

Mercury exposures in university herbarium collections

Until the early 1960s, mercuric chloride was used in the United States for the preservation of plant specimens in herbarium collections. Collections that contain specimens treated with mercuric chloride can possibly expose herbarium employees and visitors to mercury. The herbaria at two large public universities were evaluated for mercury levels in air and on surfaces. Airborne mercury levels briefly exceeded the OSHA ceiling limit when opening specimen storage cabinets that housed older specimens. Peak levels slowly dissipated as the mercury vapor that had sublimated off the specimens and become trapped inside the cabinets mixed with the ambient air. These results indicate that mercuric chloride continues to sublimate off herbarium specimens 50 or more years after their last treatment. Mercury contamination on specimen viewing tables was also found. For institutions that maintain herbaria with specimens dating to the 1960s or earlier, protective measures such as engineering controls, training, limited access, and personal protective equipment might be necessary to reduce mercury exposures.

**By W. Brent Webber,
Lorie Jayne Ernest,
Srikanth Vangapandu**

BACKGROUND

Herbarium collections are present in many universities, museums, and archives, and consist of dried and treated plant specimens generally mounted on backing paper. In order to preserve specimens from consumption by pest insects such as the cigarette beetle, plant specimen curators have used various chemical preservatives. Mercuric

W. Brent Webber, MSPH, CIH, CSP is affiliated with the University of Kentucky, Environmental Health & Safety, 252 East Maxwell Street, Lexington, KY 40506-0314, United States (Tel.: 859 257 7600; fax: 859 257 8787; e-mail: brent.webber@uky.edu).

Lorie Jayne Ernest is affiliated with the University of Kentucky, Environmental Health & Safety, Lexington, KY, United States.

Srikanth Vangapandu is affiliated with the University of Kentucky, Environmental Health & Safety, Lexington, KY, United States.

chloride (HgCl_2), also known as mercury(II) chloride, is an inorganic form of mercury that was formerly used in the preservation of specimens due to its lethality to all insects known to devour plant collections.¹ However, it was also highly toxic and capable of sublimation, resulting in airborne exposures and also the necessity to periodically re-treat the specimens. Inhaled elemental and inorganic mercury can cause dyspnea, pneumonitis, bronchitis, and edema, along with central nervous system damage leading to mental and motor disorders. Ingested or absorbed mercury can also damage the liver, kidneys, and reproductive systems. All forms of mercury exposure can lead to fetal developmental toxicity, primarily through damage to the developing brain.

The lowest published toxic concentration of mercury in humans is $150 \mu\text{g}/\text{m}^3$ as a daily time-weighted average.² At this level, gastrointestinal effects (diarrhea and hypermotility) and behavioral effects (anorexia, insomnia) were observed. To quantify the potential hazard from exposures to inorganic and elemental mercury, the American Conference of Governmental Industrial Hygienists (ACGIH) evaluated existing data and published a Threshold Limit Value (TLV, a non-binding but recommended eight-hour

daily exposure limit) of $25 \mu\text{g}/\text{m}^3$, with a “skin” notation to indicate that dermal absorption is a potential exposure route.³ This level was set to minimize the risk of preclinical central nervous system changes and kidney effects, and to provide a margin of safety for workers who might want to bear children.³

Widespread use of mercuric chloride for herbarium preservation in the United States ceased in the early 1960s. This was due to its known toxicity plus the brittling effect the compound had on plant specimens.¹ Several older herbarium collections still contain mercury-treated specimens. At the two herbaria examined for this study, specimens from as recently as 1962 still contained mercuric chloride. The purpose of the present study is to determine whether herbarium specimens treated with mercuric chloride continue to expose curators to hazardous levels of sublimated mercury several decades after their last application, and whether surface contamination is another potential exposure route.

