United States Department of the Interior - United States Geological Survey Fact Sheet FS-184-96

Mercury and Periphyton in the South Florida Ecosystem

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BACKGROUND

Advisories warning against the eating of game fish due to high concentrations (0.5 to 1.5 parts per million) of mercury are common in areas of Florida. When concentrations of mercury in fish are reported, it is primarily the compound methylmercury (MeHg), a neurotoxin, that is assumed present. MeHg has caused neurological damage in people in Japan and Iraq who ate food tainted with mercury. The goal of this project is to answer the question, 'How does mercury produced in the aquatic environment of south Florida enter the food chain and become part of the body burden of animals such as game fish?'

This project is part of the South Florida Ecosystems Program. As part of the mercury studies in the Florida Everglades element, the findings of this project will contribute to an understanding of the processes that cause mercury bioaccumulation.

FIELD AND LABORATORY WORK

The assemblage of microalgae that live on shallow submerged substrates is referred to collectively as periphyton. These algae cover submerged parts of large aquatic plants (macrophytes) and form a thick carpet on the sediment in many locations in the south Florida ecosystem. Periphyton growth is responsible for the bulk of the primary production in the Everglades (Brock, 1970), and is home to, and food for, creatures that are the foundation of the food chain.

A conscious effort is made to sample periphyton from diverse sites in order to evaluate the patterns of mercury and MeHg distributions as they are affected by environmental conditions. Areas where periphyton samples have been collected are shown in figure 1.

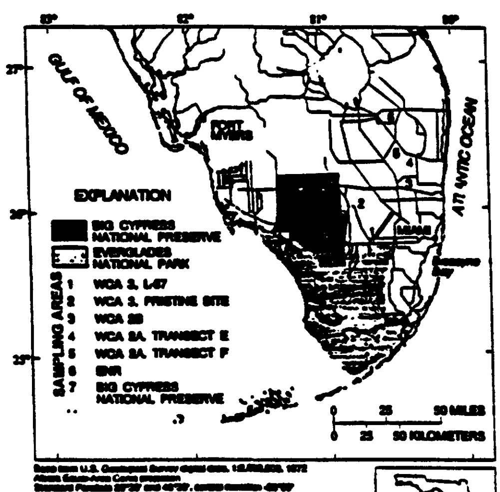

Figure 1. Map of south Florida showing the areas in which periphyton samples were collected in 1995.

PLANNED PRODUCTS

- Reports summarizing seasonal differences in mercury and MeHg concentrations in periphyton collected from sites in Water Conservation Area (WCA) 2A and WCA 3A.
- Reports summarizing the associated water-column parameters at the locations where periphyton is collected for mercury and MeHg analyses.
- Maps showing distributions of mercury and MeHg in the study areas.
- Journal articles on the topics of mercury transformations associated with periphyton mats.

PRELIMINARY FINDINGS AND ASSESSMENTS

Four observations can be made on the basis of data obtained from periphytic material collected in 1995:

- In laboratory experiments, the removal of MeHg from solution is related to the organic carbon content of plant material. Samples of utricularia (a macrophyte) that had no visible coating when collected, and samples of utricularia that had a visible periphyton coating, were used in the experiment
- The concentrations of MeHg in periphyton collected from field sites in south Florida are more closely related to the concentrations of nitrogen than to the concentrations of organic carbon in the samples (fig 2).

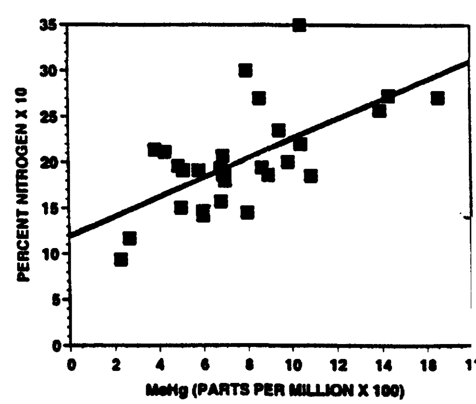

Figure 2. Methylmercury (MeHg) Concentrations and Percent Nitrogen in Periphyton Samples Collected in 1995 from the South Florida Ecosystem. (A linear regression equation is fitted to the data.)

- The concentration of total mercury in periphyton in the south Florida ecosystem decreases in a north to south direction. However, the concentration of MeHg in periphyton tends to increase from north to south.

