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Bioaccumulation of mercury in Wilson's snipe from Alabama

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Abstract: Mercury is a persistent, toxic heavy metal that can bioaccumulate in organisms, causing diseases and other health problems. Wilson's snipe (*Gallinago delicata*) feed primarily on aquatic invertebrates, which makes them prone to mercury bioaccumulation. In this study, we measured total mercury in Wilson's snipe. Total mercury was measured in the feathers and muscle tissue. Mean concentration (ppm ± SE) of mercury was 1.33 (± 0.22) and 0.087 (± 0.03) in the feathers and muscle tissue, respectively. Mercury concentration was significantly higher in feathers than muscle. Our data indicate that Wilson's snipe, an aquatic-invertebrate predator that bioaccumulates mercury from their environment may be a useful biological indicator for mercury.

Key words: bioaccumulation, feathers, human–wildlife conflict, mercury, muscle, Wilson's snipe

One of the more toxic and persistent elements found in wetlands is mercury, a metal that can cause many environmental and health problems, including behavioral and reproductive abnormalities in bird species (Spalding et al. 1994). Atmospheric deposition is one of the major pathways for mercury contamination in aquatic ecosystems (Wang et al. 2004). Once deposited, mercury may transform into methylmercury and bind to sediment that may be ingested by small organisms, resulting in its bioaccumulation within a food chain (Bowles et al. 2001). Methylation of mercury can be enhanced in wetland ecosystems (St. Louis et al. 1994). Due to its bioaccumulative abilities, methylmercury is a concern for Wilson's snipe (*Gallinago delicata*; Figure 1), which primarily ingest aquatic invertebrates that live within the sediments and feed on organic matter (McCloskey et al. 2009).

Wilson's snipe are shorebirds that are dependent on wetlands for food and habitat. They use their long, slender bill to probe into the mud in search of small invertebrates (e.g., oligochaetes). Birds, such as Wilson's snipe, have been shown to be sensitive to toxins (e.g., mercury) in their environment (Wolfe et al. 1998, Saeki et al. 2000). Wilson's snipe also is a game species and may be a source of mercury contamination in humans who consume them. Numerous human health problems have been associated with mercury exposure (Park and Zheng 2012). To assess the level of mercury that has potentially accumulated in Wilson's snipe, we ran mercury analysis on the feathers and leg muscle tissue of 11 birds.

Methods

The Swan Creek Wildlife Management Area (34.679 N, -87.010 W) in Limestone County, Alabama, was utilized for sampling Wilson's snipe. From December 21 to 23, 2011, we collected 11 hunter-killed birds for this study. Evaluating the prominence of the breast muscle and keel, we determined that all the birds looked healthy, and none appeared emaciated. Harvested birds were placed immediately in individual plastic bags and frozen until further analysis. Visual observations confirmed that the collected birds were adults (Dwyer and Dobell 1979).

We weighed and placed the breast feathers into a closed Teflon container with a digestion matrix that was a mixture of 6 M ultra-clean HCl, 15 M ultra-clean HNO3, and ultra-pure water. The samples were digested using a Chemist Electrical Engineer microwave digester and analyzed for mercury using acid digestion, sodium borohydride reduction, and pre-concentration using gold amalgamation; we quantified the samples with cold-vapor atomic-fluorescence spectrometry using to U. S. Environmental Protection Agency Method 7471B (Guentzel and Tsukamoto

Figure 1. Wilson's snipe (*Gallinago delicata; photo by David Ward, courtesy U.S. Fish and Wildlife Service).*

2001). Snipe muscle tissues were sent to Australian Laboratory Services Environmental Laboratory in Kelso, Washington, for total mercury analysis. Samples were prepared and analyzed using cold vapor atomic absorption spectrometry. We used descriptive statistics and a paired *t*-test to determine differences between the concentrations of total mercury in the muscle tissues and feathers.

Results

The mean concentration (ppm) of mercury in the feathers and muscle tissue were 1.33 (± 0.22 SE) and .087 (± 0.03 SE), respectively. Feathers contained a significantly higher amount (t = 5.69, df = 10, P = 0.001) of mercury compared to muscle tissue.

Discussion

Mercury toxicity has been listed as a causative agent in declining populations of wetland birds (Sundlof et al. 1994). Although methylmercury is the most toxic form of mercury and readily bioaccumulates in wetlands, all forms of mercury are toxic to organisms (St. Louis et al. 1994). Because bird feathers accumulate mercury, they have been widely used to determine a reliable measure of bird mercury concentrations (Thompson and Furness 1989). Mercury in feathers is stable, and several studies (e.g., Vo et al. 2011) have been able to utilize museum specimens to examine it in feathers over long periods of time. Birds, however, can eliminate >90% of mercury by molting of feathers with the remainder of mercury accumulating in muscles, liver, bone, and fat (Burger et al. 1994). Wilson's snipe completely molt their feathers between July and October, prior to migrating to their wintering grounds (Bent 1927). Their primary breeding grounds are the northern United States and Canada, and they over-winter in the midwest and southern states. Therefore, the mercury in our bird feather specimens was obtained primarily from food sources within their summer breeding grounds, whereas, the mercury in muscle could have been garnered within their breeding and over-wintering areas. Additionally, birds often are used to evaluate mercury bioaccumulation in wetland environments (Beyer et al. 1997, Frederick et al. 2002). Bioaccumulation of mercury in birds, such as Wilson's snipe, may provide a source of mercury to both organisms and humans who consume them.

Mazloomi et al. (2008) examined mercury levels in common cormorants (*Phalacrocorax carbo*) in the Caspian Sea and found that levels of mercury in feathers also exceeded levels in muscle tissue. Dauwe et al. (2003) conducted a study on raptors and owls and found that mercury levels in feathers accurately reflected mercury levels in blood. All of these birds contained higher levels of mercury within their tissues compared to our study birds. Coots (*Felicia americana*) and mallards (*Anas platyrhynchos*), which share a similar trophic level as Wilson's snipe, were found to have similar muscle and feather concentrations of mercury to our birds (Anazami et al. 2011). Although there is conflicting evidence regarding how mercury in muscle correlates with other tissues (Horaia et al. 2007), overall, muscle is thought to be a storage area for mercury (Anazami et al. 2011) and is reflective of their immediate diet.

Mercury is dangerous for humans and animals even in minute quantities because of its ability to bind to enzymes and proteins, thus rendering them unable to perform bioreactions (Duruibe et al. 2007). Chan et al.'s (2003) review of the literature showed that numerous bird health problems are associated

with mercury exposure, and chronic, low-level mercury exposure (in diet) could result in behavioral and reproduction anomalies. Bioaccumulation of mercury can occur in both animals and humans who consume them (Duruibe et. al. 2007). Different agencies (e.g. WHO, European Union, FDA, etc.) have set widely differring "safe" mercury limits for food items consumed by humans. However, others have argued that even these levels could cause mercury poisoning in some people who regularly consume contaminated game (Nriagu et al. 1992). Increasing knowledge and concern about contaminants in self-harvested game should be a priority among scientists and other management agencies. Although the Wilson's snipe in our study contained mercury levels below most acceptable consumption levels, our data demonstrated that Wilson's snipe contained moderate levels of mercury in their feather and muscle tissues, which suggests that mercury is being bioaccumulated in their wetland habitat.

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