after failing to demonstrate transmission using experimentally infected *An. crucians* in the laboratory.

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EVACUATION RATE OF MOSQUITO-FED NEWTS, *NOTOPHTHALMUS* V. *VIRIDESCENS*

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Newts have long been suggested as a natural control for larval mosquitoes in temporary ponds which are devoid of fish (Chandler 1918, Sergent and Foot 1922, Matheson and Hinman 1929). However, much information on newt feeding habits shows that they live on quite an opportunistic diet (Hamilton 1932, Morgan and Grierson 1952, Wood and Goodwin 1954, Ries and Bellis 1966, Christman and Franz 1973). This probably reduces the mosquito destroying efficiency of the newt.

Nonetheless, there is evidence that newts can concentrate their feeding on mosquito larvae (Hamilton 1940) and have a significant impact on animal biomass in limited areas of a lake ecosystem (Burton 1977). As newts and mosquitoes frequently coexist in the field, experiments were conducted to verify the mosquito-feeding capacity of newts and to measure their evacuation rate.

Experiments on feeding capacity were conducted at room temperature (25°C) in 5 liter aquaria filled with filtered pond water. The newts, *Notophthalmus* v. *viridescens* (Rafinesque), were captured in outdoor ponds or purchased in pet shops and acclimatized for at least a week on an *Aedes atropalpus* (Coquillett) mosquito diet. These larval mosquitoes were easily available from rock pools of La Gabelle (Québec). Photoperiod was maintained at 16L:8D. Newts were starved 24 hr before experimentation and then individually tested at densities of 25, 50, 75 and 100 mosquito larvae (3rd and 4th instars). Experiments started at 0900 (3 hr after morning light started) and ended 24 hr later.

Table 1 shows that the newts can easily consume more than 40 larvae/24 hr and seem to reach full satiety with approximately 70 larvae. This corresponds well with the newt feeding rate of 45 larvae/day as cited in the literature (Sergent and Foot 1922, Matheson and Hinman 1929). These data appear to be more closely related to ingestion rate or capacity rather than to evacuation rate. They give little, if any information about the length of time for transit of food through the intestine.

To collect data on intestinal clearance speed, four newts were placed in water at 17°C, each single newt being allowed to eat 25 mosquito larvae after a preliminary fasting period of 3 days. Observations were then made at 6 hr intervals for any dropping containing undigested mosquito cephalic capsules until all 25 head capsules were recovered from each newt. The temperature of 17°C was selected in order to approximate the conditions found during the spring in temporary ponds (Bourassa and Aubin 1974).

The evacuation rate of the newt appears to be a linear function of time described as, $Y_x = Y_0 - RX$, where Y_x is the number of mosquito larvae still inside the newt digestive tract after X hours, Y_0 is the ordinate intercept corresponding to the initial number of eaten larvae, and R is the instantaneous rate of evacuation. The equation obtained is: $Y_x = 27.18 - 0.117X$ ($n = 24$, $R^2 = 0.73$, $F = 60.8$); the F test is highly significant ($P < 0.001$). In fish, gastric evacuation rates generally display an exponential function against time, but linear relations do exist (Elliott 1972, Persson 1979).

Solving the equation gives an estimate of 153 hr to recover all 25 mosquito head capsules from each newt. The first feces to be evacuated by the newts contained a mean number of 13.7 capsules and came after 65.2 hr. This last

Table I. Mean number of *Aedes atropalpus* larvae eaten by a single newt in 24 hr at four different densities.

	Density of mosquito larvae			
	25	50	75	100
Mean ± S.D.	25.0±0	41.8±14.3	69.1±11.9	63.4±28.3
Number of newts tested	11	11	11	12

number is in good agreement with an estimate of 69.7 hr found by Bobka et al. (1981) for intestinal transit of a terrestrial salamander, *Plethodon cinereus* (Green), fed on drosophila flies at 15°C.

Owing to their low evacuation rate (13.7 capsules/69.7 hr or ca 5 mosquito larvae/day), newts cannot be viewed as efficient predators on larval mosquitoes, especially in snow-melt shallow pools where they are found at very high densities. In these natural habitats low temperature can also affect newt feeding activity (Attar and Maly 1980) or amphibian intestinal clearance speed in general (Rozdzial 1981)[1]. However, as shown for lizards (Windell and Sarokon 1976), larger rations or continuous feeding might enhance a faster evacuation rate in the newt.

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