

## NOTE

### Occurrence of Mercury in Periodical Cicadas (*Magicicada: Cassini*)<sup>1</sup>

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An analysis of soil-dwelling, herbivorous seventeen-year periodical cicadas [*Magicicada septendecim* (L.), *M. cassini* (Fisher), and *M. septendecula* (Alexander & Moore)] from Brood X in Cincinnati, OH, has revealed the presence of mercury in concentrations ranging from 0.01-4.46 ppm. Previous research on mercury contamination (USEPA, 1997, EPA-452/R-97-005) has focused on aquatic life forms and water-based transport mechanisms. After 0.17 ppm mercury was discovered in shark muscles (Thieleke 1973, Ph.D. Diss., Univ. Wisconsin, Madison) and 0.128 ppm was found in yellowfin tuna (Kraepiel et al. 2003, Environ. Sci. Tech. 37: 5551-5558), numerous additional studies confirmed the presence of mercury in both piscivorous and herbivorous fish (USEPA, 2005, EPA-823-F-05-004.) Aquatic insects such as dipterans, ephemeropterans, trichopterans, heteropterans, coleopterans, and odonates (Tremblay et al. 1996, Water Qual. Res. J. Can. 31: 851-873) also contained mercury.

The presence of mercury in cicadas was confirmed through 3 USEPA-approved procedures using acid digestion. The 3 methods were: ASTM D6784-02, the Ontario Hydro Method (OHM); the USEPA Standard Operating Procedure HC520B.SOP; and USEPA Method PP-006. Reagents and cicadas were combined into 100 ml Teflon® perfluoroalkoxy resin polymer (TPFA) digestion vessels according to the referenced procedures and processed overnight in a water bath. The aliquots were analyzed by cold vapor atomic absorption spectroscopy (CVAAS, Model 400A Mercury Analyzer, Buck Scientific, Inc., East Norwalk, CT). The detection limit was ~0.01 µg.

Table 1 contains the results of the analysis of cicadas and discarded exuviae. The smallest cicada, a *M. cassini* male, weighed 0.14 g. The largest cicada, a *M. septendecim* female, weighed 1.03 g. On average, the cicadas weighed 0.5 g and exuviae weighed 0.2 g. Any aliquot containing exuviae contained more than 1. The first batch

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**Table 1. Mercury analysis of Ohio cicadas using various digestion methods**

Species	Collection site (latitude, longitude)	Digestion method	Sample weight (g)	Total mercury ( $\mu\text{g}$ )	Mercury concentration ( $\text{ppm}_w$ )
Mixed	N39° 11.7503', W84° 26.344'	OHM	1.01	0.110	0.11
Mixed	N39° 10.290', W84° 30.481'	OHM	1.10	0.205	0.19
Exuviae	N39° 13.6178', W84° 29.5912'	OHM	0.51	0.022	0.04
Mixed	N39° 11.7503', W84° 26.344'	USEPA SOP	5.16	0.093	0.02
Mixed	N39° 11.7503', W84° 26.344'	USEPA SOP	4.41	0.230	0.05
Mixed	N39° 13.6178', W84° 29.5912'	USEPA SOP	3.90	0.630	0.16
Exuviae	N39° 13.6178', W84° 29.5912'	USEPA PP-006	1.01	4.501	4.46
<i>M. cassini</i>	N39° 11.7503', W84° 26.344'	USEPA PP-006	0.68	0.050	0.07
<i>M. cassini</i>	N39° 12.0787', W84° 32.6061'	USEPA PP-006	0.67	0.075	0.11
<i>M. cassini</i>	N39° 12.9136', W84° 28.4157'	USEPA PP-006	0.43	0.025	0.06
Exuviae	N39° 13.6178', W84° 29.5912'	USEPA PP-006	0.31	0.929	3.02

of fresh cicadas, processed according to OHM, revealed a higher concentration of mercury in the discarded exuviae than in the adult insect. The EPA SOP confirmed the presence of mercury. To verify the above results, a third batch was processed according to EPA PP-006 using cicadas, which had been frozen at  $-20^{\circ}\text{C}$  for 2 wks. Again, a higher concentration of mercury was noted in the exuviae. The reasons for this variation have not been determined.

Considering the 3 methods, USEPA PP-006 permits information about each cicada to be retained. OHM requires a smaller amount of reagent for each gram of tissue; therefore, it is possible to digest more than 1 cicada in each digestion vessel. The highest correlation between cicada weight and mercury content,  $R^2 = 0.5844$ , existed in aliquots containing a single cicada and the reagents specified in Method PP-006. For the OHM, the  $R^2 = 0.4573$ . The regression correlation coefficient for the USEPA SOP was  $R^2 = 0.3082$ .

There appears to be no significant correlation between cicada weight and mercury bioaccumulation. However, the location of the insect appears to have influenced the mercury concentration. For example, the concentrations in cicadas collected from site N39°13.6178', W84°29.5912' for both insects and exuviae were higher than those from the other sites (Table 1).