- Factors related to water-column pH influence MeHg concentrations in periphyton at sites located in Water Conservation Area 2A or from within Big Cypress National Preserve. Figure 3 shows data from WCA 2A.

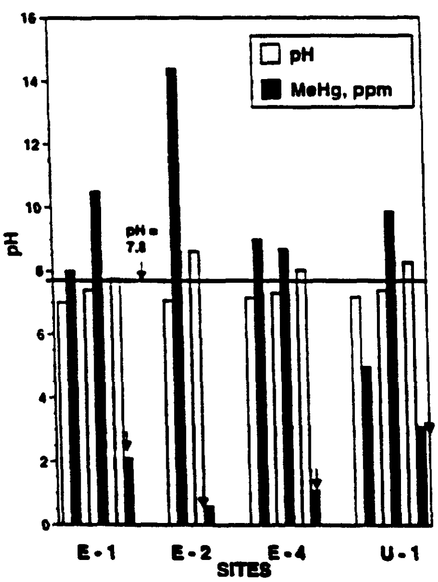

Figure 3. Relation of Concentration (parts per million, ppm) of Methylmercury (MeHg) in Periphyton to pH of Water Column in Samples Collected in WCA 2A, March, August, and December 1995. (Arrows indicate MeHg concentrations in periphyton when pH of the water column is greater than 7.8)

Why is MeHg found in the periphyton mats of south Florida? Could MeHg be produced in the periphyton mats? Methylation of mercury is a biological process in natural systems. It is an activity attributed to sulfate-reducing bacteria. Because sulfate-reducing bacteria cannot live in the presence of oxygen, one would not expect to find them in periphyton mats where algae are producing oxygen during photosynthesis. For sulfate-reducing bacteria to be active in the mats, microenvironments must be present where oxygen is depleted or absent. Bacteria are known to populate the areas around the heterocysts of cyanobacteria (common in the south Florida ecosystem) creating microzones or microenvironments where oxygen concentrations are depleted by bacterial metabolism. Oxygen levels in these microzones can range from subsaturated to anaerobic (oxygen absent) while surrounding waters appear oxygenated or even supersaturated with oxygen (Paerl, 1982).

FUTURE STUDY PLANS

Results of work up to this time indicate that the periphyton in the south Florida ecosystem is a reservoir of mercury and MeHg. However, the processes that occur within the periphyton involving the cycling of mercury have not been established and the bioavailabilty of MeHg in the periphyton to biota is unclear.

Preliminary results raise several interesting questions and point to the need to include several research activities in future work. Does MeHg found in the periphytic mats originate in the benthic sediment? Is MeHg produced in the periphyton? If MeHg is produced in periphyton mats, is the process related to a particular algal species? Are different processes occurring in different parts of the periphyton mats? Where are the biota with respect to active areas of mercury transformation in the periphyton mats? Algal species at collection sites need to be identified to examine the link among water-column parameters, plant variety, and mercury chemistry. Examination of the strata within the mats could provide insight into the mechanisms for mercury transformation in the mats and possible transport to, or from, the mats. Isotopic analyses for carbon and nitrogen can help to identify the entry points for MeHg into the food chain

Decisions on the management of the south Florida ecosystem are influenced by water levels and flow. If readily-measured water-column parameters indicate favorable conditions for mercury methylation, this information could result in modification of water-quality regulations and the amelioration of the "mercury problem" in the south Florida ecosystem.

COMPLETED AND ANTICIPATED ACTIVITIES

- March and August 1995 Field trip to collect periphyton from WCA 2A and WCA 3A.
- July 1995 Field trip to collect periphyton from the Big Cypress National Preserve.
- December 1995 Field trip to collect periphyton from WCA 2A, WCA 2B, WCA 3A, and the ENR area.
- June 1996 Field sampling trip to collec periphyton from WCA 2A, WCA 2B and WCA 3A for intensive analysis including collection of biota for identification and microscopic and chemical analyses of layers within the periphyton mats.
- August 1996 Paper to be presented at the American Chemical Society on mercury geochemistry in the periphytic mats of the south Florida ecosystem.
- Fall 1996 Collection of field samples t complete a description of mercury biogeochemistry processes that occur in periphyton collected on a north to south gradient in the south Florida ecosystem.
- Fall 1996 Prepare synthesis report of findings to date.

REFERENCES

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