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Effect of Sublethal Doses of Cadmium on the Phototactic Behavior of *Daphnia magna*

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The effect of a sublethal concentration of cadmium (0.06 mg/L) was tested on the phototactic behavior of a positively phototactic *Daphnia magna* clone. In experiments lasting 10 min, using animals that had been exposed to cadmium for 1 to 6 h, it was observed that the animals became significantly less positively phototactic after 4 h of exposure to 0.06 mg/L cadmium compared to control animals that had not been exposed to cadmium. In flow-through experiments that lasted for 6 h and during which there were repeated measurements, there was again a significant effect of cadmium exposure on the phototactic behavior of the animals. Irrespective of treatment, time had a significant effect. Results suggest that phototactic behavior can be used to detect sublethal concentrations of pollutant within a few hours, in short-term as well as in longer-lasting experiments with continuous flow-through and repeated stimulation of the animals. © 2000 Academic Press

Key Words: **phototactic behavior *Daphnia*; continuous biomonitoring; early warning systems; cadmium.**

INTRODUCTION

Recently, continuous monitoring of water quality has attracted growing attention, as it provides an early warning system (Chapman and Jackson, 1996). Several continuous biomonitors have been developed in which a physiological or behavioral response of a living organism is used as a variable to estimate overall water quality (Kramer and Botterweg, 1991; Schmitz *et al*., 1994; Chapman and Jackson, 1996). If rigorously standardized, behavioral criteria can be more sensitive and rapid indicators of stress than the morphological or life-history criteria used in traditional ecotoxicological tests (Charoy *et al*., 1995). Contrary to (semi) continuous chemical monitoring, the response of living organisms integrates overall water quality, since living organisms react to a multitude of chemical compounds at different levels (Chapman and Jackson, 1996). In addition, in using a biological response, bioavailability is automatically accounted for.

Daphnia has been found to be very sensitive to the presence of a large number of chemicals in the environment, and to respond to the presence of pollutants with a multitude of traits (e.g., Dodson and Hanazato, 1995). A number of authors have suggested the use of phototactic behavior of *Daphnia* for the detection of sublethal concentrations of toxic compounds (Flickinger *et al*., 1982; Di Delupis and Rotondo, 1988). Three biomonitors using behavioral traits in *Daphnia* have so far been developed. The monitor of Knie (1978) uses the swimming activity of *D. magna* to assess stress and the monitor developed by Kerren (1991) uses changes in phototactic behavior of *D. magna*. More recently, the *Daphnia* Toximeter, manufactured by BBE Moldaenke (1997) was developed. It uses an alarm analysis based on swimming velocity, swimming behavior, and growth observation for continuous detection of hazardous compounds. The Kerren (1991) monitor has been found to exhibit a very variable response, which reduces its reliability (Van Hoof *et al*., 1994). In a previous study (Michels *et al*., 1999), data were presented that indicated that the sensitivity of a biomonitor using phototactic behavior can be increased considerably by the use of specific clones of *D. magna*. The use of clonal test organisms increases standardization of ecotoxicity tests, because there is genetic variation in the sensitivity of *D. magna* to a number of pollutants (Baird *et al*., 1989, 1990). Michels *et al*. (1999) suggested the use of extremely positively phototactic clones of *D. magna* in a monitor, as these animals exhibit very typical behavior in the absence

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