3 years action plan

Community assembly rules and resource partitioning in Malagasy chameleon communities: a critical test of the ecomorph concept?

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DESCRIPTION

Understanding how communities of closely related species are formed and how closely related species co-exist and partition the available resources has been at the heart of ecological and evolutionary studies. Moreover, understanding the rules underlying community assembly and co-existence is essential for conservation purposes and the management of endangered species (Corline et al., 2021). Most of our understanding of the evolution of complex communities in lizards is based on decades of research on *Anolis* lizards (Losos, 2009). Anolis lizards are a classic example of evolutionary convergence with species that occupy similar habitats being morphologically similar despite being phylogenetically distantly related. This morphological similarity is largely driven by the selective pressures on locomotor capacity in different microhabitats (different branch diameters) driving the evolution of so-called 'ecomorphs' or groups of species with similar ecologies showing similar morphological traits (Losos, 2009). This 'ecomorph' concept is at the heart of our understanding of the evolution of complex communities. In *Anolis* lizards it has been shown that evolutionary divergence overcomes niche conservatism causing closely related species to be no more ecologically similar than expected by random divergence. Distantly related species are, however, often ecologically similar, leading to a community in which the relationship between ecological similarity and phylogenetic relatedness is very weak (Losos et al., 1998, 2008).

However, despite suggestions that the ecomorph concept may hold for other lizards and may be an important driver of community establishment, this has rarely been tested. Chameleons provide an exceptional model to do so, especially in Madagascar where complex communities that differ in species composition occur throughout the island (Measey et al., 2013; Tolley and Herrel, 2013). Yet, the data needed to test these ideas are currently absent.

Here we propose an integrative project focusing on the different axes of divergences in Chameleon communities: morphology, performance and ecology. An understanding of the way species in complex communities partition resources is crucial in proposing adequate conservation measures.

1. Work package 1: niche occupation in the field

We will quantify niche utilization among members of a single chameleon community. To do so, we will focus on the chameleon community in the Vohimana Reserve in the East of Madagascar. This community consists of four species of *Brookesia* (*superciliaris*, *therezieni*, *thieli*, *ramanantsoai*), three species of *Furcifer* (*bifidus*, *pardalis*, *willsii*), and six species of *Calumma* (*brevicorne*, *furcifer*, *gallus*, *gastrotaenia*, *nasutum*, and *parsonii*). This community is interesting due to its specific and generic diversity, as well as the fact that it contains both the largest (*C. parsonii*) and some of the smallest chameleons (*Brookesia*).
Furthermore, several species that appear very similar coexist in this area. For these animals, we will quantify habitat use (perch height, perch diameter, distance to the nearest perch, diameter of the nearest perch, substrate type) through nocturnal observations following existing protocols (Herrel et al., 2011; da Silva et al., 2014). We will capture animals and use non-invasive stomach flushing techniques to understand their diet (da Silva et al., 2016; Dollion et al., 2017). Finally, we will measure the thermal habitat of chameleons during daytime data collection, as well as the preferred temperatures of different species following established protocols (Segall et al., 2013). In addition to the detailed theoretical aspects mentioned above, all this entirely novel field information on the lifestyle of these species in their natural habitat will be a crucial source of information that could lead to advancements in zootechnical practices, improving the conditions of chameleon breeding within the context of potential *ex situ* conservation projects.

