Effect of corridors on dung beetle diversity, dispersal, & ecosystem services

Project Personnel

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Research proposal (1500 words max):

Background

In an increasingly fragmented world, corridors are considered a key strategy for promoting connectivity and facilitating the movement of organisms through the landscape. Such movement is hypothesized to help maintain species diversity in fragments; it could also have patch- and landscape-level consequences for the ecosystem processes in which influenced by these species. Although there is some evidence that animals disperse between patches via corridors, and that connected patches have higher species diversity than unconnected ones, little work to date has investigated the consequences of these corridor-driven patterns for ecosystem ecosystem.

Dung beetles have emerged as a model system with which to test hypotheses on how changes in landscape structure driven by human activities influence biodiversity. They are locally species rich, exhibit variety in key functional traits (e.g., size, foraging style, resource-use), are capable of long-distance dispersal (e.g., some species up to 1 km), and that they influence a number of critical ecosystem services (e.g., seed dispersal, nutrient cycling). Previous work has shown that isolated patches of habitat frequently have lower dung beetle diversity and abundance than areas of continuous habitat, as well as documented their presence in linear strips of habitat that resemble corridors. However, it remains unknown if corridors can reduce the loss of species from fragments, how such declines are influenced by inter-specific differences in dispersal capability, and what the consequences of these patterns are for the ecosystems services provided by dung beetles. Though there are several reasons for this, one major factor is the challenge in finding locations where one can assess the role of corridors while also while controlling for confounding factors such as patch size, edge, and corridor length.

We propose using the community of dung beetles at the SRS Corridor Experiment to test for **(1)** higher species richness, species diversity, and functional diversity in patches connected by corridors than in unconnected patches **(2)** interspecific differences in corridor use and inter-patch movement, and **(3)** higher rates of dung removal in connected than unconnected patches. The SRS Corridor Experiment is an ideal location in which to conduct our stud. The design overcome the primary technical impediments to isolating the effects of corridors *per se*, its spatial scale allows for drawing and realistic and relevant conclusions regarding dung beetle

dispersal in fragmented landscapes, and the local dung beetle assemblage is a highly tractable one with which to address our questions (i.e., taxonomically and functionally diverse, keys for species identification are readily available, there are multiple abundant species from different functional groups with which to conduct experiments, and the experimental/survey methods are standardized and straightforward).

Our sampling and experiments will test the following predictions:

1. **Prediction 1:** Species Richness, Species Diversity, and Functional Diversity will be higher in patches connected by corridors than in unconnected patches
2. **Prediction 2:** Corridors are suitable habitat for all species. However, the speed at which in individuals move through corridors and the probability of successful inter-patch movement is size-dependent (i.e., larger beetle species move more quickly and are more likely to reach the connected patch).
3. **Prediction 3:** Dung removal rates will be highest in connected patches. This is due to the higher functional diversity of beetles in these locations.

Below we describe the combinations of sampling and experiments with which we will test these predictions.

Study Site and Methods

Study site

Methods **Methods - Prediction 1:**

To calculate species richness, species diversity, and functional diversity we will sample the dung beetle community in each location with pitfall traps baited with cow dung (Spector 2006, Andrade et al. 2011). In each site we will arrange traps in a grid, with traps separated from each other by 25 m. The traps will be 25 m from the edge of the patch to avoid attracting beetles from the matrix outside of the patch. Traps in each location will be set on the same day and left out for 24 hours.

The traps, modified from the design of Wood and Kaufman (2008), are constructed from 6 inch sections of (4?) inch(cm) diameter PVC pipe fitted with a screen on the bottom and a – cm diameter funnel on top with an extended –cm plastic platform used to suspend the trap over a hole in the ground. The traps will be set level to the ground by placing them into a semi-permanent hole that was maintained by a larger section of PVC while traps were not in use. Dung is wrapped in paper towel to exclude beetles and suspended over the trap on a wire cloth platform. Note that although the traps of Wood and Kaufman (2008) were designed as a live catch trap, ours will be converted to a wet trap by placing a –ml cup containing 95% ethanol inside the trap (the original design allows some beetles to escape and for predatory beetles to enter the traps).

