EFFECTIVENESS OF AERIALLY APPLIED AROSURF® MSF IN THE CONTROL OF THE CATTAIL MOSQUITO, *COQUILLETTIDIA PERTURBANS*

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ABSTRACT. Arosurf® MSF was applied to a Massachusetts cattail marsh at 0.5 gallons/acre (4.67 liters/hectare) to prevent emergence of *Coquillettidia perturbans*. One application was made by helicopter and three, later in the season, by fixed-wing aircraft. The material appeared to prevent adult emergence for about a week after the helicopter application, but due to large inter-trap variances in untreated controls the results were not statistically significant. Control was spotty with the fixed-wing application. One problem was obtaining good coverage at a site with difficult aerial access, the second was the interference to delivery of the pupicide as the emergent plant canopy developed later in the season.

At our latitudes, *Coquillettidia perturbans* (Walker) has one major brood per year, generally in mid-summer, although a smaller late summer brood may be produced (Olds et al. 1989). Its larvae commonly attach their siphons into the water roots of cattails (*Typha latifolia*) and stay there for 10 to 11 months until the pupae release, come to the surface, and emerge as adults. Such larval behavior has rendered this mosquito one of the most difficult to attack in the larval stage. David Henley (personal communication) proposed that we try to attack the pupae with Arosurf® MSF, by keeping a film of oil on the marsh during the period of peak emergence. A fringe benefit was thought to be that female adults which were returning to oviposit might drown, and some of the newly hatched larvae might asphyxiate before they could attach to the cattail roots.

A small pilot study using Arosurf applied by hand from an aerosol can in Lynnfield, MA during 1988 showed that *Cq. perturbans* emergence could be expected from the last week of June through the first week of August, although emergence rates seemed to diminish after the third week of July (Kenny and Ruber 1990). There was evidence of suppression of *Cq. perturbans* emergence following Arosurf application, but because of the large number of negative traps in both control or treated areas, evaluation of significance was difficult. In 1989 we expanded this experiment to a large cattail marsh in Hanson, Massachusetts.

The area was surveyed for larval incidence before treatment. Larvae were caught both by using a modified bilge pump (Walker and Crans 1986) and the more traditional scraping of the cattail water-roots with a dipper. Such sampling is tedious and disruptive to the habitat which places a limit on the larval data which can be obtained prior to treatment.

One control and 2 treatment areas were established. Mosquito emergence was assessed with Essex County emergence traps fitted with polystyrene for flotation. These were designed and constructed by Jack Card (Kenny 1991[1]). Twenty traps were placed in control area A, 10 in treated area B and 10 in treated area C. The traps were placed in various types of sites, some next to very large pools, others in small pools in the middle of the marsh, between the cattails.

Since the depth and under-foot support of the marsh was very irregular we laid out a large number of surplus wooden pallets to use as a walkway into each of the 3 study areas. The traps were kept 4–6 feet (1.3–2 m) from the walkway to reduce disturbance, and were collected by use of a long pole.

Arosurf MSF in water at 0.5 gallons per acre (4.67 liters/ha) was applied by aircraft on 4 dates in the summer of 1990. This is the maximum recommended dosage (Sherex 1984). The first aerial application, on June 28, was carried out by a helicopter which contained equipment for shear agitation of the Arosurf-water emulsion. It was not possible to obtain the helicopter again, but a fixed-wing aircraft (lacking a mixing apparatus) was available which belonged to the Plymouth County Mosquito Control Project. When we tested the stability of shear-agitated Arosurf-water emulsion, it was greater than 45 minutes. Consequently, we pre-mixed it at the airfield, and delivered the Arosurf without onboard shear agitation on July 7, 18 and August 2. Sherex provided an indicator solution (Adol) to test directly for the presence of Arosurf on the marsh sites, but we were unable to use it effectively in the field.

Before each of the 4 Arosurf applications, the

[1] Kenny, E. A. 1991. The effectiveness and side-effects of Arosurf-MSF used for the control of *Coquillettidia perturbans*, and an examination of the incidence of mermithid nematode parasites of this mosquito in Massachusetts. M.S.H.S. thesis. Northeastern University, Boston.

emergence traps were moved onto the walkways and placed in plastic bags to avoid getting Arosurf on the traps and to permit complete access of the material to the trap site. The traps were emptied with a battery powered aspirator (Hausherr's Machine Works, Toms River, NJ) on the second and sixth days after each application and the mosquitoes killed afterward in an ethyl acetate jar.

