[Study Proposal] Mycophagous Vertebrates as Agents of Spore Dispersal for Critically Endangered *Geopora cooperi* in Turkey

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Background

Fungi play a crucial role in terrestrial and even aquatic ecology around the world, especially in terms of recycling organic matter to make insoluble nutrients available to dependent organisms and primary producers. In other words, they fill a niche fundamental to the trophic balance - but not without reliance on their ecosystem and its constituents. (LibreTexts, 2021) We are just coming to understand the unique interspecies interactions that lead to fungal fitness and abundance, among these interactions certain species' consumption of the fruiting bodies of fungi (known as mycophagy) that promotes the dispersal of spores (and thereby promoting abundance and diversity introducing fungi to a greater area that in turn contributes to the overall nutrition of the mycophagous). Spores are cited to be dispersed by vertebrates and invertebrates, natural forces, bacteria, and human interference, for all of which the literature is lacking (and would require a series of intensive studies). (Elliott et. al., 2020) However, the proposed study examines this exact cycle of *mycophagy* taking place by *vertebrates*, one of the more obvious (yet understudied) agents of dispersal. Also, perhaps this lack of information stems from the very complicated and widespread nature of fungi existing around the world through shared and different interactions; so to address a moment of ecological urgency, the proposed question focuses on the mycophagy of *Geopora cooperi* where the fungi is critically endangered in Turkey. (Çinar et. al., 2014)

Figure 1. Photo of a Geopora cooperi *fruit unearthed.* Photo: © Michael Wood

Proposed Question and Hypothesis:

Which vertebrate contributes most significantly to *mycophagy-driven* dispersal of the fruiting terrestrial fungi *Geopora cooperi* in Turkey?

The proposed hypothesis states that small mammals (rodents) perform the most mycophagy on average of *Geopora cooperi* in Turkey.

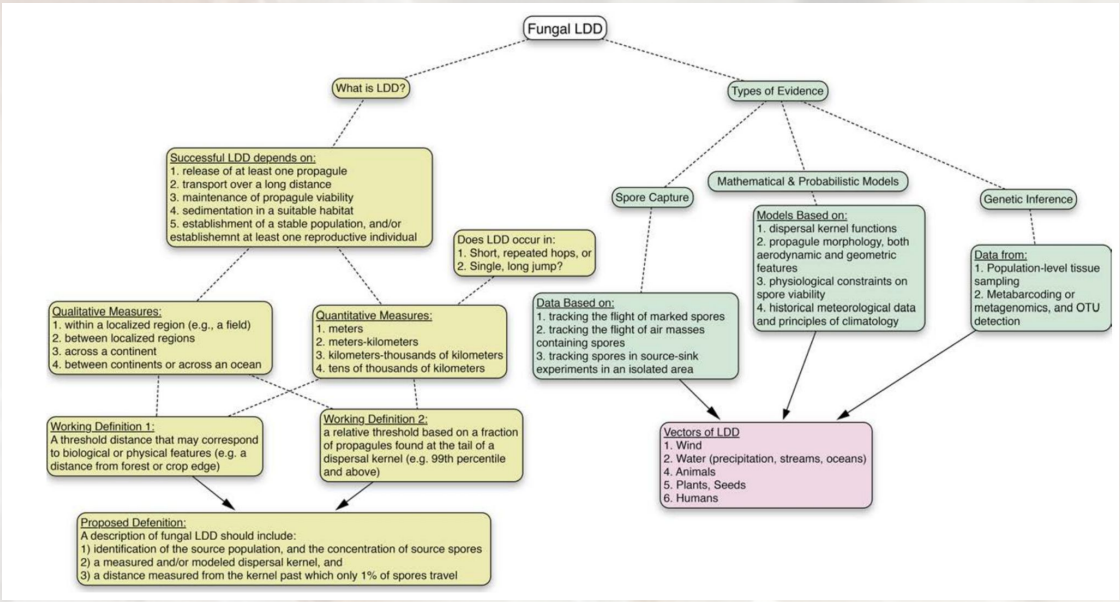

Figure 2. The multitude of considerations that go into tracking fungal spore dispersal, just by airborne dispersal alone. Photo: © American Society for Microbiology