METHODS

Levels of airborne and surface mercury were measured in the state herbarium collection sites at two large, public research universities in the Southeast-

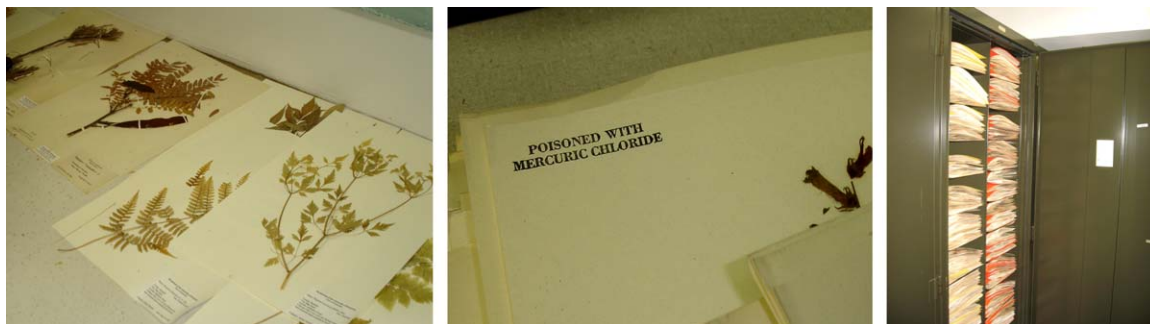


Figure 1. Left: Preserved herbarium specimens. Center: Stamp indicating that specimen was treated (“poisoned”) with mercuric chloride. Right: Storage cabinet containing hundreds of specimens.

ern United States. Both collections contained a substantial number of specimens that had received mercuric chloride treatment, and specimens were stored in indexed metal cabinets (Figure 1). For both locations, real-time airborne spot monitoring was performed using Ohio-Lumex RA-915+ Mercury Analyzers. These are highly sensitive atomic absorption spectrophotometers, with a lower limit of detection of two nanograms per cubic meter air. Both instruments were within the span of their annual factory calibrations, and user serviceability tests recommended by the manufacturer were completed prior to field use. Spot monitoring was performed at the entrance doors to specimen cabinets, as the cabinets were opened. Long-term sampling of ambient mercury levels was conducted per NIOSH Method 6009,⁴ using sampling pumps with Hydrar media and pre-filter. Pumps were pre- and post-calibrated with a primary flow meter (Bios Dry-Cal) at a rate of 0.25 L/min. A combination of personal and area sampling was performed, based on the availability of herbaria personnel on the day of sampling. For personal samples, media were affixed near the breathing zone at the lapel. Wipe sampling for surface mercury contamination was conducted in accordance with accepted industrial hygiene practice.

RESULTS

Table 1 shows the results of airborne spot monitoring performed at each university herbarium. These results

are presented separately because a different RA-915 instrument was used at each location. The upper limit of detection for the RA-915 used at Site 1 was $50 \mu\text{g}/\text{m}^3$, while the upper limit of detection for the RA-915 used at Site 2 was $100 \mu\text{g}/\text{m}^3$. Measurements were conducted over the course of one minute, with the peak level documented. At both sites, the peak levels of airborne mercury occurred within the first five seconds of opening specimen storage cabinets. Over the course of the one-minute sampling period, peak levels slowly dissipated as the mercury vapor from the specimens that had been trapped inside the cabinets mixed with the ambient air.

At Site 1, the peak mercury exposure levels when opening specimen storage cabinets exceeded the instrument's

upper limit of detection of $50 \mu\text{g}/\text{m}^3$ for 2 of 12 sampled cabinets. In order to estimate the average peak level in the sampled cabinets, the readings that were above the upper limit of detection were conservatively set at $50 \mu\text{g}/\text{m}^3$. The mean level and 95% confidence interval at Site 1 was $22.02 \pm 5.33 \mu\text{g}/\text{m}^3$. At Site 2, peak mercury exposure levels when opening specimen storage cabinets exceeded the instrument's upper limit of detection of $100 \mu\text{g}/\text{m}^3$ for 8 of 15 sampled cabinets. When readings above the upper limit of detection were conservatively set at $100 \mu\text{g}/\text{m}^3$, the mean level and 95% confidence interval at Site 2 was $72.31 \pm 8.99 \mu\text{g}/\text{m}^3$.

The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) set a ceiling limit for

Table 1. Results of Airborne Spot Mercury Monitoring at the Two Herbarium Sites.

Site 1		Site 2	
Cabinet Number	Mercury Level ($\mu\text{g}/\text{m}^3$)	Cabinet Number	Mercury Level ($\mu\text{g}/\text{m}^3$)
66	9.8	4	30.0
112	2.2	7	18.1
126	39.5	10	66.5
127	20.9	12	>100
128	>50	15	76.9
129	44.9	20	>100
130	>50	24	23.0
131	11.1	27	>100
190	7.3	30	>100
213	11.1	33	14.3
231	9.6	34	>100
255	7.8	37	>100
		40	>100
		42	>100
		44	55.9

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