EXILE - EXobIoLogy on Earth

How vertebrate communities adapt to - and thrive in - their environment has been widely tested in "*young*" landscapes (most landscapes surrounding us today). However, the drivers of vertebrate population density in *ancient* landscapes, and more particularly in fragmented paleosurfaces, are essentially unknown. The main objective of this project is to explore, document, and understand how the most remote fragmented paleosurfaces (renowned for their isolation and hostile environmental conditions), may have driven or altered particular anatomical and physiological adaptations in the few species thriving there. In other words, did the animal lineages surviving for a long time in these rare and remote landscapes develop adaptations that are unknown in others? This project focuses on one of the most enigmatic and jaw-dropping paleosurfaces of our planet, often referred to as the "Lost World", a direct reference to the well-known fiction novel by Sir Arthur Conan Doyle (who took his inspiration from the area). The Lost World is located in northern South America and is home to ancient moonlike tabletop mountains called "tepuis" reaching up to 3 km elevation. The summits of these mountains are among the oldest rocks exposed to the earth's surface and were formed well before the dinosaurs started roaming the earth. Nowadays, highest tepui summits are still so strongly isolated (physically and ecologically) from the surrounding uplands and lowlands that they are sometimes called "islands in the sky". These continental islands face extreme, challenging climatic conditions, including severe winds, extreme temperature/hygrometry variation, and high solar, infrared and ultraviolet radiation.

Our working hypothesis is that ancient endemic lineages of vertebrates thriving on these paleosurfaces, such as the toad genus *Oreophrynella* and the lizard genus *Riolama*, have developed unique behavioural, bio-physical and eco-physiological traits/strategies to cope with the tepuis' highly contrasted environmental conditions. And we do not start from nowhere. Indeed, our previous expeditions in the region allowed us to witness some very strange behaviours in a small tepui summit endemic (meaning living only in this location) toad species. For instance, we noticed that they are able to bask in full sun and under high solar radiation while maintaining their body temperature much cooler than the ground, allowing them to remain more than an hour on dry, very warm (>30°C) rocks. This is quite unusual because solar radiation is very strong on tepui summits and terrestrial amphibians are very sensitive to heat and dehydration (which are intimately linked) due to the high permeability of their skin. In addition, preliminary field experiments in small environmental chambers showed that highly desiccated individuals recover within a few hours even though they were assumed dead.

Based on these exciting preliminary data we will focus on two main complementary research axes: the **thermal biology** and the **anatomical adaptations to dehydration** of three species of amphibians and reptiles on the summit of Roraima-tepui in Guyana at 2,800 m elevation. Understanding the thermal physiology and the resilience to desiccation of these frogs and lizards is also crucial to infer their vulnerability to global climate change, a major threat to these animals that are not viewed by the public except in television documentaries. To situate these results in the appropriate ecological and evolutionary context, we will also work on two other landscapes: the forest surrounding the tepuis at much lower elevation (about 1,000 m), and a younger landscape in the Andean sub-paramo of Ecuador at the same elevation as Roraima-tepui.

Indiana Jones-style expeditions coupled with futuristic techniques such as the use of highly sensitive thermal cameras and drones to record thermal images of the landscapes from the air are necessary to complete our project. We will also run a variety of behavioural tests and use modern imagery techniques (such as high-resolution X-ray microcomputed tomography and electronic microscopy) to reach our goals. Our study will fill a large gap in fundamental knowledge by thoroughly documenting unique bio-physical/eco-physiological adaptations, potentially providing new research avenues for eco-physiology and climate change related research in all parts of the world, as well as cues for global mitigation and conservation efforts.