PROCEEDINGS

OF THE

THIRTEENTH SYMPOSIUM

ON THE

NATURAL HISTORY OF THE BAHAMAS

Edited by
Jane Eva Baxter
and
Eric Stephen Cole

Conference Organizer
Thomas Rothfus

Gerace Research Centre
San Salvador Bahamas
2011

Cover photograph -- Amanda Rubasch and Anna Thomas of St. Olaf College

Printed at the Gerace Research Centre

ISBN 0-935909-93-3

MERCURY CONCENTRATIONS IN *PINCTADA LONGISQUAMOSA* AND *ISOGNOMON ALATUS* FROM ANCHIALINE LAKES ON SAN SALVADOR ISLAND, BAHAMAS

J.A. Easton[1], D.G. Rumbold[1], and R.B. Erdman[2]
[1]Department of Marine and Ecological Sciences, [2]Department of Biological Sciences
Florida Gulf Coast University
10501 FGCU Blvd, S.
Fort Myers, FL 33965-6565

ABSTRACT

Mercury contamination has become an area of growing concern in the fields of human as well as ecosystem health. Originating from both natural and anthropogenic sources, mercury transport and deposition can resonate on both a local and global scale and has the potential of bioaccumulating throughout the biota of many natural ecosystems. For the purpose of this research, 40 bivalves of two different species (*Pinctada longisquamosa*, n=20; *Isognomon alatus*, n=20) were collected from two anchialine lakes (Oyster Pond and Mermaid Pond) on San Salvador Island and analyzed for mercury content. Mean concentrations showed a significant difference between the two sampling sites with bivalves from Oyster Pond (mean = 0.052 ± 0.01 SD mg/kg) having higher levels than bivalves from Mermaid Pond (mean = 0.026 ± 0.01 SD mg/kg) in both species. Based on the Florida Everglades paradigm, this contamination was initially presumed to be a result of atmospheric deposition via global transport. However, findings from others may suggest the variation between the sites to be the result of mercury contamination from the Dixon Hill Lighthouse, located approximately 1.75 kilometers from Oyster Pond.

INTRODUCTION

Mercury is distributed in the environment as a result of both natural and anthropogenic emissions. Sources for natural presence of mercury and mobilization of mercury include geological processes such as erosion of rock and volcanic activity. Anthropogenic sources relate primarily to the redistribution of mercury from its natural origins (Rice *et al.*, 1997) and include a number of industrial processes such as mining, coal combustion, and smelting. The amount of mercury mobilized via these anthropogenic activities have been reduced substantially within the United States; however, mobilization and transport of mercury from elsewhere continues to contribute the global pool making mercury contamination essentially a local problem with global origins (Rumbold and Evans, in).

In South Florida, we know that atmospheric deposition is the leading source of high concentrations of mercury that have been observed in freshwater and estuarine fish species monitored in the Everglades (Axelrad *et al.*, 2008). The long-range transport of mercury is estimated to represent >50% of the mercury present in the Everglades due to atmospheric deposition (Guentzel *et al.*, 2001). While the Everglades offers an excellent example of how mercury transport, microbially mediated methylation, and ultimately biomagnification can resonate across an entire landscape, it is important to understand as well that this sort of dilemma happens on a global scale and effects many ecosystems and organisms.

This paper presents the results of a survey of mercury levels in bivalves on San Salvador Island, Bahamas. The two species chosen for analysis of mercury content were *Isognomon alatus* (Flat Tree Oyster) and *Pinctada longisquamosa* (Scaly Pearl oyster). Both *I. alatus* and *P. longisquamosa* are sympatric species in San Salvador Island's inland lakes (Figure 1) and can be conveniently sampled. Although there is no evidence that these bivalves are being consumed by the island's inhabitants and thus pose no real human threat, the observed levels of mercury can be used as an indicator of local ecosystem health.

