Behavioural and chemical correlates of reproductive hierarchies in the queenless ant Dinoponera gigantea (Formicidae, Ponerinae)

Chloé Leroy, Fabrice Savarit, Dominique Fresneau, Nicolas Châline

Laboratoire d'Ethologie Expérimentale et Comparée, PRES Sorbonne Paris Cité,
Université Paris 13, Villetaneuse, France
e-mail :leroy@leec.univ-paris13.fr

- *Dinoponera gigantea* is one of the biggest ants in South America. Workers are identical but in each colony one of them mates and reproduces sexually, becoming what has been called a **gamergate**. **Subordinates** workers generally have undeveloped ovaries whereas **high-ranking workers** can lay unfertilized eggs.

- In this species, the **hierarchy** is maintained through specific **ritualized behaviour** such as gaster rubbing, blocking and immobilization. **Young individuals** usually challenge the hierarchy shortly after emergence.

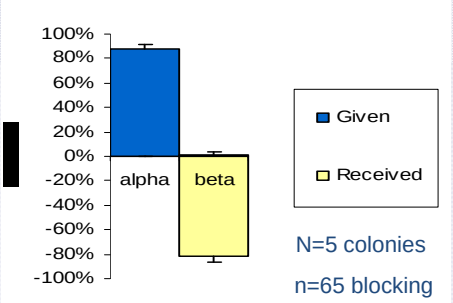
Gaster rubbing | Blocking | Immobilization

- The *Dinoponera gigantea* colonies studied were collected in Belém, state of Parà, Brazil.
- Firstly, we characterized the **hierarchies** in colonies to identify the **top-ranking workers**. Several behaviours were observed : gaster rubbing, gaster curling, blocking, antenal boxing, licking, submission and immobilization. **Blocking** was the most useful behaviour to define the hierarchy.
- Secondly, we analysed cuticular extracts of young, high and low-ranking individuals by Solid Phase MicroExtraction (SPME) and Gas Chromatography coupled to Mass Spectrometry (GC-MS) to relate the **dominance rank** to the production of **cuticular hydrocarbons**.
- A fused-silica fiber coated with 7µm PDMS was rubbed directly against the membranes of the abdomen for 2 min and organic compounds are adsorbed into the stationary phase.

Solid Phase Micro Extraction (SPME)

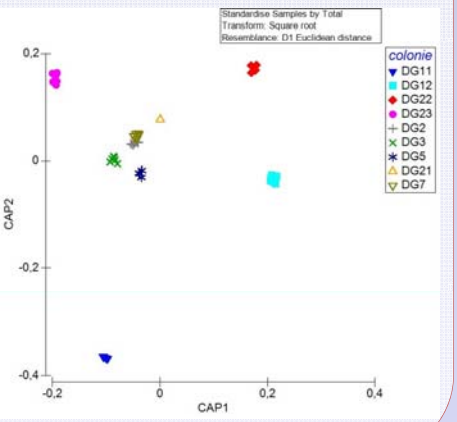
SPME Fiber

Figure 1: ***Average number of blockings given and received by the 2 high-ranking workers in the hierarchy***



The behavior of blocking makes it possible to identify only an Alpha and a Beta in the colonies.

Figure 2: ***Discriminant analysis showing differentiation of each colony using only the low-ranking workers***



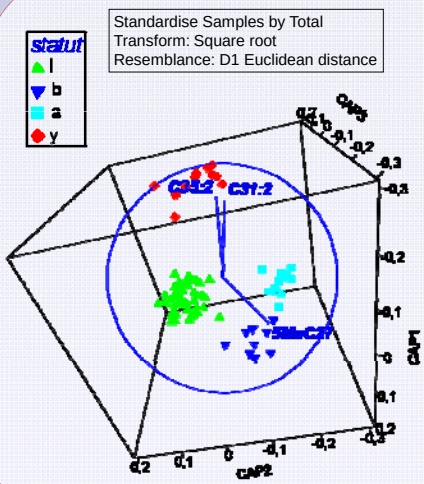


Figure 3: ***Canonical analysis showing differentiation of cuticular profile of young (y), high-ranking (a: gamergate and b : Beta) and low-ranking (l) workers.***

5-Methylheptacosane (5MeC27) is associated with the hierarchical dominance of the high-ranking individuals.

Our chemical analyses of cuticular hydrocarbons showed a correlation between the relative proportion of Dienes C31:2 , C35:2 and the young individuals, also involved in the hierarchy.

Conclusion :

The study of a particular interaction, called blocking, observed between a small number of individuals in each colony, is particularly useful when studying the dominance hierarchy . In particular, blocking can be used as a **behavioral marker** of the alpha rank, and it also identifies beta.

The present study indicates that **chemical cuticular profiles** combined with **aggressive interactions** allow ants to stabilize the hierarchy of dominance in colonies. The dominance hierarchy is linked to the production of cuticular hydrocarbons reflecting the reproductive activity of ants.

Young individuals, which challenge the established hierarchy also exhibit specific profiles, which may be used as a marker of their status and trigger other behaviors such as immobilization.

The other observed behavior need to be analyzed to investigate more finely the relationships between colony members, especially **licking** and **antennal boxing** which may evidence more **complex networks** inside colonies. These networks may have a function in regulating colony life, for example during colony fission.

References:
Monnin T , Peeters C Behavioral Ecology 1999;10:323-332