2. Work package 2: form ~ function relationships

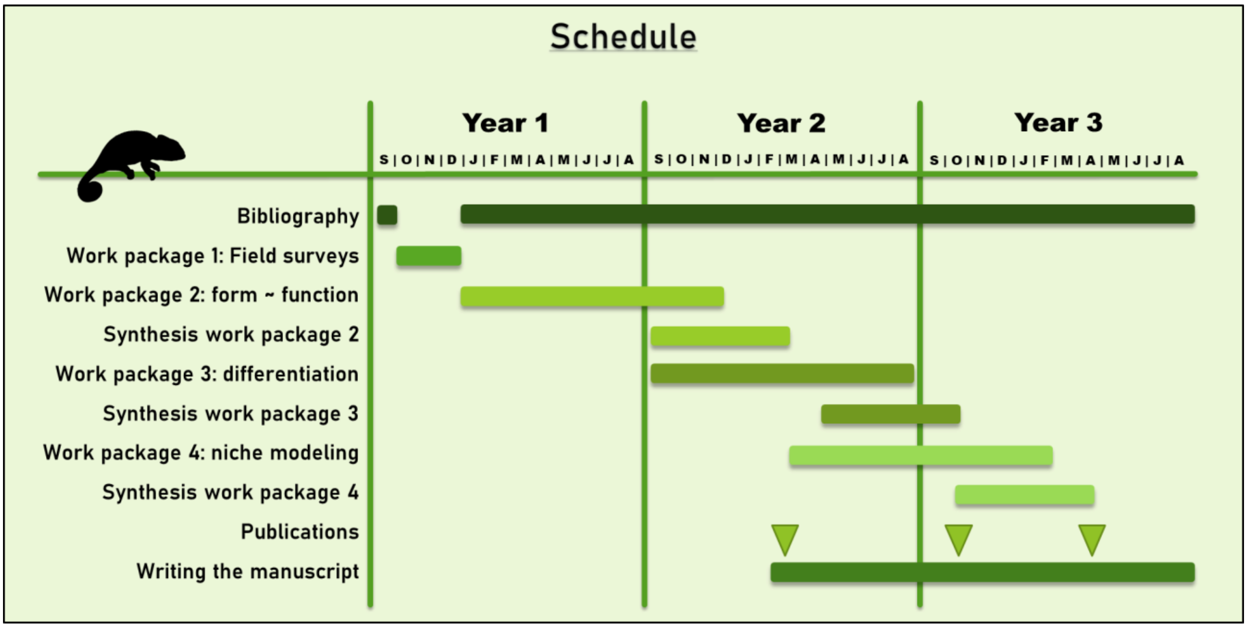
To better understand how morphological variation can facilitate niche partitioning in chameleons, we will focus on chameleons in the Vohimana Reserve. We will measure critical performance traits, including bite force (da Silva et al., 2014), hand, foot, and tail gripping force (Herrel et al., 2013) using force transducers and portable force plates, as well as sprint speed by filming animals running on a track (Herrel et al., 2013). We will also film prey capture and quantify tongue projection performance for all species using portable high-speed cameras that we will bring to the field (Herrel et al., 2014). Once performance characters are established, we will quantify their thermal dependence at 5 different temperatures and measure physiological limits for each species (Ctmin and CTmax; Segall et al., 2013).

3. Work package 3: axes of differentiation

Using existing chameleon collections at the National Museum of Natural History in Paris and elsewhere, we will assess how chameleon communities differ or resemble each other. To achieve this, we will compare and contrast chameleon communities from five different regions in Madagascar in terms of community composition (species diversity) and morphological occupation (morphological diversity). If the patterns described for Caribbean *Anolis* are applicable, chameleons should partition the morphological space independently of community or clade identity. We will measure at least 30 individuals of each species at each site whenever possible to establish intra- and inter-species morphological variation. Head, body, and limb morphology will be measured using established protocols (Herrel et al., 2011; Da Silva et al., 2014a,b).

4. Work package 4: niche modeling and community persistence under climate change

Based on the previously collected data, we will undertake niche modeling to estimate whether complex communities, such as those observed in Vohimana, will be able to persist under various climate change scenarios. To achieve this, we will integrate data from the three previous datasets to establish mechanistic niche models that incorporate information on the biology and physiology of these species for future predictions. Previous efforts have shown that these models provide better and more accurate estimates of potential future niches compared to traditional presence-absence-based models (Ginal et al., 2021). We will calculate temperature and body size-dependent response surfaces characterizing chameleon performance in geographical space. These surfaces will be scaled within a range corresponding to physiological limits. Environmental layers will then be used to assess the predicted species performance in geographical space. These ecophysiological performance layers will be employed in a traditional correlative SDM framework (Maxent) to predict the potential future distribution of chameleons with different body sizes and ecologies in Madagascar.



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