OPERATIONAL AND SCIENTIFIC NOTES

SIMULIID LARVAL MIDGUT PH AND ITS IMPLICATIONS FOR CONTROL

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Larvae of Lepidoptera have long been known to have highly alkaline midgut contents, sometimes exceeding pH 10.0. Similar high pH values have recently been found to occur in the midguts of mosquito larvae (Dadd 1975). Because of the importance of the gut pH as a triggering stimulus for the initiation of infections by certain entomopathogens, experiments were conducted to determine the midgut pH of simuliid larvae.

Late instar larvae of *Simulium verecundum* and *Cnephia ornithophilia* were chosen for this study because of their availability locally and their relative transparency. *Simulium vittatum* larvae were also tested but, because of their higher degree of pigmentation, the results were more difficult to score. Larvae were placed in 250 ml beakers, with a cylinder of clear plastic sheet covering the inner wall. The water bathing the larvae contained 0.01% pH indicator and either Kaolin or Tetra® fish food as filler, to move the dye through the larval gut. After 1–4 hr, the experimental material completely replaced the original larval gut contents. The plastic sheet was removed from the beaker and placed on the stage of a dissecting microscope. The larvae, still attached to the plastic, were examined for regions of major color change in their midguts, and these regions were plotted on schematic diagrams of the larval midgut. The pH range of the sharpest color change of each dye was determined with a pH meter and titration with an appropriate buffer.

The pH at the anterior end of the midgut increased rapidly to the limit of the most alkaline indicator used (Alizarine Yellow R) then dropped rapidly, towards the posterior end, to neutrality (Fig. 1). The maximum pH was at least 9.8. Results with all 3 species, whether Tetra® or Kaolin fed, were similar and so all data were grouped into Fig. 1.

Results within a group of larvae with any particular dye were often variable. Examinations had to be made quite rapidly, as all of the midguts were neutralized within a few minutes after the larvae had been placed under the dissecting scope. Neutralization was almost immediate after dissection of the gut from the larva. Because adverse environmental conditions and mechanical injury served only to reduce the pH and not to increase it, the higher values probably should be considered physiologically normal. Because of the variability, species differences which might exist were not evident.

Midgut alkalinity is important in lepidopteran susceptibility to *Bacillus thuringiensis* crystal toxin and nuclear polyhedrosis virus. It could be equally important to simuliid larval susceptibility to entomopathogens, both those specific to black flies and those of other insects which require alkaline stimulation to initiate the pathogenic process. Spores of the microsporidian *Nosema algerae*, a mosquito pathogen, *N. eurytremae*, a hyperparasite of larval trematodes and *Variomorpha necatrix*, a lepidopteran pathogen all germinated in the black fly larval midgut (Undeen, unpublished). *N. eurytremae* and *V. necatrix* (Undeen 1978) require alkaline conditions for germination (optimum about pH 9.5), providing another check on the gut alkalinity. That none of these pathogens infected the black fly larvae indicates that, however important it may be to germination, pH is not the only factor governing susceptibility.

Lepidoptera pathogenic *B. thuringiensis* has some simuliid larvicidal effect (Lacey and

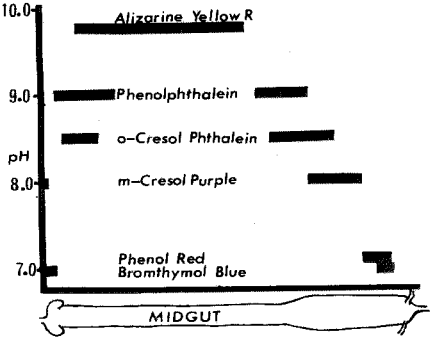

Figure 1. pH range in the midgut of simuliid larvae

Mulla 1977) and a new serotype, *B. thuringiensis* var. *israelensis* has been found with a very high degree of toxicity for both mosquito (Goldberg and Margalit 1977) and black fly (Undeen and Nagel 1978) larvae. It is not yet known if alkalinity is a common factor in this toxicity. If this alkalinity is unique among stream dwelling insects, it might also be a useful characteristic in the formation of microencapsulated insecticides increasing specificity as demonstrated in methoprene (Altosid®) lab and field tests (Thompson and Adams 1979).

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NOTES ON THE GEOGRAPHICAL DISTRIBUTION OF THREE SPECIES OF *CULISETA*

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At the Medical Entomology Project, U. S. National Museum of Natural History, Smithsonian Institution I recently examined specimens representing species of the genus *Culiseta.* As a result the following distribution records are reported:

Cs. (Culicella) morsitans dyari (Coquillett)
VERMONT: Laurel Lake near Jacksonville, VI-15-1952; 2 males collected and determined by H. D. Pratt. New state record.

Cs. (Cuc.) silvestris minnesotae Barr
ALASKA: Pt. Woronzof, Anchorage, June 10, 1964, stationary trap; 1 female collected by K. M. Sommerman. This specimen was labelled "*Culiseta morsitans dyari*?" by Dr. Sommerman. *Cs. s. minnesotae* has pale brownish bands both basally and apically on the abdominal terga; *Cs. m. dyari* has only basal bands, and the pale scales are distinctly white. New state record.

Cs. (Culiseta) alaskaensis (Ludlow)
NEVADA: Baker, Mt. Diablo Mer., 11–9–39, 1 male collected by T. O. Thatcher. New state record.
UTAH: Escalante, no date; CCC Survey; 2 females. I assume that this collection was made in the 1930's. New state record.

ANTIBODY LEVELS IN BLACKBIRDS TO ST. LOUIS ENCEPHALITIS VIRUS

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Each winter in central and southern Kentucky large numbers of blackbirds congregate. Roosts consist of grackles, red-winged blackbirds, and starlings with smaller numbers of other species also seen. During the summer these roosts break up with the birds scattering across the region. Many of the species found in these winter roosts live in intimate association with man in the summer months, especially in suburban areas. Sentinel birds and trapped wild birds have routinely been used to monitor antibody levels to St. Louis encephalitis (SLE) in the bird population. These levels can then be used to predict the possibility of SLE outbreaks and the need for mosquito control spraying (McLintock 1976, Wong 1976). It was of interest to us to determine the level of anti-