Found or Fly: do flight demands constrain reproductive strategy in ants?

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Ants (Formicidae) are an ideal system to explore reproductive diversity at the community level, given their abundance, global distribution, diversity, and ease of collection. A colony's early reproductive life, where over >90% of queen mortality occurs, consists of two poorly understood parts- the flight phase where winged females mate, disperse, and find a new nest site; and colony founding where new queens lay eggs and raise the first workers. 'Classical' models of ant reproduction view two basic strategies for the flight phase- *lekking* in which ants swarm and mate aerially, and *calling* in which males fly to females and mate on a surface.[1,2] Similarly, a queen can found independently, raising the first workers on her own fat reserves, or dependently, where she is accompanied by workers from her home colony or joins an existing colony.[1,2] However, we lack a comprehensive theory tying this life history variation together.

Much of this variation is intimately tied to abdomen mass investment,[3] a trait which varies within and between species, with over two-fold variation among conspecifics in Panama (J. Helms, unpublished data). Fatter abdomens increase founding phase fitness by enhancing early colony growth, with different founding strategies requiring different abdomen investments.[3] Due to the role of weight in flight dynamics, fatter abdomens should come at a cost of decreased dispersal distance and maneuverability,[4] decreasing fitness during the flight phase.

Here I propose to test my *Found or Fly* (FoF) hypothesis, which posits a fitness tradeoff between colony foundation and flight performance manifest through investment in queen abdomen size. Although similar to the tradeoff plants face between investment in seed dispersal ability and energy content, ants must also cope with maneuverability demands of aerial mating. FoF assumes A1) colonies manipulate abdominal fat in their queens, A2) larger abdomens increase foundation fitness, and A3) larger abdomens decrease flight performance. In general, fat content is more important for independent founders that depend on their own body reserves, compared to dependent founders that inherit workers [3]. Flight performance affects all species' dispersal ability, but is especially critical for aerially mating lekkers.[2] As a consequence, FOF predicts that the optimal fat content investment varies with reproductive strategy- lekking vs. calling and independent vs. dependent founding (Fig. 1). The FoF tradeoff model incorporates flight demands of reproduction to increase our understanding of this narrow window of life history.

Methods- I will test the FoF hypothesis using the ca. 400 species ant community of Barro Colorado Island, Panama. This community offers a wealth of data with broad phylogenetic reach, the mating patterns are better known than any other tropical community, and queens of many species from throughout the year are available in the University of Oklahoma collections. First, I will test A1 in the field by harvesting conspecifics throughout the year and measuring variation in abdomen size, and in lab studies by maintaining colonies on a range of diets and following female offspring size. To test A2 I will measure conspecific variation in early egg

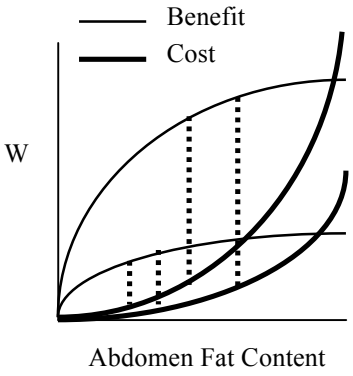

Fig. 1. Fitness as a function of abdomen fat content. Benefits are from increased foundation success; the upper line is for independent founders, the lower for dependent founders. Costs are from decreased flight performance; the upper line is for lekkers, the lower for callers. Vertical lines are fitness optima for given strategies.

production as a function of abdomen size. I will test A3 through a morphological analysis investigating variation in flight performance metrics as a function of abdomen size. Finally, by using data from the literature and my own studies, I will test for reproductive strategy correlates. Specifically, I will test the model's predictions that P1) independent founders, phylogenetically corrected, will have higher fat content than dependent founders, P2) lekkers will have lower fat content than callers, and P3) lekkers will have better flight performance measures than callers. These data will fill a critical gap in our taxonomic knowledge by linking queen and worker morphology, and will be germane to three ancillary questions- 1) do the patterns hold in highly seasonal environments where temperature constrains morphology?; 2) does the tradeoff vary along a productivity gradient or with seasonal food availability?; and 3) do different reproductive strategies have different population genetic signatures, due to differential dispersal, outbreeding, and gene flow? To explore these follow up questions I will sample communities at several research stations within the US, including potential NEON sites, at different latitudes and along a productivity gradient, and investigate the implications for population genetic structure.

Significance and Broader Impacts- This study seeks to replace classical categorical models of ant life history with a new quantitative model based on tradeoffs. Ants are not only intrinsically fascinating, but are also key players in most terrestrial ecosystems. To contribute to an international effort to catalogue ant diversity and identify cryptic species I will DNA barcode each species for genetic analysis. Given that queens of most species can be sampled using passive traps, my taxonomic work will introduce a new tool for biomonitoring ant populations in a changing world. To that end, I will continue to participate in the Oklahoma Biological Survey's annual BioBlitzes to document regional ant diversity and educate the public. I will also take advantage of OU's "Night at the Museum" seminars, guest lectures in our Intro Biology courses, and Oklahoma Teacher Training summer workshops to engage the public and the next generation of scientists

Sources Cited

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