

Quantitative Bioimaging to Investigate the Uptake of Mercury Species in *Drosophila melanogaster*

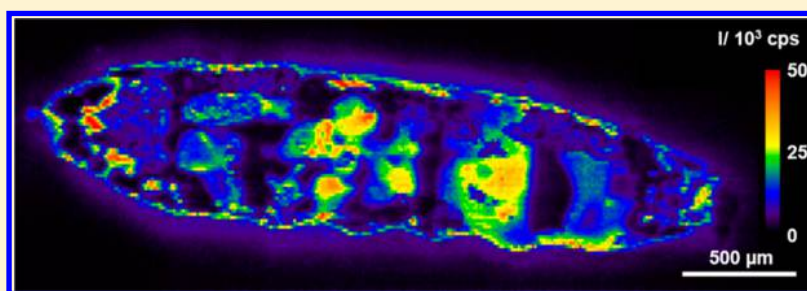
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ABSTRACT: The uptake of mercury species in the model organism *Drosophila melanogaster* was investigated by elemental bioimaging using laser ablation-inductively coupled plasma mass spectrometry (LA-ICPMS). The mercury distribution in *Drosophila melanogaster* was analyzed for the three species mercury(II) chloride, methylmercury chloride, and thimerosal after intoxication. A respective analytical method was developed and applied to the analysis of the entire *Drosophila melanogaster* first, before a particular focus was directed to the cerebral areas of larvae and adult flies. For quantification of mercury, matrix-matched standards based on gelatin were prepared. Challenges of spatially dissolved mercury determination, namely, strong evaporation issues of the analytes and an inhomogeneous distribution of mercury in the standards due to interactions with cysteine containing proteins of the gelatin were successfully addressed by complexation with *meso*-2,3-dimercaptosuccinic acid (DMSA). No mercury was detected in the cerebral region for mercury(II) chloride, whereas both organic species showed the ability to cross the blood–brain barrier. Quantitatively, the mercury level in the brain exceeded the fed concentration indicating mercury enrichment, which was approximately 3 times higher for methylmercury chloride than for thimerosal.

The heavy metal mercury has been known as a toxic element for centuries.^{1,2} The public interest for mercury intoxication and mercury related diseases has increased during the last decades starting with the *Minamata disaster* in the 1950s and the *Iraq poison grain disaster* in 1971.^{3–7} The reflection of these demonstrated that the toxicity of mercury is significant depending on its chemical species.

Generally, there are three main categories of mercury species including elemental (Hg^0), inorganic (Hg^{2+} , Hg_2^{2+}) and organic (e.g., MeHg^+ , EtHg^+ , PhHg^+) mercury.^{1,8} Regarding the physical and chemical properties and especially the toxicology of the different species, it is obvious that medical or toxicological assumptions can only be generated via speciation analysis.^{9,10} The global existence of mercury in the environment is based on both natural (e.g., thermal evaporation from oceans and land masses, biomass burning, and emissions of volcanoes) and anthropogenic sources (e.g., fossil fuel combustion, chlor-alkali electrolysis plants, artisanal gold mining, cement production, waste incineration, and dental amalgam) of which the anthropogenic emissions represent the greater part and mainly originate from Asia.^{6,11–13} Because of the long lifetime

and persistence of mercury in the atmosphere and hydrosphere, mercury can be transported over large distances leading to a global distribution. Thus, biotransformation of mercury in aquatic ecosystems into organic mercury species via methylation is a process that leads to the formation of highly toxic methylmercury.^{14–16} In the case of organic mercury species, a large accumulation in the food chain can be observed. Fish consumption, especially of long-lived and predatory fish like tuna and shark, is one of the main sources of human mercury exposure and even culinary treatment does not show a significant decrease of mercury species.^{14,15,17–19}

Furthermore, rice as a staple food may represent another important source of human mercury uptake due to various and diffuse mercury pollution. Hence, Meng et al. recently described the speciation and localization of mercury in rice grain (sampled from a Hg-contaminated region in China).²⁰

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