Research

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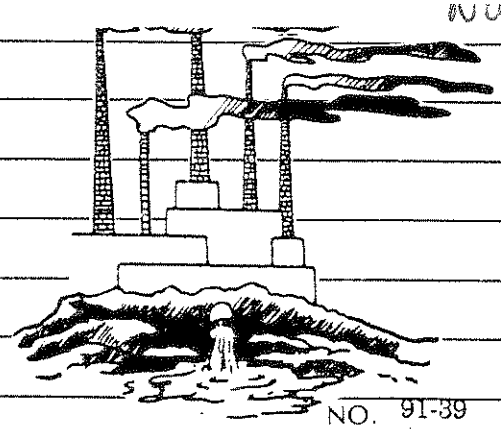

Cadmium Affects Respiration in Freshwater Mussels

Cadmium (Cd), a toxic metal found in the upper Mississippi River and other large rivers, adversely affects some aquatic organisms at concentrations as low as 0.8 µg/L. Even in waters that are moderately contaminated with cadmium, subtle biological effects may occur as a result of long-term, low-level exposure.

In marine bivalves, several physiological responses have been used to evaluate the toxicological effects of low-level exposure to contaminants. Application of such techniques to freshwater mussels has lagged, but could provide useful information on sublethal effects of certain environmental stressors. The respiration rate of freshwater mussels, defined here as the mass of oxygen consumed over time, is one sensitive physiological response that can be measured rapidly and inexpensively. We developed a static respirometer to experimentally evaluate the effects of sublethal concentrations of aqueous cadmium on respiration rates in adult pocketbook mussels *Lampsilis ventricosa*.

Respirometer Developed for Freshwater Mussels

Respirometers were constructed from 1.5-L glass canning jars (Fig. 1). The snap-on jar lids were modified for insertion of a dissolved oxygen probe (YSI Model 5739), which was connected to a YSI Model 51-B dissolved oxygen meter. Each respirometer contained a stir bar under a perforated plastic platform to circulate water evenly in the jar. The respirometers were placed in a water bath and maintained at 20° C during the test. Each mussel was cleaned with a toothbrush to remove any attached organisms, which consume oxygen, and placed in a respirometer. After a mussel began siphoning water, the concentration of dissolved oxygen was measured at 10-minute intervals until the percent saturation decreased to less than 65% or until a decrease of at least 1.5 mg O_2/L was observed. The hourly oxygen consumption rate (mg/L) of each mussel was calculated by subtracting the final dissolved oxygen concentration from the initial concentration and dividing the difference by the length of time over which the measurement was made.

Respiration Rates Reduced by Cadmium Exposure

Pocketbook mussels were exposed to cadmium (0, 30, 100, and 300 µg/L) in a continuous-flow diluter for 28 days. On days 0 (before cadmium exposure), 14, and 28 of the test, mussels were removed from this system for measurement of respiration. Data were analyzed by repeated measures analysis, which indicated that respiration rates did not differ over time ($p = 0.05$) in mussels exposed to each cadmium treatment.

Mean respiration rates (± 1 SE) were significantly lower in mussels exposed to 30 µg Cd/L (508 ± 44 µg O_2/h/g dry weight) and 300 µg Cd/L (388 ± 45 µg O_2/h/g dry weight) than in controls (563 ± 46 µg O_2/h/g dry weight). Mean respiration rates in control

mussels in this study were within the ranges reported elsewhere. Respiration rates in mussels exposed to 100 µg Cd/L (513 ± 46 µg O_2/h/g dry weight) differed marginally ($p = 0.056$) from controls and from mussels exposed to 30 µg Cd/L.

Many mussels responded to the higher cadmium levels by producing copious mucus. If the gill surfaces are coated with mucus, their capacity to sort and transport food may be reduced. This could eventually affect growth and survival.

Respiration Rate a Reliable Indicator

The measurement of respiration rate in the laboratory is a sensitive and reliable indicator of cadmium exposure in *L. ventricosa*. Lower rates of oxygen uptake indicate lower metabolic rates in many aerobic organisms, and it is possible that mussels respond to cadmium exposure by decreasing their metabolic rates. Thus, cadmium-stressed mussels may allocate energy to maintenance metabolism rather than to other vital processes such as growth and reproduction. In any case, it appears measurement of respiration rate provides an early physiological indication of sublethal contaminant stress in freshwater mussels. Moreover, the static respirometer described herein is an inexpensive, humane, and reliable means of obtaining such data.

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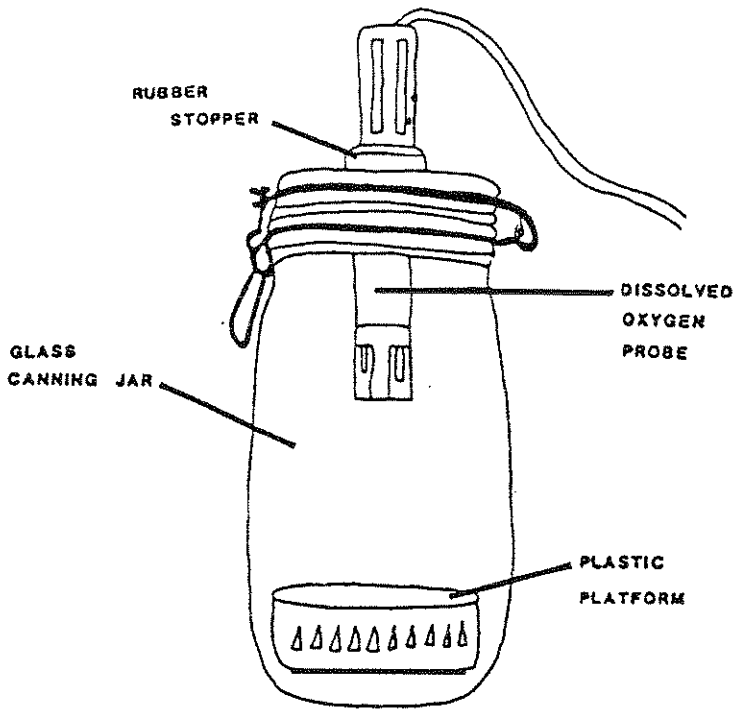

Fig. 1. Respirometer developed to measure respiration rates in freshwater mussels. A stir rod under the perforated plastic platform circulates water evenly.