More than 98% of insects in the emergence traps were *Cq. perturbans*. Three Odonata and one *Uranotaenia sapphirina* (Lynch-Arribalzaga) were captured. There was no statistically significant difference between the treated area and the controls when data were aggregated over the whole period (Table 1). This implied that there was no control, which on closer examination proved not to be the case (Table 2). Emergences were examined 2 and 6 days after each application. Control was almost complete after the first (helicopter) application, but after the next 3 (fixed-wing) applications control was erratic. One reason for this was the difficulty which the pilot of the fixed-wing aircraft had in getting in and out of the spray zone safely. This resulted in less complete coverage than was achieved by the helicopter application.

There was however a second reason for the inadequate control in later applications; the growth of the plant cover. Some of the traps were so overgrown with cattails and associated vegetation that they could scarcely be seen. In area B, two overgrown traps yielded 50% of total emergences. It is unlikely that the emulsion could have reached the water at these sites, but since we could not use the indicator, this remains a supposition. Vegetational overgrowth was not a problem early in the season.

It has been pointed out by an anonymous reviewer that the partial separation of the Arosurf-water emulsion cannot be detected visually in its early stages, and that helicopter rotors create a downflow which enhances the penetration of applied materials through vegetation. Both points contribute to the explanation of the failures of our applications with the fixed-wing aircraft.

The potential impact on the data by a few traps which are inadequately treated is considerable (Table 1). When the 20% of traps with the highest catch are removed from the data, the mean catches in the control and the 2 treated areas are reduced by 61, 86 and 37% of their overall amounts, respectively. We observed that some of the most overgrown traps also yielded some of the highest adult emergences. Overall, 20% of the "treated" traps yielded 50–90% of all emergences in the treated areas. This was equivalent to 26–72% of all emergences in the control area.

Another question we wished to answer was whether the Arosurf would lose its effectiveness over a period of 1 week. To do this we sampled 2 days and 6 days after each spraying (Table 2). There appeared to be no significant reduction in control during this interval. A 21 day period

Table 1. Collection of emerged *Coquillettidia perturbans* from 3 areas of the Hanson marsh, June 28 to September 1, 1989[a].

	Area		
	Control-A	Treated-B	Treated-C
Traps (*n*)	20	10	10
Mean catch ± SE	0.56 ± 0.16	0.81 ± 0.42	0.60 ± 0.48
Without highest[b]	0.22	0.11	0.38
% reduction[c]	61	86	37

[a] Collections made on 17 dates, only first 15 included above; no catches after August 18.
[b] Means recalculated after removing the 20% of traps with the highest catches.
[c] Reduction of mean catch after b.

Table 2. Mean number of *Coquillettidia perturbans* adults caught per trap-day in collections 2 days and 6 days after spraying.

	Application							
	First		Second		Third		Fourth	
Area	2	6	2	6	2	6	2	6
Control A	0.23	0.21	0.35	0.11	0.28	0.34	0.40	0.28
Treated B	0.00	0.00	1.05	0.23	1.15	0.40	0.00	0.18
Treated C	0.00	0.08	1.55	0.18	0.00	0.20	0.15	0.03

elapsed between the third and fourth applications. During this interval emergences rose considerably in the treated areas. Because of the large variances in trap data, even large differences between areas were not statistically significant, i.e., note the first application in Table 2.

In 1988 at the Lynnfield site, populations peaked earlier in the season, and the last catch was on August 11, compared with August 18 in this study. We do not know whether this is related to site differences or to differences between 1988 and 1989 weather (Kenny and Ruber 1990, Kenny et al. 1990).

We censused zooplankton regularly and detected no population changes between treated and control areas, but we did not census populations of other insects or invertebrates (Kenny[1]). Since these others are likely to be more vulnerable to the Arosurf than is the zooplankton, potential side effects of these groups should be assessed.

We concluded that the Essex County emergence trap was an effective device for the sampling of emerging *Cq. perturbans* adults. However, because of extreme patchiness in trap catches, variances associated with collected data were high. This meant that even large control/treatment differences were not statistically significant.

When the Arosurf MSF was delivered properly and thoroughly, at the concentration of 0.5 gallons per acre (4.67 liters/ha), directly over the water surface of the cattail pools, it did control the emergence of adult mosquitoes, possibly for a full week or even slightly longer. Three to 4 such applications would span the peak portions of *Cq. perturbans* emergence in our area. As the season progressed plant growth seemed progressively to interfere with the penetration of the Arosurf. This may be a major problem because a few highly productive traps, where the spray has failed to penetrate, can compensate statistically for adequate control at many other trap sites. If the product were formulated in a soluble capsule which could penetrate the vegetation this problem might be resolved.

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