The dung used to bait traps will be collected from the University of Florida's Beef Teaching Unit from cattle that were unsupplemented – (with what). It is collected fresh in the morning, homogenized, and formed into approximately (_ml) balls and frozen at (_degrees Celsius) until deployment. While some dung beetles have a clear preference for a particular type of dung, most species are generalists that use a broad diversity of vertebrate excrement (cite - check

Gordon 1983, and Mart´in Piera and Lobo 1996, and see what Woodruff has to say; see page 13 of Haffter and Edmonds). All beetles captured will stored in 95% ethanol and identified to species or morphospecies using Woodruff (1973). A collection of voucher specimens will be deposited at the FLMNH and ——.

1. Design Prediction 1 (pitfall sampling)

- 5 traps in a grid in the central 50 x 50 m of each patch + 1 sampling grid in the matrix. The 25 m buffer from the edge is to avoid beetles coming into the plot from the matrix.
- will try to test buffer width with marked beetles released at different distances, including from outside matrix
- 4 arrays per blocks = 36 traps per array, 7 blocks = 252 traps total
- need to make sure - ebnough “coverage” without a buffer too small, meaning bugs from matrix come into patch

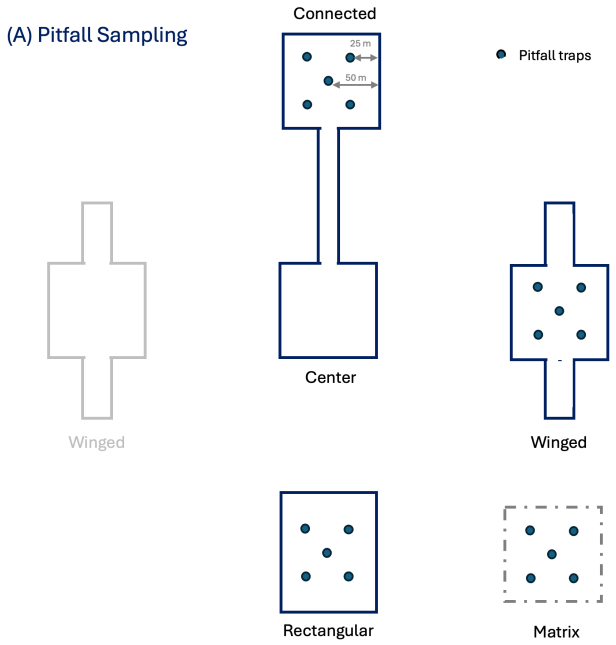

Figure 1: Sampling Design

Methods - Prediction 2: 2. Design Prediction 2 (Dispersal)

- using connected patches + unconected: 2 dung baits in center patch. one at ende closest to isolated patch, one at end of corridor,. release marked beetles at ende of isolated patch and entry of corridor. Check at intervals of X to see if they will make it.
- to consider: passive traps to see if they are moving through? shouidl we start experiment with smaller distances into the orridor and then eventually the full length?
- tech to follow them?

Field Methods - Prediction 3: 3. Design Prediction 3 (Dung Removal Experiment)

- field experiment: 300 g of dung on surface, 300 g on surface covered with mesh (controls for dessication), weigh after 48 hours