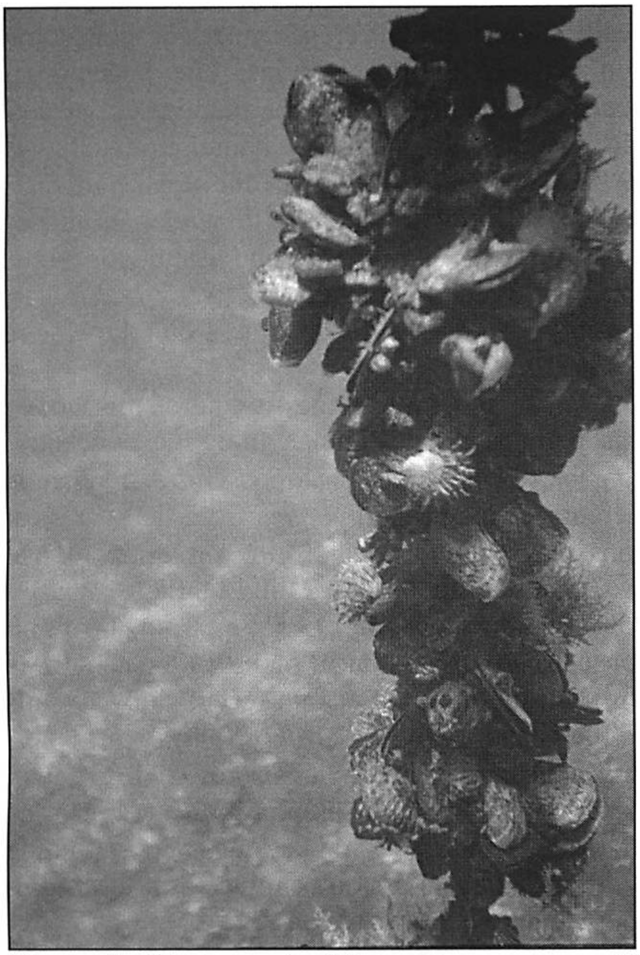

Figure 1. Photograph of P. longisquamosa and I. alatus collected from Mermaid Pond. Photo by R. Erdman.

METHODS

Collection of Bivalves

Bivalves, *P. longisquamosa* and, *I. alatus* were collected from Mermaid Pond and Oyster Pond for analysis of total mercury content. individuals of each species were collected from each study site totaling 40 oysters in all.

Mercury Analysis

Total tissue for each individual bivalve was analyzed for total mercury using a combustion-based mercury analyzer (Nippon Model MA-2000) located in the marine chemistry laboratory at Florida Gulf Coast University in Ft. Myers, Florida during the summer of 2008. Protocol for mercury analysis was based on EPA METHOD 7473 (US EPA METHOD 7473). Laboratory duplicates had a relative percent deviation (RPD) of <10.7% (n = 3 pairs); recoveries ranged from 108% from an internal reference material (i.e., sample of freeze dried fish) to 101% from the certified reference material, DORM-3 (National Research Council Canada).

Total mercury concentrations are reported in mg/kg on a wet weight basis.

Statistical Analysis

Data did not meet requirements for normality (using the Kolmogorov-Smirnov test with Lilliefors' correction; Sigmastat, version 3.5) or equality of variance (Levene Median test, Sigmastat, version 3.5) despite attempts at transformation; thus preventing a 2-way ANOVA. Accordingly, a Mann-Whitney Rank Sum Test was used to test for difference in concentration between locations and between species using Microsoft Analyse-it® software.

RESULTS

Between Species Comparison

Mercury concentrations averaged 0.031 ± 0.01 SD mg/kg in *I. alatus* and 0.047 ± 0.01 SD mg/kg in *P. longisquamosa* (Figure 2). This between-species difference was statistically significant (U=294.0, P<0.01).

