Comparison of Mercury in the Feathers of Purple Martin Nestlings in Lake County

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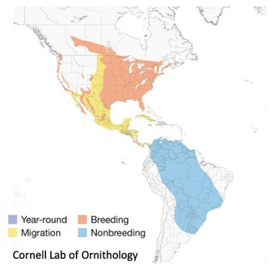
Introduction

Purple Martins (*Progne subis*)

- Member of the swallow family
- Average Length: 19 cm
- Average Weight: 56 grams
- Males: dark purple/blue/black plumage
- Females: some purple feathers in the head area

Diet
- Aerial insectivores
  - Dragonflies, moths, butterflies, flies, beetles, wasps, and other flying insects

Nesting
- In Eastern North America Martins nest exclusively in human-supplied housing, such as gourds
- Average 4-6 eggs per clutch
- Incubation period around 16 days after the next to last egg is laid



Migration
- Migrate from Eastern North America to Brazil
- Average migration takes 4-6 weeks and covers 4,000 to 6,000 miles one way

Mercury
- Heavy metals have a high atomic weight and a density >5 times that of water
- Mercury is a widespread heavy metal pollutant
- Avian insectivores have been found to have higher heavy metal accumulation compared to their grainivore and omnivore counterparts [1]
- Higher mercury levels have been associated with altered parental nesting behaviors, including more frequent incubation breaks and decreased incubation time [2]

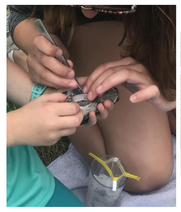
The purpose of this research is to determine if the location of the Purple Martin colony affects the amount of mercury found in the feathers of the nestlings. This research will allow for a better-informed decision on the locations of future colonies.

Materials and Methods

Permits for the Collection and Possession of Feathers
- IACUC 21175-AVR-AS
- OH ODNR DOW Permit: 24-010
- US FWS: MBPER0005464

Feather Collection

Purple Martin adults and nestlings (age 12 – 22 days) were captured at the gourds. Data on age and body composition were determined. The birds were then banded, and breast feathers (10 - 15 feathers per individual) were collected. Nestlings were placed back in the gourd; adults were released at the capture location. Feathers were stored in WhirlPaks until analysis.



Feather Preparation

Feathers were weighed and pooled as necessary from locations to achieve a feather dry weight (d.w.) of 10 – 20 mg. They were then digested with 2.5 mL Aqua Regia (25% *v/v* HNO_3, 75% *v/v* HCl) for 30 minutes at 95°C.

Mercury Isolation

Mercury calibration standards were prepared in H_2SO_4 (0.023 N) and HNO_3 (0.172 N). The mercury standards were made fresh daily. Feather samples and calibration standards were then oxidized with potassium permanganate (0.575% *w/v*) and potassium persulfate (0.307% *w/v*) at 95°C for 2 hours. Samples were cooled overnight and then reduced with sodium chloride-hydroxylamine hydrochloride. Samples were filtered with 0.45 µm PTFE prior to analysis.

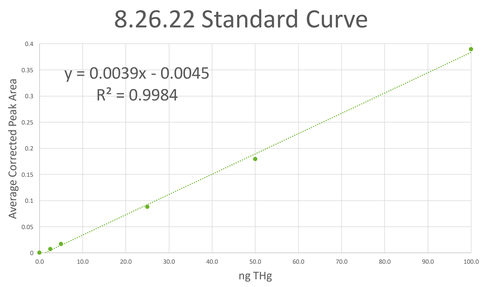


Figure 1. Standard curve for FIMS100.

Mercury Analysis

Mercury was quantified on a Perkin Elmer Flow Injection Mercury System (FIMS 100) at 253.7 nm using stannous chloride (58 mM) and 3% v/v HCl. The stannous chloride was made fresh daily. Mercury levels in samples were determined based on the standard curve from each day and then normalized by dividing the concentration by the mass of the feather sample.

Results

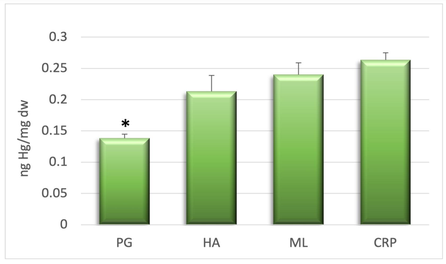


Figure 2. Comparison of mercury concentration per milligram of feather in Purple Martin nestlings from Penitentiary Glen (PG, 5 nestlings), Holden Arboretum (HA, 8 nestlings), Mentor Lagoons (ML, 32 nestlings), and Chagrin River Park (CRP, 15 nestlings). Statistical significance between locations analyzed using one-way ANOVA with Tukey-Kramer post-hoc test, $p < 0.05$) as indicated by *. Feather samples from Summer 2021.

