Defending the fortress: comparative studies into disease resistance in ant societies

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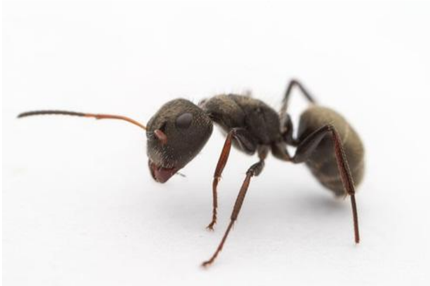
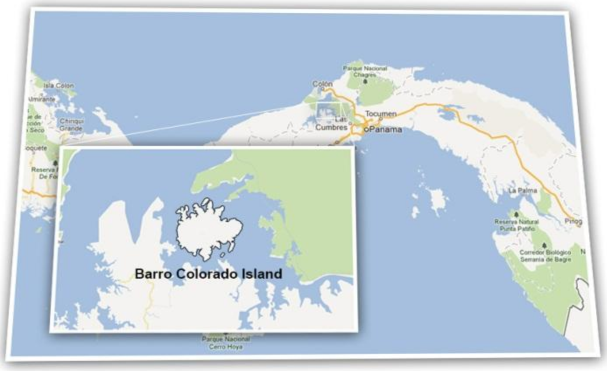


Project Background

Social insects, such as ants, are of tremendous importance, ecologically, economically, and as study organisms in biology. Just as with human societies, their colonies are threatened by disease-causing microbes which have the potential to decimate their societies. However, they generally do not appear to suffer as much from disease as would be predicted. There is therefore considerable interest in understanding the disease resistance mechanisms of social insects. However, our understanding is severely restricted by lack of comparative data for species with different life-histories: with studies generally having focused only on individual resistance mechanisms in individual species. Different disease resistance mechanisms may often be traded-off against one another, or against other traits, and studies are therefore needed which measure resistance through morphological, physiological and behavioural adaptations and selection on immune genes in order to gain an accurate picture of an organism's resistance to disease. In addition, the trade-offs are very likely to be taxa-specific, so information from multiple species as part of a comparative framework is needed in order to understand the resistance mechanisms and to elucidate the factors which drive their evolution in ant societies.

Panama for Ants

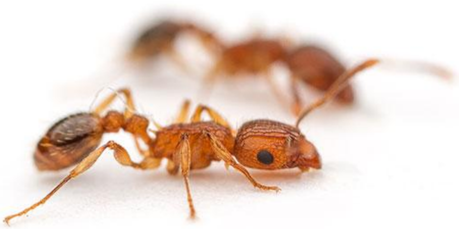
Barro Colorado Island (BCI) is located on lake Gatun which forms part of the Panama Canal. Despite its small size the island is home to over 300 species of ants (compared to just 50 in the UK) and therefore provides an ideal place to study ants and to look at how disease resistance varies with a range of different life-histories.

