TOXICITY OF ALTOSID® TO THE CRUSTACEAN, *GAMMARUS AEQUICAUDA*[1]

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ABSTRACT. *Gammarus aequicauda* (Martynov 1931), which is considered an important food constituent of fish, shares its breeding places with *Aëdes detritus*, (Haliday) a major pest mosquito in Central Italy coastal marshes. The susceptibility of this crustacean to Altosid® was studied in the laboratory, and the LC_{50} and LC_{90} values for adult males and females, and young, were determined. It was shown that Altosid had no effect on *G. aequicauda* embryos at concentrations that rapidly kill all newly hatched young. These findings were compared with the LC_{50} and LC_{90} for *A. detritus*. A high margin of safety appears to exist between the lethal doses for *G. aequicauda* and those for *A. detritus*, thus allowing local mosquito antilarval measures employing Altosid. The speed of action of Altosid on *G. aequicauda*, obtained by plotting the LC_{50} values against time, showed a similar trend for the two sexes, while a faster action was shown on young.

Gammarids are considered important food items for some economically important fish species (Kinne 1953). Little is known, however, about the effects of insect control chemicals on this crustacean group, except for casual reports on *Gammarus* sp. following the use of DDT in simuliid control (Kershaw et al. 1968), of toxaphene as fish poison (Hooper and Grzenda 1957) and of Dursban in *Culex tarsalis* control (Muirhead-Thomson 1970).

Due to the high susceptibility of mosquito larvae to insect growth regulators (IGRs) and in view of a possible use of IGRs for mosquito control, attention has already been focused by several authors on different nontarget organisms (Steelman and Schilling 1972, Darlington et al. 1972, Miura and Takahashi 1973, 1974a, 1974b, 1975, Schaefer et al. 1974, Norland and Mulla 1975, Steelman et al. 1975, Mulla et al. 1975).

It was, therefore, deemed useful to determine the susceptibility of *Gammarus aequicauda* (Martynov) to Altosid and to report briefly the results obtained. This species is abundant in coastal salt waters associated with typical mosquito larvae breeding places, in particular *Aëdes detritus* (Haliday), of our area (Province of Grosseto, Central Italy).

MATERIALS AND METHODS. *G. aequicauda* used in the present experiment was collected by dipper during September 1975 on the shores of Orbetello's lagoon, next to *A. detritus* breeding places (Maroli et al. 1973). Sexes were separated and the individuals kept at room temperature (18–20°C) for 1–2 days in enamel basins containing sea water. The adults selected for the experiments were uniform in size, although their age was undetermined. Most of the females were gravid, while the others showed ovaries. In order to obtain young for testing, gravid females were maintained in containers as colonies, according to Sexton (1928), for 2–3 days, i.e. until the eggs hatched.

Tests were carried out on mature females and males and the young, employing technical Altosid 65.8% (isopropyl-11-methoxy-3, 7,11-tri-methyl-2,4-dodecadienoate),[4] serially diluted. Lots of 10 individuals were placed in 1,000 ml glass jars containing 500 ml of sea water with different Altosid concentrations and kept there continuously until mortality was estimated. Each concentration was run in duplicate and the material was tested on two different occasions.

Organisms were fed with elm leaves which had been previously washed in

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fresh water for 24 hr and then dried. Three or four leaves per container gave sufficient nourishment for the whole experiment. The surface scum was skimmed off twice a day. Mortality was assessed at ceasing of pleopoda movements. Abbott's formula was used for correcting mortality data. The corrected percent values were plotted on log probit scale against concentration, and the LC_{50} and LC_{90} values in ppm were determined at different times.

A test was also run on *G. aequicauda* embryos. To this end, 5 gravid females were kept in containers at a sublethal concentration of Altosid (1 ppm) until all eggs had hatched (7 days), and another lot of 5 gravid females was kept, for 5 days only, at the same Altosid concentration. Before the eggs had hatched, this second lot of gravid females was washed and transferred to control water. The hatching period was easily forecast 1–2 days ahead by observing the embryos' color which in this phase turns from green to clear yellow.

RESULTS AND DISCUSSION. As shown in Table 1, the LC_{50} values of *G. aequicauda* adults, males and females, are of the same order of magnitude as those obtained with other nontarget species belonging to zoologically related groups by Miura and Takahashi (1973) in acute toxicity laboratory tests of 24 hr duration, carried out with the same compound (from a minimal LD_{50} of 0.90 ppm for *Daphnia magna* to a maximal of 5.00 ppm for *Triops longicaudatus*).

