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Detecting Heavy Metals in Feathers Using an Electron Probe Microanalyzer: Can It Be Done?

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Using birds as environmental indicator species and analyzing their feathers for accumulated toxic elements is a well-established protocol [1]. A robust literature review indicates a number of studies have attempted to address the distribution of external versus internal metal contamination of feathers [2, 3, 4]. However, traditional methods, such as atomic absorption spectroscopy, atomic emission spectroscopy, GC-MS, and ICP-MS, condense and consume the entire sample during analysis; thereby, creating two fundamental issues: (1) it is difficult to differentiate findings between bioaccumulation inside and atmospheric deposition on the outside of feathers, and (2) these methods destroy the sample; thus, they are not available for subsequent analyses. Consequently, my work explores the applications of an innovative avian ecotoxicology research technique of using an electron probe microanalyzer (EPMA) to detect, spatially describe, and quantify the internal and external variation of heavy metals in feathers. An extensive literature review indicates that this research approach has not been investigated previously, and therefore, is indeed pioneering. This proof of concept study attempts to expand the current literature by employing novel techniques and procedures; thus, the research objectives are two-fold: (1) to determine if and how feathers could be mounted for electron probe microanalyses; and (2) to determine if heavy metals may be detected in a feather sample using wavelength dispersive spectroscopy (WDS). Primary flight feathers were obtained through the mist netting of live birds known to be nesting and foraging in habitats found within an EPA listed Superfund site in North Carolina. To limit the variables for this proof of concept study, flight feathers were only sourced from the adult Carolina Wren (*Thryothorus ludovicianus*) and analyses were performed on feathers collected from a single bird (band #: 1481-49102).

To first verify whether a feather could be sufficiently mounted for analysis using a JEOL JXA 8530F HyperProbe, five 3-4cm segments were cut from a single feather and each of the five segment samples were individually mounted in an epoxy cell and allowed to harden for 24 hours. After curing, each prepared epoxy cell was hand-polished using grit paper, as well as felt and silk to provide a smooth sample surface prior to carbon coating and WDS analysis. Mounting and polishing a sample is as much art as it is science and must be done accurately to obtain quality analytical results. Prior to analyses, the HyperProbe detectors were standardized using lead metal, skutterudite, cinnabar, and cadmium metal. Samples were analyzed at an accelerating voltage of 7 kV and a beam current of 50 nA. Findings showed that feather samples mounted in an epoxy resin could be analyzed using a JEOL JXA 8530F HyperProbe. Additionally, the presence of arsenic, mercury, lead, and cadmium were detected and spatially displayed in detailed images using WDS analyses. Continued exploration of this analytical method applied to feathers is needed to refine procedures for quantifying amounts of detected elemental x-rays. It is also reasonable to broaden research methodologies and applications to include interdisciplinary concepts such as the identification of trace elements as biochemical markers for species dispersal, technique application to other fur

bearing wildlife species, and remote sensing/GIS analyses of social, economic, spatial and temporal environmental factors.

References

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