RESULTS OF TOTAL MERCURY ANALYSIS IN SALT MARSH INVERTEBRATES

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INTRODUCTION

Analysis of blood samples obtained from saltmarsh sparrows revealed high levels (> 1.0 μg/g(wet)) of mercury (Hg) in sparrows inhabiting a salt marsh site in the Narrow River, RI (also known as Pettaquamscutt River). These analyses were conducted by Oksana Lane at the Biodiversity Research Institute, Gorham ME (Lane and Evers, 2007). We were contacted by Ms. Suzanne Paton (U.S. Fish and Wildlife Service) to assist in the determination of the possible causes of these elevated Hg concentrations. The prey of these birds include primarily insects, spiders and marine invertebrates (http://www.allaboutbirds.org/guide/Saltmarsh_Sparrow/lifehistory); therefore, we collected insects and spiders from the Narrow River site in addition to three other salt marshes located in southern Rhode Island (Sachuest Point National Wildlife Refuge in Middletown, RI; Sapowet Management Area, Tiverton, RI; and Round Marsh, Jamestown, RI). Our goal in this study was to determine whether the Hg concentrations in samples of insects and spiders from the Narrow River salt marsh were elevated relative to those found at the other locations.

METHODS

The four salt marsh sites were sampled in August-October, 2005. Samples were obtained by sweep nets, jars and the use of a gas-powered, handheld leaf blower/vacuum modified by placing a mesh bag between the two piece intake funnel. The vacuum simplified collection of invertebrates from large areas of the marsh surface relatively quickly. For example, a 3x10m area of marsh surface, including marsh grasses and wrack, could be sampled in 10 minutes using the vacuum collection. Approximately 60 minutes of sampling was done using the vacuum at each marsh site. After collection, samples of invertebrates were put in Ziplock® bags labeled with the collection date, marsh location, and grass zone of the collection within the marsh (e.g. *Spartina alterniflora*). Bagged samples (invertebrates and associated debris) were also recorded by site and date in a waterproof field notebook and then transported back to U.S. EPA Atlantic Ecology Division in Narragansett, RI. At the laboratory, sample data were logged into a Log Book of Field Samples, and samples were assigned a unique identifier. Samples were then stored in a freezer pending sorting. Insects and spiders were picked from samples of grass, allowed to air dry to constant weight, separated and stored in glass vials.

Samples of insects were identified by Dr. Richard Casagrande at the University of Rhode Island, Kingston, RI. However, attempts to locate an expert to identify the spiders collected at the marsh sites were unsuccessful. These samples were identified by the author using field guides (National Audubon Society 2005, Borror andWhite 1970) and have been photographed for later identification if more detailed identifications are required.

At some sites collections included large golden orb spiders and preying mantes, however, for statistical comparisons, we selected groups of insects and spiders that were common to all four marsh sites. This approach excluded some organisms (e.g. golden orb spiders and preying mantes) from inclusion in the statistical analyses. Further, the collections used in the statistical comparisons were by marsh and were combined from different grass zones. The organism groups used in the statistical comparisons were, spiders (small brown spiders occupying marsh wrack and grass zones) (excluding golden orb spiders), picture-winged flies (*Chaetopsis sp*.), grass bugs (Miradae - *Trigonotylys uhleri*) and various diptera (flies) (Table 1).

Except for large organisms (golden orb spiders and praying mantes - which were ground individually) samples consisted of numerous organisms from collections. Prior to analysis samples were ground to a fine powder using a mortar and pestle and placed into labeled vials. Aliquots of these samples were analyzed for total mercury concentration using a Milestone Direct Mercury Analyzer (DMA 80) using established laboratory operating procedures which were developed from USEPA method 7473 (US EPA 1998). The limit of detection for these analyses was 1.0 ng/g. Data groups were analyzed by a two-way ANOVA and t-tests were performed where statistical differences were found. The level of difference considered to be significant was $p<0.05$.

RESULTS AND DISCUSSION

The means of Hg concentrations in samples included in the statistical analyses showed spiders had the highest concentrations followed by flies, picture-winged flies and grass bugs (Table 1). The results of the two-way ANOVA showed no significant differences in Hg concentrations among sites, but there were significant differences among organism groups within sites. There was no site and organism group interaction. The t– tests showed significant differences among organism groups at three marshes: Narrow River (spiders vs. picture-winged flies, spiders vs. grass bugs, grass bugs vs. flies), Sepowet (spiders vs. flies, spiders vs. grass bugs) and Sachuest (spiders vs. grass bugs, spiders vs. flies, spiders vs. picture-winged flies). No differences among organism groups were found at Round Marsh.

Organisms not collected at all sites, but common to two or more sites showed that predatory invertebrates (golden orb spiders and praying mantes) contained the highest Hg concentrations and herbivorous leaf hoppers had the lowest concentrations (Table 2).