Table 1. Lethal concentration of Altosid for *G. aequicauda* adults and young, in ppm.

	LC_{50}	LC_{90}	Time of mortality assessment
Adult females	2.15	4.10	96 hrs
Adult males	1.95	7.80	96 hrs
Young	0.32	1.05	24 hrs

The LC_{50} and LC_{90} values for *G. aequicauda* young are 6–7 times lower than those corresponding to the adults of the same species. The LC_{50} and LC_{90} values of the different species of mosquitoes tested by other authors (Hsieh and Steelman 1974, Mulla et al. 1974), are in all cases much lower than those obtained with *G. aequicauda* adults, males and females. However, by comparing mosquito

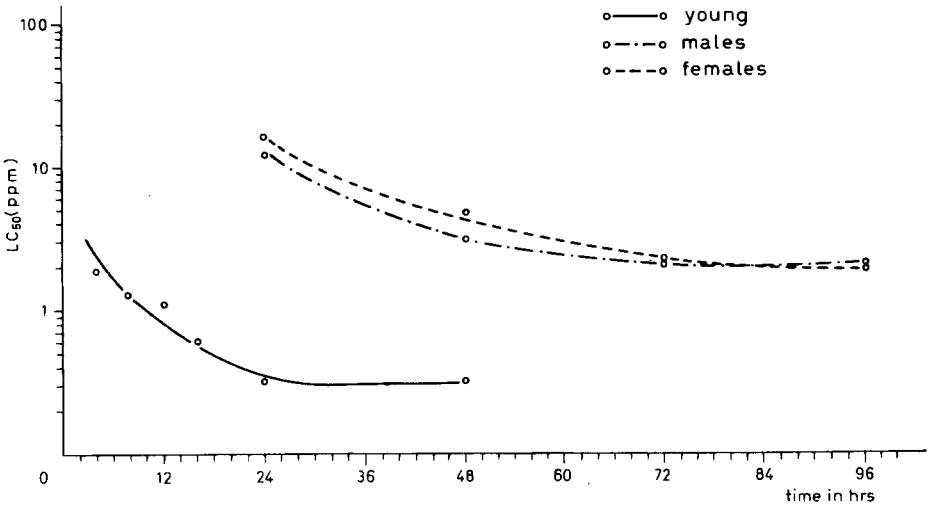

Fig. 1. Lethal concentration of Altosid for *G. aequicauda*.

Table 2. Effects of Altosid (1 ppm) on *Gammarus aequicauda* embryos through exposure of gravid females.

	No. of dead individuals and % mortality							
	adults	young	adults	young	adults	young	adults	young
A	0	–	1 (20%)	0	1 (20%)	7 (20%)	1 (20%)	35 (100%)
B	1 (20%)	–	2 (20%)	0	2 (40%)	0	0	4 (16%)
C	0	–	0	0	0	0	0	5 (14%)
Days of observation	4th		5th		6th		7th	

A) Gravid females and young in contact with Altosid throughout 7-day observation.
B) Gravid females transferred from Altosid to breeding water on the 5th day.
C) Gravid females and young left in breeding water throughout 7-day observation.

species with *G. aequicauda* young, these differences are smaller. The LC_{50} and LC_{90} values of Altosid SR_{10} (10% flowable microencapsulated slow release) for *A. detritus,* the most abundant and aggressive pest species, as determined by one of us (Majori G.) are respectively 0.0009 and 0.0085 ppm. A sufficiently high margin of safety, therefore, appears to exist allowing local mosquito antilarval measures using Altosid as the control agent.

As shown by the graph, the speed of action of Altosid on the two sexes follow the same trend; practically no mortality is observed after 72 hr (Fig. 1). Altosid, on the other hand, acts much faster on young, reaching the final effect at about 24 hr. Since the half-life of technical Altosid (under field conditions) is about 2 hr (Schaefer and Dupras 1973), this difference of speed of action may be ascribed either to a faster penetration of Altosid in young during this brief period of contact and/or to its higher activity on hormonal systems of the young stages. On the other hand, the LC_{90} values for mosquitoes in general are in some cases of the same order of magnitude as those obtained with *G. aequicauda* young. These cases refer, however, to exotic species. Any such comparison, therefore, should be confined to target and nontarget species belonging to the same environment.

The experiments on gravid females reported in Table 2 clearly show that Altosid has no effect on *G. aequicauda* embryos at the concentration of 1 ppm which rapidly kills all newly hatched young.

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