RESPONSES OF THE SHORE CRAB, *CARCINUS MAENAS* (DECAPODA, BRACHYURA), TO AN ACUTE DOSE OF CYPERMETHRIN

BY

BEN GOWLAND

Fisheries Research Services, Marine Laboratory, P.O. Box 101, Aberdeen, AB11 9DB, Scotland, U.K. and

Zoology Department, University of Aberdeen, Tillydrone Avenue, Aberdeen, AB24 2TZ, Scotland, U.K.

The shore, or green, crab *Carcinus maenas* (Linnaeus, 1758), is an endemic species of northern Europe. It has become an important species internationally due to its introduction to foreign waters where it has become so successful that it is now considered one of the most serious marine pests in the U.S.A. and Australia (Geller et al., 1997). *Carcinus* is used in pollution studies, not only because of the widespread and topical nature of the animal, but also because it is easy to maintain in the laboratory, and at high stocking densities.

Cypermethrin is a synthetic pyrethroid used as an insecticide and also to treat salmon against the infestation of sea lice (i.e., parasitic Copepoda). It was authorized within Scotland in 1997 for use on salmon farms. Cypermethrin acts on nervous systems by prolonging the opening of Na$^+$ channels leading to trains of spikes in neurons (WHO, 1989). Cypermethrin is especially toxic to Crustacea (cf. Clark et al., 1989), in particular marine decapods (WHO, 1989). This study was designed to investigate the effect of 5 µg/l of cypermethrin on the shore crab (the same concentration used to kill sea lice). These findings are reported here in order to share some new ideas for the use of *Carcinus* as a biomonitoring species.

Two 125 litre plastic, static seawater tanks were set up with aeration, each containing 12 *Carcinus* (70-85 mm carapace width) at 12°C and a light : dark cycle of 12:12 hours. The crabs were acclimated for 4 days prior to the experiment and were not fed during acclimation or the experiment. The treatment dose of 5 µg cypermethrin/l was created in the treatment tank using ethanol as a carrier. The control tank was treated with an equal dose of pure ethanol (0.5 ml). The water in each tank was then mixed to equilibrate the treatments within the tanks. Crabs were observed at various intervals after the start of the experiment to remove mortalities and look for any visually recognizable effects of the cypermethrin. At 96 hours the experiment was stopped and the remaining crabs were externally and...
internally inspected and notes recorded. Cypermethrin was quantified by GC-ECD, after extracting water samples that were taken from the cypermethrin treated tank at each time period of 0, 6, 24, 48 hours after the application of cypermethrin.

Cypermethrin showed an exponential decrease in the water column, with concentrations down to 20% of the nominal dose after 6 hours, 10% of nominal dose after 24 hours, and 5% at 48 hours; presumably due to absorption by crabs and onto tank walls and also chemical and microbial degradation. This indicates that there was cypermethrin available in the water until at least 48 hours into the 96 hour experiment. When the experiment was stopped at 96 hours, there had been 6 mortalities (50%) in the treatment tank and 1 mortality in the control tank (fig. 1). The crab in the control was observed to be limp and relatively unresponsive after 3 hours, and subsequently died after 5 hours.

In the first hour of the experiment there was no noticeable difference between the cypermethrin tank and the control, however, after three hours one crab had died and was removed, and two crabs were starting to show signs of a behavioural effect of cypermethrin. The affected crabs were rigid with all limbs extended and their chelae clamped shut. They did not respond to visual or mechanical stimuli. After another two hours, 8 of the remaining eleven crabs were in this state (fig. 2). This tetanus-like state looked similar to the usual aggressive stance given by a crab, other than three important factors, which are characterized below:

1. The chelae were clamped shut and were pointing forward, unlike the broadly opened and sideways pointing chelae of an aggressive crab.
2. If still upright on its legs, the crab was only facing slightly above horizontal, less than 10 degrees, unlike aggressive crabs which generally face about 25 degrees, or more, upwards.
3. All the pereopods faced in roughly the same direction, whereas in an aggressive crab the two rear pairs of pereopods face backwards and the front pereopods face forwards.

These observations give strong evidence of a tetanus-like effect of cypermethrin, which could be explained by the trains of impulses down peripheral nerves that arise from the toxic effect of cypermethrin on Na\(^+\) channels in nerve membranes. After 6 hours no crabs were observed with this behaviour, but after 12 and then 24 hours the majority are showing this effect again. Crabs that died and were removed ceased to show any rigidity. There is some scope for using this effect as a biomarker for cypermethrin, but only in circumstances where a large amount of cypermethrin has been released, around the treatment dose of 5 \(\mu\)g/l, and considerably above the environmental quality standard (EQS) of 16 ng/l (Henderson & Davies, 2000).