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The Effect of Endosulfan on Macroinvertebrate Communities in Artificial Streams

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Abstract

A system of 24 artificial streams was constructed on the banks of the Namoi River, New South Wales (NSW) to simulate the lotic environment of the rivers in the surrounding cotton-growing region. The streams were built to test the effects of the organochlorine pesticide endosulfan on aquatic macroinvertebrates under realistic environmental conditions.

The artificial streams were similar in their limnological characteristics and thus served as replicate units for toxicity testing, while also being representative of the environmental conditions in the nearby rivers. The macroinvertebrate communities in the streams were initially developed by natural colonisation processes, but this proved slow and resulted in macroinvertebrate communities with low diversity and abundance. The streams were then seeded with macroinvertebrates that were collected from an uncontaminated creek, upstream in the Namoi River catchment. The resulting communities were diverse and abundant, and contained a large proportion of taxa which are known to be sensitive to endosulfan. Seeding was used to develop macroinvertebrate communities for the subsequent toxicity tests.

The toxicity of a 12 h pulse of endosulfan was tested in two experiments in which macroinvertebrate communities were exposed to a range of endosulfan concentrations for a 12 h period and subsequently monitored for 4 days. In the first experiment, endosulfan was bound to fine river sediment and applied to the streams (treatments: 0, 0.09, 0.25, 0.61, 3.41 $\mu\text{g/L}$ measured) as a contaminated sediment slurry to simulate runoff during a storm event. Application of endosulfan in this way did not cause changes in benthic community structure; however, significant increases ($p < 0.05$) in macroinvertebrate drift were detected in the streams receiving the highest dose treatment (3.41 $\mu\text{g/L}$). In the second experiment, an endosulfan solution was added to the streams (treatments: 0, 0.09, 0.16, 0.97, 4.76, 48.12 $\mu\text{g/L}$ measured) to simulate direct contamination such as overspray. This caused significant ($p < 0.05$)

changes to the macroinvertebrate communities in the streams treated with 48.12 $\mu\text{g/L}$.

The effect of a 48 h pulse of endosulfan on macroinvertebrate communities was tested using 13 of the 24 artificial streams. Streams were dosed for 48 h (treatments: 0, 1.05, 6.09, 27.86 $\mu\text{g/L}$ measured) and monitored for 13 days. Significant changes in the macroinvertebrate communities ($p < 0.05$) were detected in the streams treated with 6.09 and 27.86 $\mu\text{g/L}$ but not in those streams treated with 1.05 $\mu\text{g/L}$. Analysis of the functional structure of the macroinvertebrate communities highlighted a decline in the abundance of shredders in the 6.09 and 27.86 $\mu\text{g/L}$ treated streams. Changes to the macroinvertebrate communities in the pool sections of the streams were also detected at 6.09 and 27.86 $\mu\text{g/L}$. Algal blooms occurred in the 6.09 and 27.86 $\mu\text{g/L}$ treated streams as a secondary effect of endosulfan dosing. Algal biomass was significantly greater ($p < 0.05$) in the 6.09 and 27.86 $\mu\text{g/L}$ treated streams compared to the control and 1.05 $\mu\text{g/L}$ treated streams.

The results of the artificial stream studies indicate that a single pulse exposure to endosulfan can cause major changes to the ecology of lotic ecosystems, in particular macroinvertebrate communities. These effects can occur at concentrations that have been previously measured in the rivers of the NSW cotton-growing region. Exposure to concentrations lower than those causing community effects may result in significant changes to macroinvertebrate populations.

A series of single species toxicity tests using the mayflies, *Atalophlebia* spp. and *Jappa kutera*, was conducted in the laboratory and in artificial streams. In general, single species tests were able to predict the toxicity of endosulfan to macroinvertebrate communities in the artificial streams. However, single species tests could not predict the secondary or sublethal effects that were detected in the artificial stream experiments. The results of this study highlight the need for mesocosm community studies to predict secondary ecosystem effects.