Applied Organometallic Chemistry (1988) 2 181–184
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0268–2605/88/02212181/$03.50

SHORT PAPER

Uptake of mercury by caged crayfish*

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Received 5 November 1987 Accepted 18 December 1987

An *in situ* caged crayfish experiment was conducted in the Wabigoon River System, Ontario, Canada to determine the relative importance of food and water pathways for mercury accumulation in crayfish. Two groups of 160 crayfish were suspended in the water column; one at an uncontaminated site, the other at a location with highly elevated total mercury and methylmercury levels in water. Crayfish at each site were divided into two groups. Crayfish were fed either sucker flesh obtained from an uncontaminated lake (low mercury diet) or walleye flesh from contaminated Clay Lake, Ontario, Canada (high mercury diet). After 10 weeks crayfish at both sites fed the high mercury diet had over 20 times mercury accumulation compared to crayfish on the low mercury diet. There was no statistical effects due to sharply elevated water concentrations of total and methylmercury on mercury bodyburdens. This indicated that food was the dominant pathway for mercury accumulation in crayfish.

Keywords: Mercury bioaccumulation, crayfish, water, food.

INTRODUCTION

Although crayfish have been recognized as good indicators of mercury contamination in freshwater systems,[1,2] little is known about the relative importance of food and water pathways in the determination of total mercury bodyburdens. Most mercury in crayfish muscle is believed to be in the methyl form;[1] yet most mercury in the abiotic ecosystem compartments to which crayfish are exposed (water, suspended solids and sediments) is inorganic[3–5] The role of crayfish in aquatic communities has been described by Momot *et al.*[6] as 'polytrophic and a key energy transformer between various trophic links through utilization of all the trophic levels in lakes'.

*The views expressed are those of the authors and do not necessarily reflect the view of the Ontario Ministry of the Environment.

EXPERIMENTAL

To elucidate the relative importance of food and water components to the mercury bodyburden in crayfish we conducted, during the summer season, an experiment in which caged crayfish were exposed to different contaminated and uncontaminated waters and to varied diets of known mercury concentration levels. We collected 320 crayfish at one of our control sites upstream of any known industrial discharges of

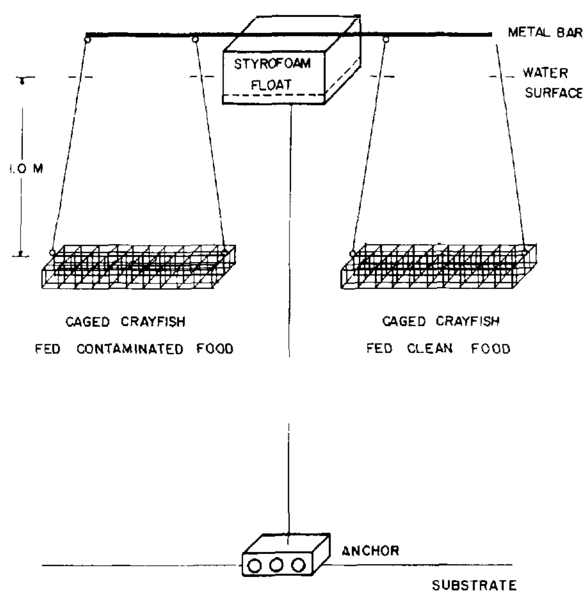

Figure 1 Apparatus used to suspend crayfish in the water column.

