Epibiotic Diatom Assemblages on Texas Freshwater Turtles

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Introduction

- Texas' Guadalupe river has over 7 species of turtles (Testudines)[1], including the endemic Cagle's Map Turtle (*Graptemys caglei*).
- Turtles host epibiotic diatom communities on their shells, but characterization and ecological significance are poorly documented[2,3].
- Diatoms (Bacillariophyceae), single-celled, golden brown algae with a silica cell wall, select host substrates based on environmental factors including desiccation risk, water flow, and light exposure.
- Due to their rapid generation time and sensitivity to environmental factors, diatoms have been used to infer water quality and ecological conditions[4].
- As turtle ecologies differ, the epibiont habitat conditions provided by their shells may differ.
- Turtle ecology differs between species, sex, and age class, and diatom assemblages on shells have potential for indirect inferences of behavior, habitat use, and life history stage.

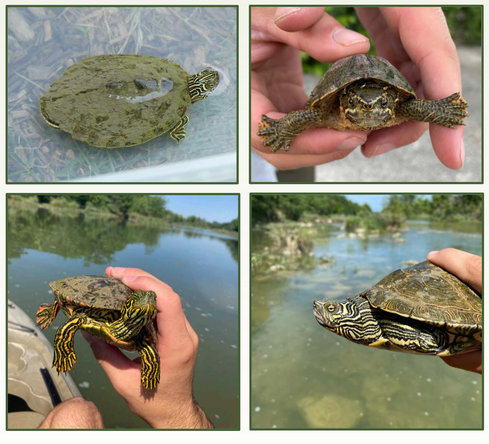

Figure 1. Study species, clockwise from top left: Cagle's map turtle (*Graptemys caglei*), stinkpot (*Sternotherus odoratus*), Cagle's map turtle, and Texas Cooter (*Pseudemys texana*).

Objectives

- Determine whether carapacial diatom assemblages differ among turtle species, sex, and body size, as well as substrates, from a single location on the upper Guadalupe River in central Texas.
- Evaluate potential use of diatom assemblages for inferring turtle behavior and ecology.

Methods

- Turtles were caught via hoop net traps, basking traps, and dip nets on the Guadalupe River at Ingram City Park in June 2021.
- Diatom scrapings were collected from turtle carapaces and nearby rocks to compare substrates.
- Turtle species, sex, and size were recorded.

Figure 2. Clockwise from top left: hoop net trap, basking net trap, study site at Ingram in Guadalupe River drainage, diatom sampling on location in Ingram.

- Diatom valves were cleaned using hydrogen peroxide to aid in identification, and then plated on microscope slides.
- Up to 200 diatom valves were counted per sample using optical light microscopy. Diatoms were identified to genus.
- Diatom assemblages were characterized as relative abundances using nonmetric multidimensional scaling (NMS) for a two-axis solution.
- ANOVAs compared NMS axis means across species, sex, and substrate, and linear correlations compared NMS axes to body size.

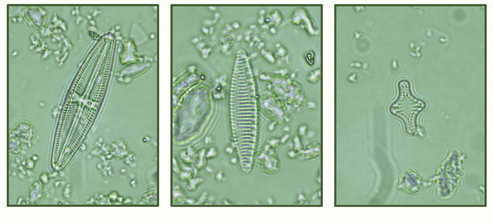

Figure 3. Representative common diatom genera, from left: *Luticola, Nitzschia*, and *Staurosira.* Light micrographs at 1000x magnification with oil immersion. Size range 10-30 um.

Results

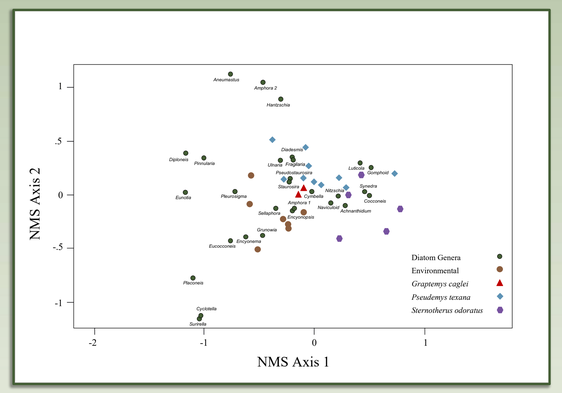

Figure 4. Non-metric multidimensional (NMS) scatterplot showing ordination of diatom genera and host samples. Stress of the final solution was 0.11, indicating adequate ordination of samples on two axes. Species and environmental samples showed minimal overlap with respect to diatom assemblages.