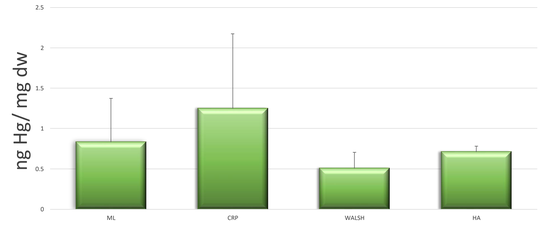


Figure 3. Comparison of mercury concentration per milligram of feather in Purple Martin nestlings from Mentor Lagoons (ML 11 nestlings), Chagrin River Park (CRP, 6 nestlings), Holden Arboretum (HA, 2 nestlings), and Edward Walsh Park (WALSH, 4 nestlings). Statistical significance between locations analyzed using one-way ANOVA ($p > 0.05$). Feather samples from Summer 2022.

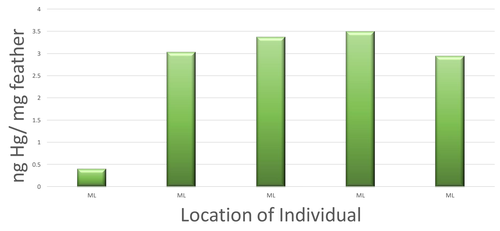


Figure 4. Comparison of the concentration of total mercury per milligram of feather in nestlings from Mentor Lagoons (n=5). Samples collected Summer 2022.

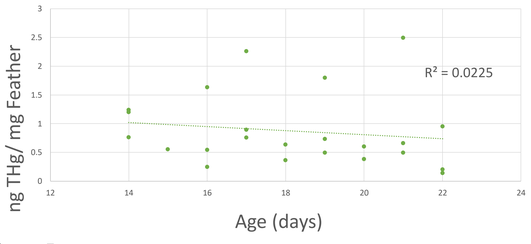


Figure 5. Comparison of the concentration of total mercury per milligram of feather in nestlings from ML (n=11), CRP (n=6), HA (n=2), and WALSH (n=4).

Conclusions

- Lowest concentration of mercury was found in nestlings at Penitentiary Glen in 2021, no significant difference observed between the other three locations.
- No statistical difference was found in the mercury concentrations at all four locations in 2022.
- Mercury concentration is not dependent on the age of nestling.

Future Directions

- Use ICP-OES to quantify other heavy metals (Pb, Cr, Cd, Fe) present in the feathers.
- Analyze additional Purple Martin feathers collected in 2022 and to be collected in 2023.
- Quantify mercury in migratory and resident bird species in Northeast Ohio comparing diet and residence status.

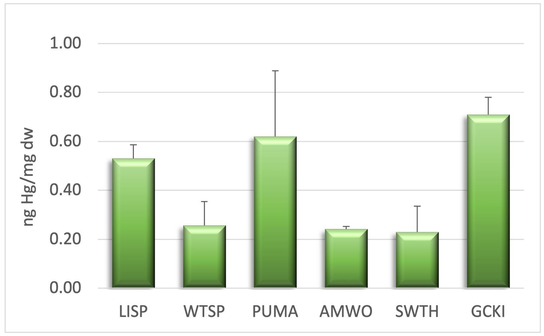


Figure 6. Comparison of the concentration of Hg per milligram of feather in various species found in Northeast Ohio (Cleveland State University and Mentor Lagoons). (LISP: Lincoln Sparrow, WTSP: White-throated Sparrow, PUMA: Purple Martin, AMWO: American Woodcock, SWTH: Swainson's Thrush, GCKI: Golden-crowned Kinglet). PUMA $n = 14$; others $n = 1$, each sample analyzed 2 – 4 times)

Literature Cited

1. Ackerman, J. T.; Hartman, C. A.; Herzog, M. P., Mercury contamination in resident and migrant songbirds and potential effects on body condition. *Environ Pollut* **2019,** *246*, 797-810.
2. Hartman, C. A.; Ackerman, J. T.; Herzog, M. P., Mercury Exposure and Altered Parental Nesting Behavior in a Wild Songbird. *Environ Sci Technol* **2019,** *53* (9), 5396-5405.
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5. Species Profile - Purple Martin Biology https://www.purplemartin.org/purple-martins/biology/38/species-profile/ (accessed 2022 -04 -05).

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