Unlocking the Evolutionary Secrets of Local Amphibians and Lizards

Two new research projects were set out to map the evolution and historical geographical migration of key amphibian and reptile species within the Lesser Antilles. Understanding critical differences between similar species and how their particular evolutionary paths deviated from neighboring populations could prove crucial in the protection of these species moving forward. In January 2020 researchers from University of California and Smithsonian Institution visited St Maarten to collect data.

The islands of the Lesser Antilles serve as biodiversity hotspots within the Caribbean, known to host a great number of endemic species (Myers et al., 2000). Two new research projects led by scientists Michael L. Yuan and Jeffery H. Frederick of the University of California and Smithsonian Institution were set out to better understand the evolutionary history of a few reptiles and amphibians native to these islands. This research is not only critical for understanding the history of these species, but in designing effective conservation strategies for the future. Specimens collected during these projects will be donated to the Museum of Vertebrate Zoology and/or Nature Foundation Sint Maarten where they will serve to further scientific research and provide material for educational outreach. As climate change continues to threaten global biodiversity, learning to properly protect endemic species will become increasingly important, especially for small islands such as those of the Lesser Antilles.

Evolution of Anole Lizards

The first research project is taking a closer look at how *Anolis*, a genus of lizards, are evolving to match conditions within their specific habitats, specifically dry scrublands versus more temperate climates. Often populations will evolve in similar ways in response to similar environments, due to either natural selection or shared evolutionary constraints (Losos, 2011). Although there have been many documented cases of this, scientists do not fully understand to what degree these observable evolutionary changes (phenotypic) relate to a genetic or cellular evolution. New technology grants researchers the ability to study specimens at both the genetic and cellular level. Researchers will work to compare Lesser Antillean anoles to better understand any overlap between phenotypic, genetic and cellular evolution.

Each island in the Lesser Antilles has been uniquely colonized by various species of Anolis lizards. Sint Maarten in particular is home to two species of *Anolis* lizards, *A. gingivinus* and *A. pogus*, the Anguilla and Bearded anole respectively. With its diverse habitat range, paired with the fact that the *Anolis* populations of the island are known to have a wide variety of colors and patterns which may be adaptive to their environment (Lazell, 1972), St. Maarten provides the perfect research site to understand the link between genetic, cellular, and phenotypic characteristics with the environment.

The St. Maarten Study

Fifty individuals were collected from each of the two species (Anguilla and Bearded Anole). Each lizard specimen had a small genetic sample removed from their tail, then measured, photographed and released alive. In addition, six Anguilla anoles from one wet site and one dry site were collected. These individuals will be used for RNA analysis to fully capture their genetic makeup along with providing additional information through x-ray and CT-scanning analyses. Upon completion, these specimens will be given to the Museum of Vertebrate Zoology to serve as a resource for the broader scientific community. Since the Bearded anole has been ranked as vulnerable, only non-lethal sampling techniques were used.

Preliminary Data

Previously, researchers completed a similar study on the island of Montserrat concerning *A. lividus* (Plymouth anole), as well the islands of Sint Eustatius, Saint Kitts, and Nevis inhabited by *A. bimaculatus* (Panther anole) and *A. schwartzi* (Schwartz's anole). Here they were able to show a clear relationship between physical characteristics of the lizard and the habitat and climate. It was also demonstrated that individuals in colder climates were typically smaller overall, and had smaller appendages compared to body size. This is in line with broader patterns observed across lizards (Ashton & Feldman, 2007; Jaffe et al., 2016). Furthermore, they showed that montane rainforest populations had fewer and larger scales than their coastal counterparts and were darker and/or greener.

Evolutionary History of Lesser Antillean Amphibians and Reptiles

The second study focuses on how the geographical history of the Leeward islands impacted the genetic evolution of local reptile and amphibian populations. Previous studies highlighted the impact of colonization from South America and the Greater Antilles, yet little is known how the unique geographical characteristics of these islands shaped local populations. To compare the evolutionary history of the Lesser Antilles, three different groups were selected: *Eleutherodactylus johnstonei* (Antilles whistling frog), *Thecadactylus geckos* (turnip-tailed geckos), and two species of *Sphaerodactylus* geckos (least geckos). Each of these is widely distributed throughout the islands yet exhibit distinct historical lineages which should provide an interesting base for comparison.
In addition, invasive species were sampled to study their impacts on native populations as they are known to introduce diseases. Samples collected will provide insight into how these diseases impacted the evolution and spread of reptiles and amphibians throughout these islands. Researchers sampled the following two invasive species: the Cuban tree frog (*Osteopilus septentrionalis*) and the house gecko (*Hemidactylus mabouia*).

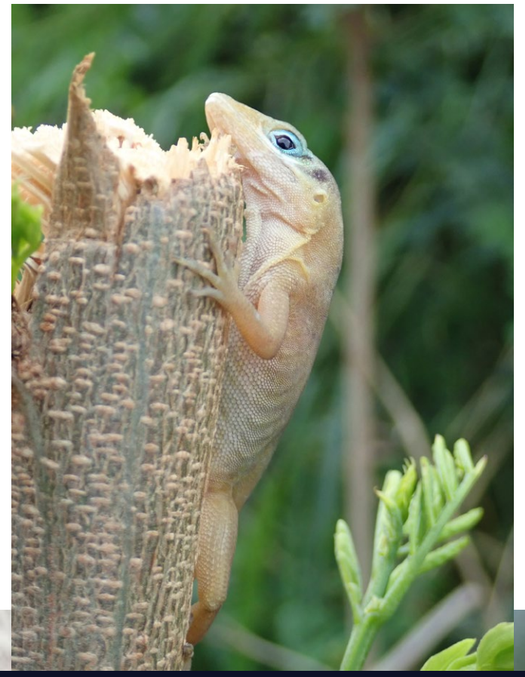
The Study

Samples were collected across Sint Maarten in January 2020. Antilles whistling frogs were photographed to collect data on their colorations and dorsal patterns. In addition, each frog was swabbed to test for the amphibian-killing fungus, Batrachochytrium dendrobatidis, known to originate from invasive species and a small tissue sample was taken for testing. Turnip-tailed geckos and both species of Least geckos were photographed and a small tissue sample was collected. Similarly, for invasive species each was photographed and a small tissue sample was collected, in addition, each frog was swabbed for fungus and blood samples were collected from lizards to test for malaria.

Genetic sequencing will give researchers insight into the relationship between various populations. Scientists can use this information to better understand the evolution of each species as they spread between the islands of the Lesser Antilles. Following this, demographic modeling can be conducted to illustrate each population's history. Lastly, unique characteristics of each species will be identified per location to highlight how the geographical history of each island played a role in the evolution of its native populations.

Greater Impact

Understanding the differences between endemic populations could prove instrumental in designing conservation plans to protect these species in the future. For example, understanding the genetic structure of island populations can identify genetically unique lineages that may be of conservation interest. Additionally, for several species including Thecadactylus and Sphaerodactylus geckos which may represent complexes of undescribed species, their diversity has not been adequately assessed. Finally, through understanding their evolutionary history and adaptation to local environments, researchers can predict how further changes in the environment may impact these populations.



A. gingivinus being measured and photographed (Nature Foundation St. Maarten, 2020)

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