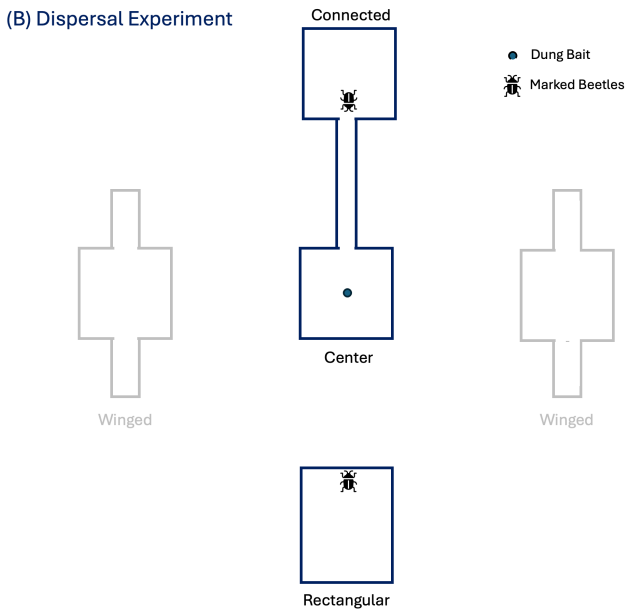

Figure 2: Sampling Design

- to consider: gather and sieve soil from outside, place in shallow pot, and place dung on that. Allows breakdown of soil without getting into their soils, if this is a concern
- repeat biweekly for X months
- lab experiment: meso-cosms in GNV based on results from diversity sampling
- need to make sure each point inside a plot is independent, and that each sampling date is independent

Each experimental landscape block consists of a 1-ha square center patch surrounded by four peripheral patches that are equal in area (~1.4 ha) but differ in the amount of habitat connectivity or edge (Fig. 1). One peripheral patch is connected to the center patch by a 150 x 25-m corridor (hereafter “connected”). The isolated patches are also 150 m from the center patch and vary in their edge amount. The winged patch type (hereafter “isolated high edge”) is a 100 x 100-m square with two 75 x 25 -m projections on either side of the patch. The rectangular patch type (hereafter “isolated low edge”) consists of a 100 x 100-m square with an area equal in size to the corridor added to the part of the patch farthest from the center patch. Each block contains one of each patch type and a duplicate of one of the isolated patch types.

Focal Species Assemblage

1. How many species, functional groups, range in size, what is known about them
2. Table of expected species

Potential impacts on corridor plots and ongoing studies

1. no holes are being dug for pitfalls: no disturbance of the seeds or soil
2. changes in dung beetle abundance due to collection: short term, unlikely to be high impact
3. Dung introduced into plots: contained in above ground traps, so also unlikely, standardized and from cows taking abntibiotics, so no disease introduced,.

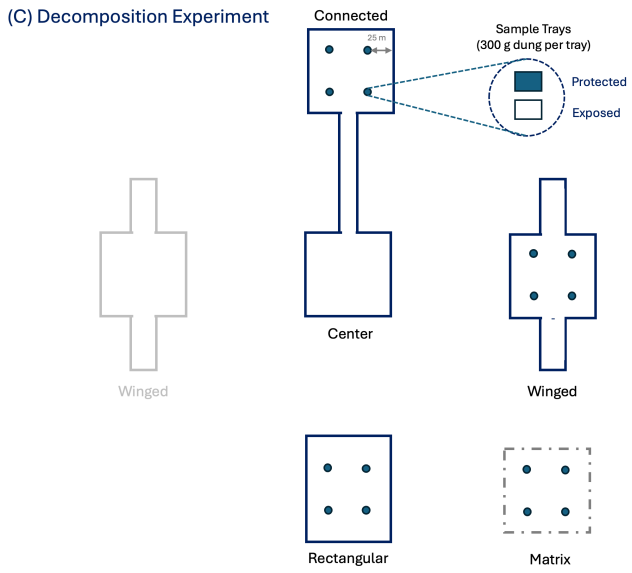

Figure 3: Sampling Design

Study duration

1. Preliminary sampling during Spring 2023
2. Summer and Fall Sampling
3. All traps and pin flags will be removed after each sampling bout

Funding sources (if applicable)

Plan for making data publicly accessible

Data will be entered into spreadsheets and backed up by saving them to a repository on the Bruna Lab's Github site (https://github.com/BrunaLab) along with a .txt file of metadata and all R scripts for data correction and analysis. When new data are added they will be automatically validated using Github actions and the `pointblank` library (e.g., https://brunalab.github.io/HeliconiaSurveys/survey_validation/survey_validation.html). This approach allows us to share the all materials with collaborators and easily archive code and data at Zenodo and Dryad (respectively) upon the acceptance of a manuscript. For an overview of our approach to data archiving and accessibility see https://github.com/BrunaLab/HeliconiaSurveys