# Variation in total mercury content among riparian and non-riparian spider species



# ABSTRACT

Mercury is a persistent environmental contaminant that primarily originates from coal-fired power plants but may arise from other sources including uncontrolled mine fires. Variation in total mercury uptake and mobilization through the apex arthropod community is poorly understood. We measured total mercury among ground and web-building spiders at sites along the Susquehanna River near a coal-fired power plant and compared total mercury levels to spiders from uncontrolled coal fire burn sites (Centralia, PA and Laurel Run, PA) and reference sites away from the river or point sources of mercury pollution (agricultural fields and headwater streams). We measured total mercury across species, age classes, and sexes for several species of ground spider and a web-building spider at these sites. Spiders from mine fire sites had total mercury levels over 2.5 times higher than those in riparian zones adjacent to the power plant and about six times higher than those from agricultural fields or riparian zones away from power plants. We found a significant interaction in total mercury levels between sex and species suggesting possible trophic dimorphism among some species or significant sex-based differences in mercury exposure. We also measured methyl mercury (MeHg) among select arthropods along one site near a former coal-fired power plant. MeHg tended to be higher among females while total mercury levels tended to be higher among males. Wolf spider eggsacs had MeHg levels ca. 3/4th that of the mother. The mechanism for biomagnification remains unclear, but intraguild predation and MeHg transfer to eggsacs among females may be contributing to sex differences and vertical biomagnification. Total mercury was concentrated in the abdomens of ground spiders compared to legs and cephalothorax. Wolf spiders had MeHg levels 8-20 times higher than ground locust or caddisflies from the adjacent water. MeHg is capable of being transported and biomagnified vertically in terrestrial environments through lycosids while mine fire sites are capable of mobilizing mercury trophically across the apex arthropod community.

## INTRODUCTION

Mercury (Hg) is a persistent neurotoxin that originates in large quantities from coal-fired power plants. Less than 10% of power-plant derived mercury is methylated into the bioavailable and toxic mercury compound methyl mercury (MeHg) (Sullivan et al. 2005). Terrestrial environments have been largely ignored in studies examining mercury contamination due to the putatively low bioaccumulation and toxicity of mercury in terrestrial ecosystems relative to aquatic ecosystems (Adriano 2001). Cristol et al. 2008 showed that insectivorous birds had higher mercury levels than piscivorous birds at a mercury contaminated site along the Shenandoah River. Cristol et al. (2008) found that spiders had the highest Hg and MeHg levels of any of the insectivorous bird's prey items. This suggests that spiders are important in mercury biomagnification possibly transferring mercury between aquatic and terrestrial sources, and particularly wolf spiders, which are a major sink for MeHg. Why wolf spiders are efficient accumulators of MeHg remains unclear. Unlike aquatic species, they may be unable to depurate mercury. Further, they may engage in cannibalism and/or intraguild predation which may significantly lengthen food chains and therefore biomagnification potential (Greenwood et al. 2010). Wolf spiders may potentially vertically transfer Hg and MeHg to their offspring. Here we examine potential sources and transfer routes by which mercury may be biomagnified through the wolf spider community along the Susquehanna River compared to non-riparian sites. These sites are at varying distances from point sources of mercury, and include mine fire sites, riparian sites near a powerplant, and non-impacted agricultural sites and headwater streams. We compared species' mercury concentration within sites as well as comparing non-riparian and riparian sites that are close to and farther away from these sources of mercury.

### QUESTIONS

- Which sources of mercury cause the highest amount of mercury contamination?
- Do closely related species have similar mercury levels?
- Do male and female spiders vary in mercury levels?
- Do spider mercury levels vary by age and where is it stored?
- How much mercury is methylated in spiders?



Adult female Pardosa milvina with an eggsac.

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power plant between 1997-2015.

### Discussion Spiders from mine fires have the highest mercury levels and riparian sites near the powerplant have higher

mercury levels than reference sites (Fig. 1) Although point sources are the likely cause of elevated mercury at these sites, the coal mine fires are not near a river, suggesting that aquatic environments are not necessary for significant mercury contamination and trophic transfer to occur. There are 48 uncontrolled mine fires currently burning in the state of Pennsylvania. This, combined with mine waste areas, likely serve as important but poorly understood point sources for terrestrial transport of mercury.

### **High levels of MeHg in wolf spiders**

- Wolf spider MeHg levels were 8-20 times higher than terrestrial or aquatic herbivores and even higher than the large aquatic-feeding fishing spider, Dolomedes tenebrosus (Fig. 2). Among collected wolf spiders, 65% of Hg is methylated and females pass on 40% of MeHg to their offspring (Fig. 4). Total mercury varied significantly by species but many concentrations were comparable to that found in
- Mercury levels vary significantly by sex.
- Some sex differences in total Hg were found but these were not consistent across species (Fig. 3). Females may offload their mercury into their eggsacs (Fig 6). Differences in sampling between pre- and post-reproductive females among species may drive these Hg level inconsistencies across sexes since much of the Hg is stored in the abdomen where eggs are yolked prior to deposition (Fig. 5).
- Adult spiders have significantly higher mercury concentration than other age classes (Fig 4 and 6).
- Adult spiders have had more time to bioaccumulate mercury than other age classes and/or cannibalism and intraguild predation may be more common with increasing body size.

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A female Tigrosa consuming a Pardosa

