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THE EFFECT OF ILLUMINATION AND POOL BRIGHTNESS ON OVIPOSITION BY *CULEX RESTUANS* (THEO.) IN THE FIELD

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INTRODUCTION. In the field many mosquitoes lay their eggs in dark pools and shaded situations, even at night. Investigations of egg laying behaviour have, however, been carried out largely in the laboratory (reviewed by Clements, 1963).

Previous investigations at this Institute (Laing, 1964) have shown that the mosquito, *Culex restuans* Theo., among others, breeds readily in artificial pools in a woodland environment. The following tests were done to determine the effect of pool linings with different brightness and of artificial illumination during the night on the oviposition behaviour of this species.

METHODS AND MATERIALS. Four artificial pools one meter square, similar to those described by Briand (1964), were set out at the corners of an approximate square with a side of 10 meters in fairly dense mixed woodland at the Institute field station near Chatterton, Ontario. Two (east) were lined with translucent and two (west) with black polyethylene film. Their exact position was determined by adjacent trees which were not disturbed. Each pool was filled to the top with approximately 250 liters of water from a nearby stream. As it was expected that larvae or contamination from larvae would occur during some of the tests, approximately 100 mixed *Aedes stimulans* and *A. trichurus* were added to each pool from a snowmelt pool some 200 m to the south, which contained final instar larvae and pupae.

Fixtures with white reflectors fitted with two 40-watt cool white fluorescent lamps were set 70 cm. above the southeast and northwest pools and controlled by a time-switch set to illuminate the pools between 6:00 p.m. and 7:00 a.m. eastern daylight time. Starting on May 9, 1966 the surface of the pools was illuminated with an intensity of 1,600–2,700 lux which is about 1/25 to 1/50 as intense as open sunlight.

Fluctuations in the temperature of the pools were measured with a thermistor recorder from May 12 to June 12 with the sensing element 1 cm. below the surface of the water. Temperatures of all four pools were taken with a floating thermometer to the nearest 0.5° C. each time the egg rafts were collected, at about 9:30 a.m. Floating debris and predators were also removed at this time.

The first test was run until June 10 when the pools were emptied except for 60 liters of water in the northeast pool containing immature mosquitoes. This water was then redistributed equally and the four pools were refilled. The lights were placed over the previously unlit pools and a second test run for 20 days to investigate the effect of the position of the pools.

In the second half of June, large numbers of insects collected at the fluorescent tubes and the surface of the illuminated pools was almost covered with cicadellids (genus *Colladonus*) on several nights. The water in the pools was left unchanged when the lights were removed on June 30, to investigate the effect of the dead insects at the bottom of the pool on raft laying. A final test was carried out after the pools had been cleaned as thoroughly as possible and refilled with fresh water.

Tests were run until clear differences in numbers of egg rafts were apparent and statistical analyses were carried out using the X^2 test.

RESULTS. The mean morning temperature of the pools over the duration of the tests were as follows: NW, 17.0; SW, 17.5; SE, 17.6; NE, 17.3° C. Daily variation in pool temperature during the first month of the experiment ranged from 2 to 8° C. depending on air temperature and cloud cover, the maximum occurring about 4:30 p.m. and the minimum about 7:30 a.m.

The maximum number of egg rafts laid in one night appears to be related to the water temperature but the converse is not true and a warm night does not guarantee that egg rafts will be laid. Rafts were laid on the coldest nights (morning temperature 10° C.), but never in large numbers.

The results of the tests of illumination of the pools during the night are clear-cut. No rafts were laid in the NW and SE and only one each in the SW and NE pools when they were illuminated. Both of these egg rafts were laid in the same 24-hour period of June 22–23. During these tests 49 rafts were laid in the unlit pools, 12 in the first test and 37 in the second.

After the lights were removed on June 30, significantly more rafts were laid in the previously illuminated pools, with a ratio of 4.1:1. Subsequent counts made after the pools were cleaned and refilled with fresh stream water showed slightly but not significantly more rafts in the two pools that had been illuminated in the second half of June compared with the numbers in their unlit counterparts, a ratio of 1.4:1.

The pools lined with black were consistently selected as oviposition sites in preference to those lined with translucent film. In the first and third tests, when the pools were relatively dirty, 114 rafts were laid in the black pools and 38 in the translucent, a ratio of 3:1; in the second and fourth tests, when the pools were cleaner, 94 were laid in the black pool and 17 in the translucent, a ratio of 5.5:1.

DISCUSSION. The temperature of the artificial pools was not a critical factor in the oviposition behaviour of *C. restuans* as eggs were laid on the coldest nights. The relationship between morning water temperature and number of egg rafts laid can probably be explained entirely on the basis of the greater abundance and flight activity of females on warm nights. The greatest difference in mean morning temperatures of the pools was less than 1° C. and this is almost certainly not the reason for the difference in numbers of rafts in the black and translucent pools.

The results show clearly that woodland pools illuminated at night are not suitable oviposition sites for *C. restuans*. Two of the 51 rafts laid were found in the illuminated pools but the lights were in fact switched off for about 30 minutes after sunset on June 22 as power was required for another experiment. It is highly improbable that both rafts were laid on the same night as a result of random oviposition over 36 nights (p=2x1/36x35 or 0.0017). The results also show that at least in May and June *C. restuans* does not oviposit between 6:00 a.m. and 7:00 p.m.

The other insects trapped on the surface of the illuminated pools may have deterred females from ovipositing on a few nights, particularly as agitation of the water surface is believed to deter *C. pipiens* (Schober, 1966). Fortunately, the flight season of the cicadellids was short and their physical presence could only have influenced the results slightly. They might, however, have produced a chemical repellent with more lasting effects, but when the lights were removed to test this, these pools proved to be more attractive than the controls.

Laing (1964) noticed that significantly fewer egg rafts were laid in pools lined with translucent polyethylene, or in white-painted metal containers one meter square than in metal containers with a layer of peat moss and debris on the bottom. The ratio of 112 rafts in the dark (peat moss) and pale (painted) containers was 2.2:1. Peat moss was purposely not used in the present experiments, to eliminate any possibility of chemical side-effects, but a comparison with Laing's results shows that its effect is probably just that of a change in brightness.

It was difficult to measure the brightness of the pool linings during the experiment owing to reflections from the water surface. To the human eye, the translucent lining was white when first installed, changing to yellowish after about a week as a film of algae and fine debris built up on the lining. Mosquitoes can probably detect this change in brightness even though the dirty pools are still very much brighter than the surrounding earth.

The behaviour of the mosquitoes in these tests can be explained as a selection of oviposition sites with a minimum of luminous radiation whether this is direct (illumination) or reflected (brightness) although other factors such as the "mirror" effect at the water surface cannot be ruled out.

This type of behaviour could be exploited in control measures for raft-laying mosquitoes with similar habits. Continuous illumination of water and sewage containers could be a simple and inexpensive method of eliminating domestic mosquitoes. Irrigation ditches and similar man-made breeding sites could be lined with pale material although this would probably only reduce egg laying and not eliminate it. The use of dark "catch-sites" that could be treated with insecticide alongside pale ones would increase the effectiveness of this method.

SUMMARY. Artificial pools in a natural woodland environment received more than three times as many egg rafts of *C. restuans* when lined with black as opposed to translucent polyethylene film. Illumination at night of either type of pool with an intensity similar to that received during the day prevented oviposition.

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