Microgeographic variation in wood frog hormonal response across suburban and rural landscapes

Research Highlights:

• Amphibian stress response can decrease immune function, reproductive output, and development.
• Hormonal response to environmental stressors can be measured through the secretion of corticosterone (CORT).
• I collected tadpole CORT concentrations from 16 ponds in the Yale Myers Forest and 17 ponds in New Haven County to assess the variation in stress hormone levels from different micro and macrogeographic environmental stressors.
• Identifying CORT inducing environmental conditions is critical for amphibian survival and continued population success.

Research Summary:

Chronic stressful conditions are known to be harmful to all vertebrate species. While an optimal level of stress is known to assist in immune response, energy activation, and increased reproductive output, continued stress from chronic exposures is linked with increased morbidity and mortality. In amphibians, this stress response can be quantified by measuring whole-body concentrations of corticosterone (CORT), a glucocorticoid hormone secreted during stressful events. CORT concentrations have been studied in a variety of amphibian species and have been shown to increase in response to human handling, temperature change, predator introduction, and pond drying. CORT is also heavily involved in the metamorphic signaling pathway, providing biochemical signals inducing thyroid hormone production that assists in the transition from eggs to tadpole to juvenile frog.
Quantifying CORT in wild populations provides a quantitative measure of individual stress response in actively developing populations undergoing varying degrees of environmental stress.
Research Summary cont.
Wood frogs are a common amphibian species in New England, providing a generalizable model for stress response to local environments. Due to this species wide habitable range and large tolerable temperature range, it exhibits adaptations to changes in both micro and macro-climates. For this project, I compared the impacts of environmental stressor both within and between different habitats on wood frog tadpoles. I collected tadpoles, environmental conditions, and pond specific water quality measures at 16 ponds in the Yale Myers Forest (YMF) and 17 ponds in the more suburban New Haven County (NHC), to compare the variation of CORT within both microgeographic regions and between different macrogeographic landscapes. Tadpoles were collected across their developmental period to determine how CORT signaling not only changed based on environmental conditions, but also based on developmental stage. Due to CORT’s developmental implications, thyroid hormone (T3) concentrations were also analyzed.

Ponds were found to have similar parameters within macrogeographic landscapes, but different risk factors for stress within each microgeographic region. Preliminary analysis has shown variation in CORT levels between ponds at YMF, and between ponds at NHC. There were also difference in CORT concentrations between ponds at YMF and NHC. Additionally, CORT concentrations varied over sampling time, consistent with the expected increase in CORT concentration over the developmental period. Additional data analysis will link specific environmental factors with increases in CORT expression and assess which pond level criteria are leading to increased CORT concentrations. Ongoing analysis will assess relationships between environmental factors, water quality parameters, tadpole level variables, CORT and T3 concentrations using multiple linear regression and multivariate statistics to determine the environmental drivers of stress in CT tadpole populations.

Amphibian populations continued to be at heightened risk of decline and extinction, largely due to global climate changes, habitat destruction, and changes in water quality. Understanding the specific microgeographic environmental stressors that lead to increased CORT signaling can provide insight on specific anthropogenic and climate effects influencing amphibian population declines. Knowledge of specific stressful environmental factors will allow useful contributions to conservation management plans and assist in preserving amphibian biodiversity.