* spp. 15–31 days after flooding was variable, ranging from 91 to 53% control. Linthicum et al. (1989) reported residual effectiveness of Altosid pellets (88% *Culex* pupal mortality) during the third week after flooding in a similar dambo system, and Floore et al. (1990) reported 98% control of *Ae. taeniorhynchus* (Wied.) 34 days after treatment of saltwater plots with 4.5 kg/ha of Altosid pellets.

The 2% *Aedes* spp. emergence in the area treated 5 wk preflood should be assessed in biological terms to the role of *Aedes* spp. as vectors of RVF virus. Rift Valley fever virus epizootics were related to periods of widespread, prolonged rainfall that flooded large areas of floodwater *Aedes* spp. habitats (Davies et al. 1985). Shorter rainfall periods may provide for the enzootic maintenance cycle of RVF virus, when smaller areas of *Aedes* spp. breeding habitat become flooded, resulting in the emergence of fewer potential RVF virus vectors.

Because a large percentage of *Aedes* spp. eggs in dambos hatched during the initial flooding (Logan et al. 1991), effective control may be expected by pretreating areas with Altosid pellets before widespread and prolonged rainfall occurs. Although some *Aedes* spp. emergence occurred in the treatment regime we used, Altosid pellets may keep adult emergence low enough to prevent a RVF epizootic. The *Aedes* egg population remaining in the dambos after first flooding may be insignificant in terms of vector production if flooding occurs again during the same rainy season. The ability to reduce significantly the *Aedes* population and to control the introduction of RVF virus into the susceptible vertebrate population with an Altosid pellet pretreatment greatly enhances the potential to reduce the impact of RVF disease. An Altosid application above label recommendations may enhance the extended residual activity of the pellets and should be evaluated, particularly for areas that require pretreatment in advance of the rainy season.

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