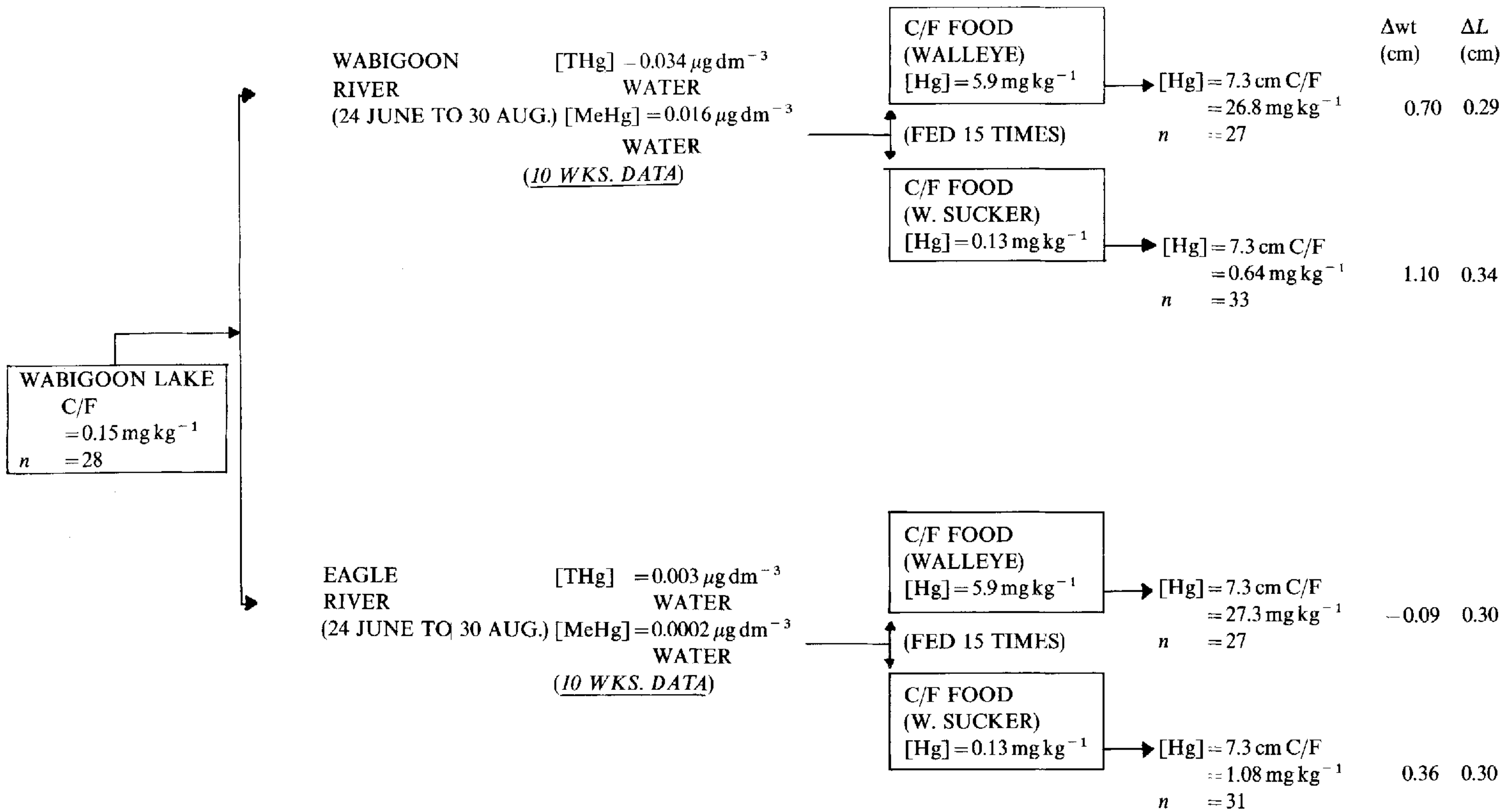

Figure 2 Schematic of crayfish experiment showing concentrations of mercury in crayfish (C/F) for different treatments, differences in crayfish weight (Δwt) and length (ΔL) before and at the end of experiments, and concentrations in unfiltered water of total mercury ([THg]) and methylmercury ([MeHg]) to which crayfish were exposed. [Hg] in crayfish was normalized for crayfish at a standard length of 7.3 cm.

mercury[5] (Wabigoon Lake) and divided them into four equal groups. Each crayfish was weighed and its length recorded. Each specimen was placed in a one-litre, numbered, compartment of a 40-compartment cage. Cages were constructed from galvanized steel, with the mesh coated with polyamide epoxy resin to prevent mercury adsorption. On 24 June, two groups (160 crayfish) were suspended 1 metre below the water surface from an anchored float (Fig. 1) in the Eagle River, a major uncontaminated tributary, 1 km upstream of the contaminated Wabigoon River. Two other groups of crayfish were exposed in similar fashion in the contaminated Wabigoon River, 2 km upstream of the inflow to Clay Lake. The water depth at each site was about 5 metres.

Every four days at each location, 80 crayfish were fed 2 g of white sucker flesh obtained from Wabigoon Lake and containing an average of 0.13 μg per g of mercury.[7] The other 80 crayfish at each site were fed 2 g of walleye flesh obtained from Clay Lake and averaging 5.9 $\mu g\, g^{-1}$ mercury.[7] On 30 August (i.e. after 68 days), surviving crayfish were weighed and measured. Abdominal muscles were removed from each specimen, placed in a labeled 'Whirl-Pak' plastic bag, and frozen. Twenty-eight Wabigoon Lake (control site) crayfish had been similarly processed on 24 June. Total mercury in the muscle samples was determined for both control and experimental crayfish and their food according to routine procedures used by the Ministry of the Environment.[7]

Water samples were collected weekly during the experiment and analyzed for total and methylmercury at the Freshwater Institute, Canada Fisheries and Oceans, Winnipeg, according to procedures published elsewhere.[8,9]

RESULTS AND DISCUSSION

Results from the caging experiment are summarized in Fig. 2. Mean mercury levels for each group were derived from geometric regressions of mercury concentrations on length, at a standardized fish length of 7.3 cm. At both test sites, mercury in crayfish fed on contaminated walleye flesh was many times higher than mercury in crayfish fed on near-uncontaminated sucker flesh. Mercury concentrations in crayfish were similar at each site on the same diet, whether or not the surrounding water was high or low in mercury. Contaminated waters with high mercury concentration had no statistical effect on mercury concentration in crayfish ($P > 0.05$). Other than a more rapid weight gain for Wabigoon crayfish compared with Eagle River crayfish, no other significant differences in length or weight could be detected (Fig. 2).

Water quality data for the two sites (Fig. 2) show that both total and methylmercury concentrations in the surrounding waters were much higher in the Wabigoon River than in the Eagle River. In this experiment, food and water were the only sources of mercury for the crayfish. Our data clearly show that food was by far the most important of these two sources. Little methylmercury was absorbed by crayfish from water at either site (see controls and data, Fig. 2) despite the large difference in mercury levels in the water at the two locations. Our findings generally agreed with those reported by Hamilton.[10] Both studies, however, revealed significant accumulation of mercury by crayfish even when fed 'uncontaminated' food containing about 0.1 μg per g of mercury. These findings suggest that the 'uncontaminated' food contained more mercury than food previously consumed by the crayfish in their natural habitat. This suggests that the crayfish diet **in nature** is not predominantly fish. This is supported by observing that caged crayfish fed contaminated fish flesh from Clay Lake had mercury concentrations about an order of magnitude greater than crayfish in Clay Lakes.

Acknowledgements We thank E Hansen and P Almost for assistance with the field study. This work was funded under the Canada Water Act.

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