The statistical comparisons suggest that the Hg concentrations in the Narrow River salt marsh are not elevated relative to those in the other three marsh sites. Therefore it appears that the high Hg concentrations found in the saltmarsh sparrows from the Narrow River marsh may have resulted from consumption of prey at other locations. However, this study did not determine whether differences in prey of the sparrows varied among sites. If selective feeding (e.g. preferential consumption of golden orb spiders and praying mantes) occurred at the Narrow River marsh it could have caused the elevated Hg concentrations in the blood of the sparrows.

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Table 1. Hg concentrations, locations and sample dates for invertebrates collected in all four marshes.

Sites	Date	Group	[Hg] ng/g (dry)	mean	stdev	max	min	n
Narrow R.	8/29/2005	spiders	58.9	79.3	18.5	94.8	58.9	3
Narrow R.	8/29/2005	spiders	84.4					
Narrow R.	8/29/2005	spiders	94.8					
Round Marsh	9/1/2005	spiders	94.8	116.1	30.1	137.5	94.8	2
Round Marsh	9/1/2005	spiders	137.5					
Sachuest	8/31/2005	spiders	66.2	88.3	17.7	118.2	66.2	7
Sachuest	10/3/2005	spiders	73.3					
Sachuest	8/31/2005	spiders	77.3					
Sachuest	8/31/2005	spiders	89.7					
Sachuest	10/5/2005	spiders	96.2					
Sachuest	10/3/2005	spiders	97.1					
Sachuest	10/5/2005	spiders	118.2					
Sepowett	9/27/2005	spiders	77.4	127.7	51.4	196.7	77.4	5
Sepowett	9/27/2005	spiders	93.3					
Sepowett	9/21/2005	spiders	104.4					
Sepowett	9/21/2005	spiders	166.9					
Sepowett	9/27/2005	spiders	196.7					
Narrow R.	8/29/2005	picture-wing fly	20.0	38.5	20.4	60.3	20.0	3
Narrow R.	8/29/2005	picture-wing fly	35.1					
Narrow R.	8/29/2005	picture-wing fly	60.3					
Round Marsh	9/1/2005	picture-wing fly	23.6	23.6		23.6	23.6	1
Sachuest	8/31/2005	picture-wing fly	12.0	30.5	26.2	49.1	12.0	2
Sachuest	8/31/2005	picture-wing fly	49.1					
Sepowett	9/21/2005	picture-wing fly	21.1	21.1		21.1	21.1	1
Narrow R.	8/29/2005	grass bugs	2.0	9.0	8.4	18.4	2.0	3
Narrow R.	8/29/2005	grass bugs	6.6					

Narrow R.	8/29/2005	grass bugs	18.4					
Round Marsh	9/1/2005	grass bugs	12.9	12.9		12.9	12.9	1
Sachuest	8/31/2005	grass bugs	4.2	5.1	1.3	6.0	4.2	2
Sachuest	8/31/2005	grass bugs	6.0					
Sepowett	9/27/2005	grass bugs	7.5	8.2	1.0	8.9	7.5	2
Sepowett	9/21/2005	grass bugs	8.9					
Narrow R.	8/29/2005	var. diptera	44.7	48.7	5.6	52.6	44.7	2
Narrow R.	8/29/2005	var. diptera	52.6					
Round Marsh	9/1/2005	var. diptera	32.6	44.0	16.2	55.5	32.6	2
Round Marsh	9/1/2005	var. diptera	55.5					
Sachuest	8/31/2005	var. diptera	16.6	38.1	30.5	59.7	16.6	2
Sachuest	8/31/2005	var. diptera	59.7					
Sepowett	9/27/2005	var. diptera	38.6	41.0	3.4	43.4	38.6	2
Sepowett	9/21/2005	var. diptera	43.4					

Table 2. Additional organisms collected at the marsh sites.

Site	**Date**	**Group**	**[Hg] ng/g (dry)**
Sachuest	10/2/2005	golden orb spider	331.0
Sachuest	10/3/2005	golden orb spider	264.0
Sepowett	9/27/2005	golden orb spider	77.9
Narrow R.	8/29/2005	leaf hoppers	11.3
Round Marsh	9/1/2005	leaf hoppers	5.9
Sachuest	8/31/2005	leaf hoppers	5.5
Narrow R.	8/29/2005	crickets	22.8
Sachuest	10/5/2005	crickets	45.4
Sachuest	10/5/2005	crickets	50.3
Sepowett	9/27/2005	crickets	24.8
Round Marsh	9/1/2005	crane fly	28.4
Round Marsh	9/1/2005	crane fly	35.4
Sachuest	8/31/2005	crane fly	106.5
Narrow R.	8/29/2005	mantis	102.6
Narrow R.	9/21/2005	mantis	168.5
Sepowett	9/21/2005	mantis	81.7