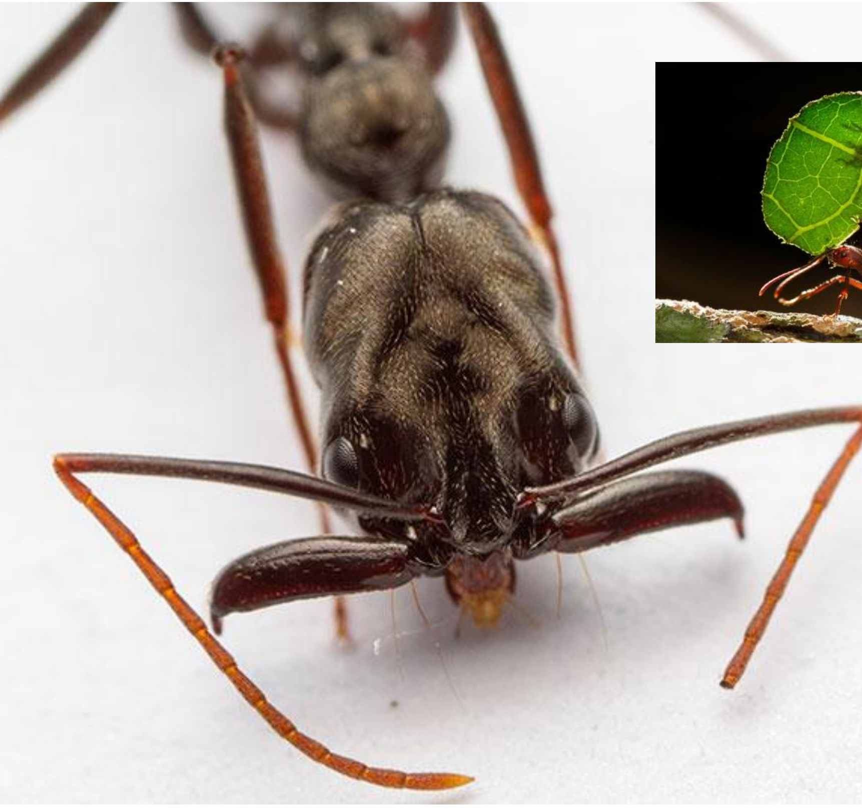


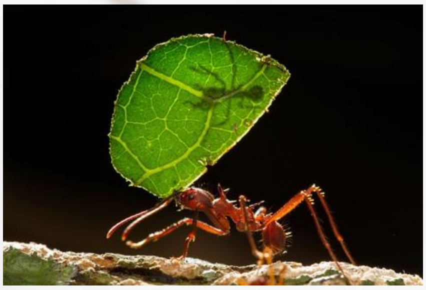
Collection & Results

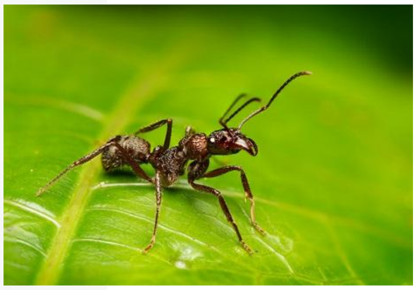
Ant samples were collected using a range of techniques including active searching, leaf litter sifting and baiting to try and sample a wide range of species. These collections were conducted on the forest floor, on low level vegetation and from the canopy in order to sample a range of habitats. Species with different nesting preferences were collected by excavating subterranean nests or exploring cavities in branches and trees. Baits allowed sampling of species with different diets. A number of baiting trials and searches were also conducted at night, to collect species of ant which are strictly nocturnal foragers.

In total 68 different species were collected, preserved and identified under the microscope. For those species collected through active searching or sifting, time was spent in the field observing the ants in order to collect data on their life-histories. These field observations were then augmented with data from the literature to build up a database of key life history information for each species.









Ants were collected that varied in their diet and foraging strategies. The jaws of this *Odontomachus* trap jaw ant (left) can snap shut at up to 200kph making it an effective predator. Other ants such as *Ectatomma* (right) are more generalist scavengers, feeding on scraps and sugary secretions produced by other insects or plants. Perhaps the most unusual case of dietary specialisation is found in the fungus growing ants like this *Atta* worker (centre). These ants cut leaves which they use as a substrate to grow their fungal food-source on.

Impact & Future work

With such a large number of species with such a complete and broad range of life histories it will be possible to conduct detailed comparative studies investigating both morphological and genetic components of disease resistance. I will use these samples to quantify and compare the resistance profiles of multiple ant species which vary in key life-history traits that affect exposure to parasites.

The main part of this work will be formed of a large-scale comparative analysis of important ant immune genes from species with varying backgrounds. By comparing the rate of change of the genetic code in immune genes and non-immune genes it is possible to see which has undergone more change. This comparison can provide evidence of selection on genes and thus may indicate the relative importance of immune genes in different species. This can then be compared firstly to other measures of immunity and disease resistance (e.g. morphological characteristics such as measurements of antimicrobial gland sizes) in order to build a combined picture of the importance of parasite and pathogen pressures in each species. Secondly the information can be compared with important life history traits which may co-vary with disease resistance in order to determine the importance of different traits as predictors of parasite and pathogen pressures. For example, pathogen levels are much higher in soils than on vegetation, so we might expect ant species that live in trees to show reduced investment in disease resistance compared to those that live in contact with the soil.

Conclusions & Acknowledgment

I am extremely grateful to the Alice McCosh Trust whose grant enabled me access to the diverse fauna found in Panama. This opportunity has provided me with the chance to collect a huge number and range of species and has significantly enhanced the scope of my PhD project. Ultimately the information will be useful in developing our understanding of how life history changes can lead to differences in parasite and pathogen pressures and how social insect species have adapted to these risks through investment into disease resistance.