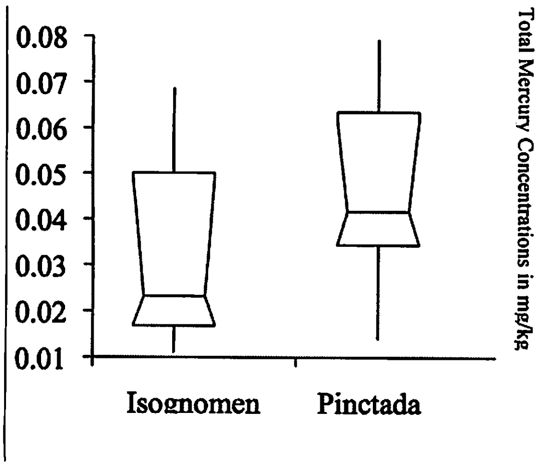

Figure 2. Box-and-whisker plot showing rank-sum distribution of total mercury concentrations present in both bivalve species.

Between Location Comparison

Average mercury concentration was 0.052 ± 0.01 SD mg/kg in bivalves from Oyster Pond and 0.026 ± 0.01 SD mg/kg in bivalves from Mermaid Pond (Figure 3). This difference in total mercury between locations was statistically significant (U=394.5, P<0.01).

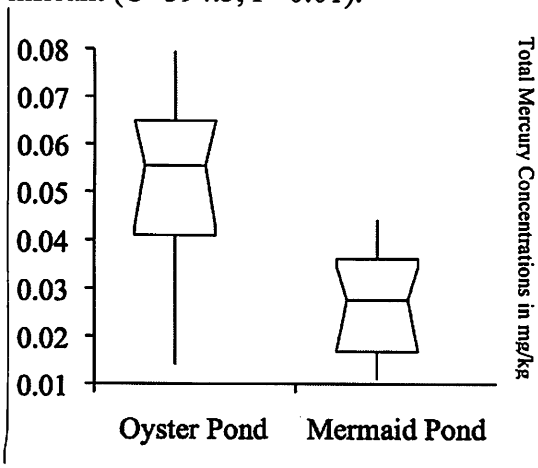

Figure 3. Box-and-whisker plot showing rank-sum distribution of total mercury concentrations present in bivalves from both sample sites.

DISCUSSION AND CONCLUSION

Quantitatively assessing the relative contributions of anthropogenic and natural emissions to the methylmercury burdens accumulated in biota has proven to be a difficult undertaking within the scientific community due to numerous sources and an array of confounding factors. Such confounding factors include spatial variation both in terms of sources as well as the biogeochemistry that transforms mercury as it is transported across a landscape (Wiener *et al.*, 2003).

Results from this survey indicated a statistically significant difference in tissue concentration between the two species. This variation is likely attributable to one of a number of species-specific physiologicalor behavioral traits (Bayne, 1998). Such traits can affect the uptake of mercury from the environment as they relate primarily to an individual's ingestion and assimilation rate, size, and general propensity to bioaccumulate mercury (Najdek and Sapuner, 1998, Fowler *et al.*, 1978).

The most intriguing finding of this survey was perhaps the difference in tissue concentrations between the two locations.This difference in mercury levels in the bivalves from the two locations may be explained by the proximity of the two ponds to the Dixon Hill Lighthouse Oyster Pond was located only 1.75 km from the lighthouse whereas Mermaid Pond was located 15.86 km from the lighthouse. In a recent study of soils on the island, Schwabe *et al*, (2008) reports mercury concentrations ranging from 0.018 to 0.060 mg/kg (n=5) in soil samples collected nearthe Dixon Hill Lighthouse. They also report finding 37.2 mg Hg/kg in a stool sample from the Lighthouse keeper's dog.

Built in 1856, Dixon Hill Lighthouse utilizes a mercury bath as a means of keeping its twin lens lighting system afloat (Cowen, 2002). It is common practice to utilize mercury baths as a low friction rotation mechanism in lighthouses (van Netten *et al.*, 1988). This may be the point source for the presence of mercury in oysters sampled from Oyster Pond and Mermaid Pond in this study as well as the soil and stool analyzed by Schwabe *et. al.*, (2008). The significant difference between the two locales may be evidence of disproportionate mercury loading into the ponds in close proximity to Dixon Hill Lighthouse or other environmental factors effecting methylation or uptake by biota within these actual bodies of water.