Observational Study Design

- Consider the existing distribution of *Geopora cooperi*. In the likely chance this data is missing or out of date, consider regions most habitable to this fungi. Also consider when fruiting bodies are mature and available for consumption. Marker sites of fungi in these regions at the start of the study. Technologies are available to detect these underground, which will limit disturbance and strengthen an observational design. (NASA, 2017)
- It would be helpful to determine all vertebrates which are mycophagous for *Geopora cooperi* in Turkey, however this may become known as the study continues. The process of fungal spore gut passage and the diet, behaviors, abundance, and rate of consumption per mycophagous species will influence the results. (Danks, 2020)
- Monitor the sites of these fungi. Motion detected cameras provide a way to monitor visits over time. Record the positioning of where a *Geopora cooperi* is being consumed. (Elliott et. al., 2020)
- Ideally, the data collected is the average # of successful (results in proliferation of *Geopora cooperi*) dispersal events captured per vertebrate. This could be determined via animal tracking after mycophagous vertebrates are identified, or scat analysis for *Geopora cooperi* fungal spores. Results consideration in this case should include whether defecation deposits spores in favorable spaces, and whether spores are viable after passing a species' gut. Resources may be limited to monitor only which mycophagous vertebrate species make the most visits, however there are promising technologies (albeit amidst a rigorous process) available for tracking mycophagy in mammals via DNA metabarcoding in feces. (Cloutier et. al., 2019)

Intended Analysis

An ANOVA statistical test will be performed to determine whether there is a significant difference between the mean number of mycophagy-based visits or visits overall (quantitative response variable) per species of mycophagous vertebrate (categorical predictor variable). A ranking can thereby be established to exhibit the most active vertebrate mycophages in consuming *Geopora cooperi*. The same test can be used if the **success** of these dispersals at the site of defecations and/or the distance of these spore-containing defecations from the original site (both response) is tracked by each mycophagous vertebrate species (predictor) and subsequently their dispersal efficiency, which more closely satisfies the question posed. The scope of inferences made from this experiment lies only in this region, since interactions between fungi and vertebrate species changes with the species which inhabit the region. It can also change with different species of fungi, but very possibly relates to other fungi that fruit underground. The question might be posed on which force (mentioned in the background section) contributes the most to spore dispersal, but this poses even greater theological and methodological challenges. (Refer to (Golan & Pringle, 2017) to read more on the challenges of tracking spore dispersal.) However, ultimately, the results will bring an understanding of one predominating vector of spore dispersal of *Geopora cooperi* and thus provide explanation for its endangered status and inform human interference to repair it (or to avoid worsening it).

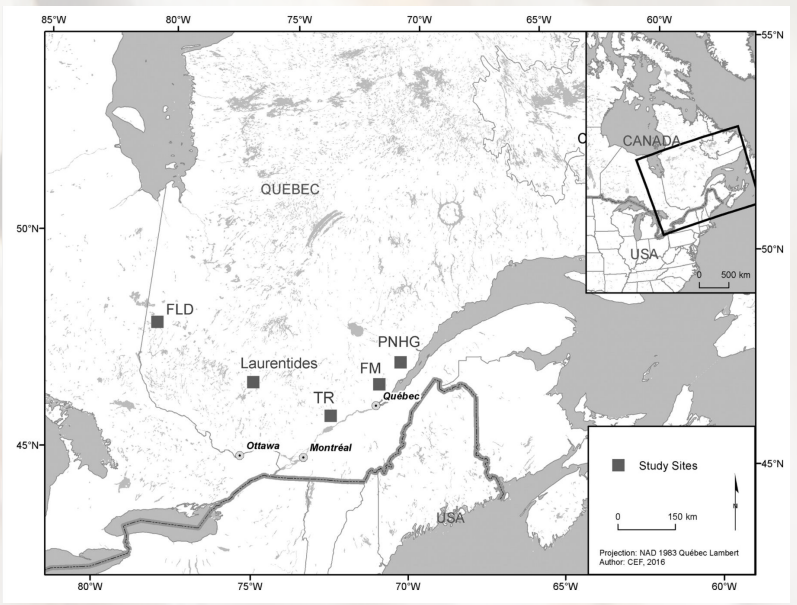

Figure 3. As one method of measuring the mycophagy of small animals across Quebec, baits provided known sites to collect feces for analysis (Cloutier et. al., 2019).

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