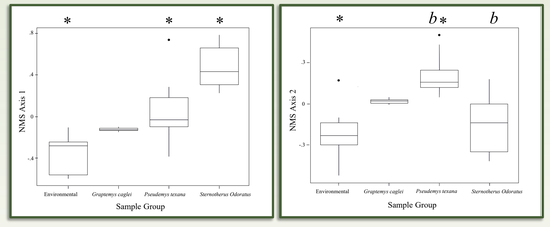

Figure 5. Boxplots of NMS values (diatom assemblage similarity) and sample groups (e.g., species and environment), showing differences in distributions (ANOVA for NMS 1: $P = 0.0002$; ANOVA for NMS 2: $P = 0.001$). Symbols * and *b* indicate significant Tukey HSD comparisons.

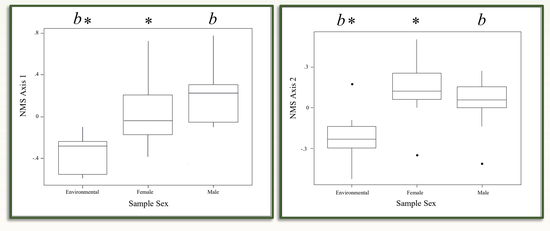

Figure 6. Boxplots of NMS values (diatom assemblage similarity) and turtle sex and environmental substrate, showing differences in distributions. ANOVAs were significant, but only for sexes versus the environment ($P = 0.004$ for NMS 1 and $P = 0.024$ for NMS 2). Sexes did not differ in mean NMS values ($P = 0.59$ for NMS 1 and $P = 0.61$ for NMS 2).

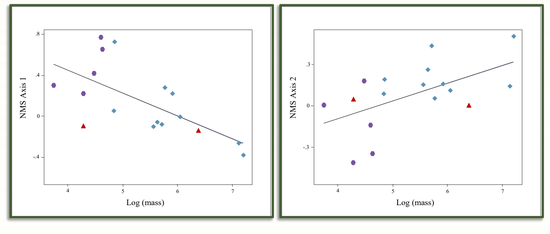

Figure 7. Relationships of NMS axes and log-transformed mass of individual turtles with linear smoothers. For NMS 1, correlation was -0.65, ($P = 0.004$), for NMS 2, correlation was 0.55 ($P = 0.02$), indicating significant changes in diatom assemblages across turtle body size.

Conclusions

- Epibiotic diatom assemblages differ across substrate and turtle species, as indicated by NMS ordination and ANOVA.
- However, diatom assemblages differ across turtle size regardless of (and within) species, suggesting that size and species are confounding variables.
- Diatom assemblages do not differ between turtle sexes, suggesting the possibility of intersexual transfer of diatoms.
- If diatom assemblages differ by species, this could indicate interspecies differences in turtle behavior with respect to basking and/or habitat use.
- If diatom assemblages differ by turtle body size, this could indicate diatom community succession with host growth.
- Diatom assemblages differed between rocks and turtles. The diatom genus *Luticola* was found almost exclusively on turtles. Motile benthic diatoms are more likely to be found on turtles than nonmotile or planktic diatoms.

Future Studies

- Increase number of turtle species examined as well as sample sizes within species to distinguish between effects of body size and host species on diatom assemblages.
- Incorporate rock size into methodology and analysis to further consider substrate size effects.
- Assemblage differences from our study reveal the potential of diatoms as indicators of turtle ecology.
- Development of carapacial diatom assemblages as water quality bioindicators in absence of other substrates.

References

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