Further large-scale surveys of mercury levels in local biota on San Salvador would be recommended as a way of gaining better insight into how the Dixon Hill Lighthouse may be affecting the local landscape.

ACKNOWLEDGMENTS

We would like to thank Dr. Donald T. Gerace, Chief Executive Officer, and Tom Rothfus, Executive Director of the Gerace Research Center, San Salvador, Bahamas for their support. Additional thanks go to Dr. Stephanie Schwabe of the Robert Palmer Blue Holes Foundation, and Dr. Billy Gunnels, Dr. Randy Cross, and Jessica Elliot of Florida Gulf Coast University.

REFERENCES

Axelrad, D.M., Lange, T., Gabriel, M., Atkeson T.D., Pollman, C.D., Orem, W.H.,Scheidt, D.J., Kalla, P.I., Frederick, P.C., and Gilmour, C.C. 2008. Mercury and sulfur monitoring, research and environmental assessment in south Florida.Volume I: *The South Florida Environment*, Chapter 3B. Available online [https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_SFER/PORTLET_SFER/TAB2236041/VOLUME1/chapters/v1_ch_3b.pdf]

Bayne, B.L. 1998. The physiology of suspension feeding by bivalve mollusks: an introduction to the Plymouth "TROPHEE" workshop. *Journal of Experimental Marine Biology and Ecology*, 219, 1-19.

Cowen, C., Overview of San Salvador Island, Carleton Geology Department, 2002, Carleton University, 11 April 2009. http://www.carleton.edu/departments/GEOL/RelatedPrograms/bahamas/info/overview.html.

Fowler, S.W., Heyraud, M., and La Rosa, J. Factors effecting methyl and inorganic mercury dynamics in mussels and shrimp. *Marine Biology*, 46, 267-276.

Guentzel J.L., Landing, W.M., Gill, G.A., and Pollman, C.D. 2001. Processes influencing rainfall deposition of mercury in Florida. *Environmental Science Technology*, 35, 863-873.

Najdek, M. and Sapuner, J. 1987. Total and methyl mercury content in bivalves, *Mytilus galloprovincialis* Lamarck and *Ostrea edulis* Linnaeus: Relationship in biochemical composition and body size. *Bulletin of Environmental Contamination and Toxicology*, 39, 56-62.

Rice, G.E., Ambrose, R.B., Bullock, O.R., and Swartout. J. 1997. Mercury Study Report to Congress. Volume III: fate and transport of mercury in the environment. Office of Air Quality Planning and Standards, and Office of Research and Development; U.S. Environmental Protection Agency.

Rumbold, D.G., and Evans, D. 2008. Mercury contamination: a global issue with local impacts. Invited paper. NOAA/USEPA Synthesis Report on Scientific Knowledge of the South Florida Marine Ecosystem (In Press.).

Schwabe, S.J., Cathcart, E.M., and Carew, J.L., 2008, Elevated levels of heavy metals detected in modern soils and flooded-cave sediments from the Bahamas, *Proceedings of the 14th Symposium on the Geology of the Bahamas and other carbonate regions* (In Press).

US EPA METHOD 7473: Mercury in solids and solutions by thermal decomposition, amalgamation, and atomic absorption spectrophotometry – Feburary 2007. Available online [http://www.epa.gov/waste/hazard/testmethods/sw846/online/7_series.htm]

van Netten C, Teschke K.E., 1988, Assessment of mercury presence and exposure in a lighthouse with a mercury drive system. *Environmental Research.* Feb;45(1):48-57.

Wiener, J.G. *et al,*. 2003, *Ecotoxicology of mercury.* Pp. 409-461 in Hoffman, DJ, *et al.*, eds) Handbook of Ecotoxicology, 2nd ed. Lewis Publishers, New York.