Macroevolutionary Analysis of Queen-Worker Size Dimorphism in Ants

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Abstract

- The evolution of queen-worker size dimorphism gives insight into the mechanisms leading to the reproductive division of labor.
- We measured the head and body sizes of queen and worker specimens from 749 ant species and performed a preliminary analysis.
- Phylogenetic comparative methods (PCMs) showed that these traits are not independent when considering the underlying phylogeny.
- We used rate correlation analysis to estimate the relative evolutionary rates of queen and worker traits. Queen traits evolve more quickly than worker traits.
- Results support the hypothesis that worker traits experience indirect adaptive selection through the direct selection of queen traits.

Introduction

Our questions:

(1) Do queen and worker size evolve independently across the phylogeny?

(2) Does queen or worker size evolve more rapidly?

Our hypotheses:

If queen size follows a specific evolutionary pattern, then worker size will follow a similar and integrated pattern.

Queen size evolves more rapidly than worker size.

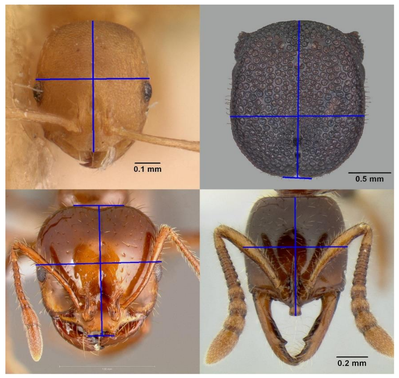
Our reasons:

This is because of limitations in dimorphism due to shared differentiation pathways.

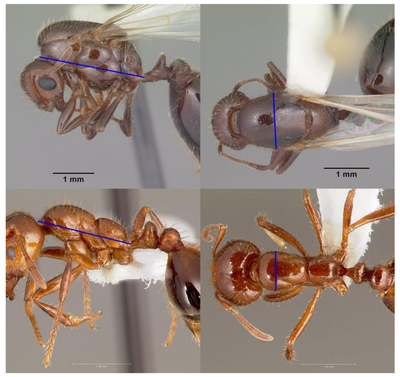
The indirect social effects of worker evolution experience weaker selection than the direct contributions of reproductive queens.

Methodology

Data collection:



We measured head length (vertical lines) and head width (horizontal lines) for 749 species.



We measured mesosoma length (left column panels) and mesosoma width (right column panels) as well.

Analysis:

Import phylogeny construct visuals

Calculate mean trait values

Log transform for normal distribution

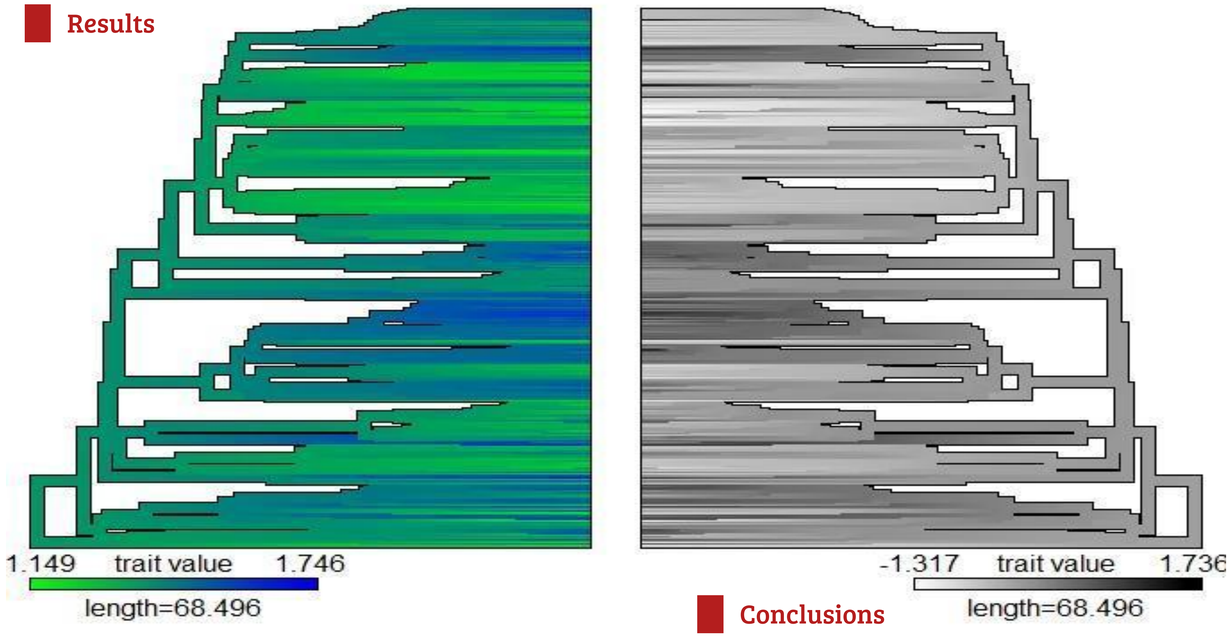
PCMs in Rstudio

Principal component analysis (PCA) (not depicted)

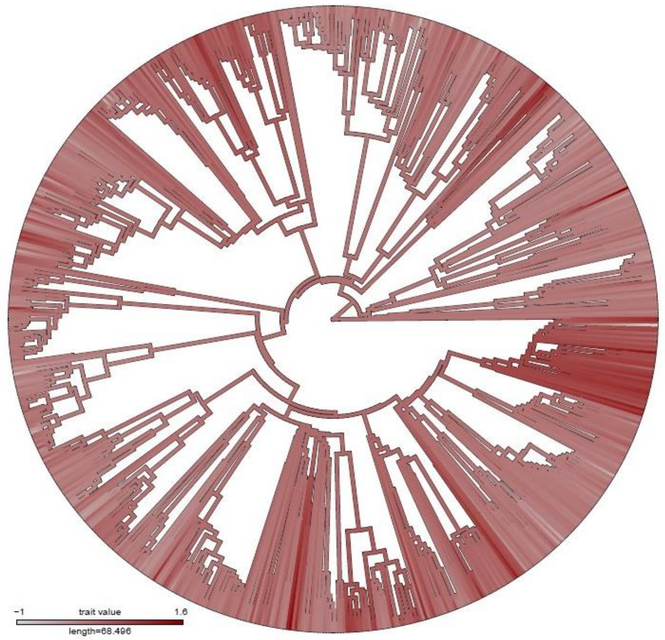
Phylogenetic generalized least squares (PGLS) regression

Rate correlation analysis

Results



Above: **Side-by-side phylogeny of** mean queen head length (left) and mean normal worker head length (right). *Below:* **Fan phylogeny of** head width ratio between queens and normal workers.



Conclusions

- All measured traits have positive correlations with one another.
- Head width dimorphism evolves in a similar pattern as mesosoma length dimorphism.
- Side-by-side phylogenies show that certain traits are highly correlated (with the ancestral state having intermediate trait values).
- The evolutionary rates of queen and normal worker traits are significantly different, with queen traits evolving more rapidly.
- Different traits may bear different levels of importance in promoting ecological speciation.

References

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