Aggregation Behavior in Polymorphic Foragers of the Japanese Carpenter Ant (*Camponotus japonicus*)

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BACKGROUND

Social insects exhibit division of labor (Polyethism)
(Hölldobler and Wilson, 2008; Wilson, 1985)

Factors affecting polyethism
- Age
- Size
- Colony composition
- Dominance interaction

Behavioral differences based on size
- Foraging
- Defending territory
- Brood-tending
- Aggregation behavior

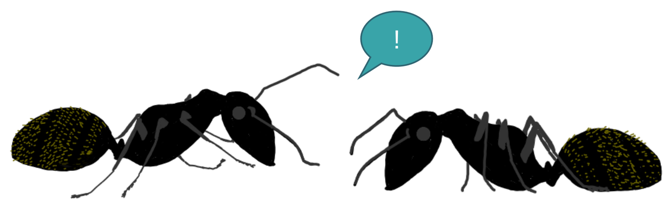
Why aggregation behavior?
- Critical for colony maintenance and survival (Depickere et al., 2008).
- Smaller workers mainly forage and are agile, while larger ants defend the colony and show less mobility, which may affect aggregation behavior (Tross et al., 2022).

Ultimate Goal

To investigate the **behavioral differences in the aggregation behavior between different size classes** of worker ants in Japanese carpenter ant, *Camponotus japonicus*.

Hypotheses

1. *Clustering propensity* would differ in different size classes.
2. *Immobile* ants would affect clustering propensity.
3. *Spatial isolation* from the cluster would differ in immobile ants between different size classes.



METHOD

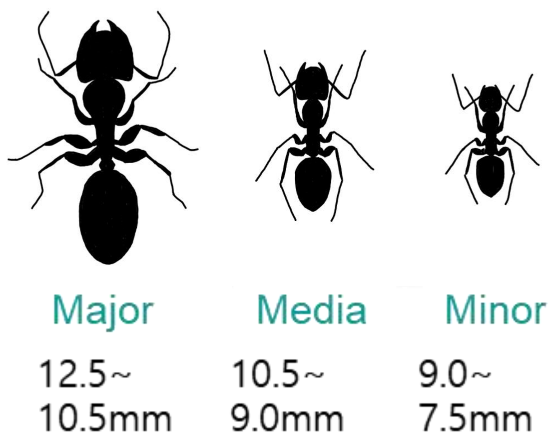
1. Ant collection

Colony1 — Majors, medias, minors; 16 ants per size

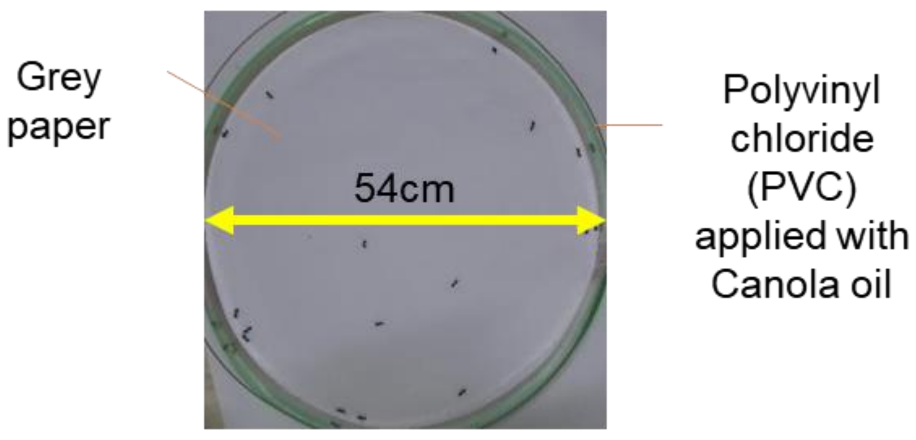
Colony2

…

Total 8 colonies

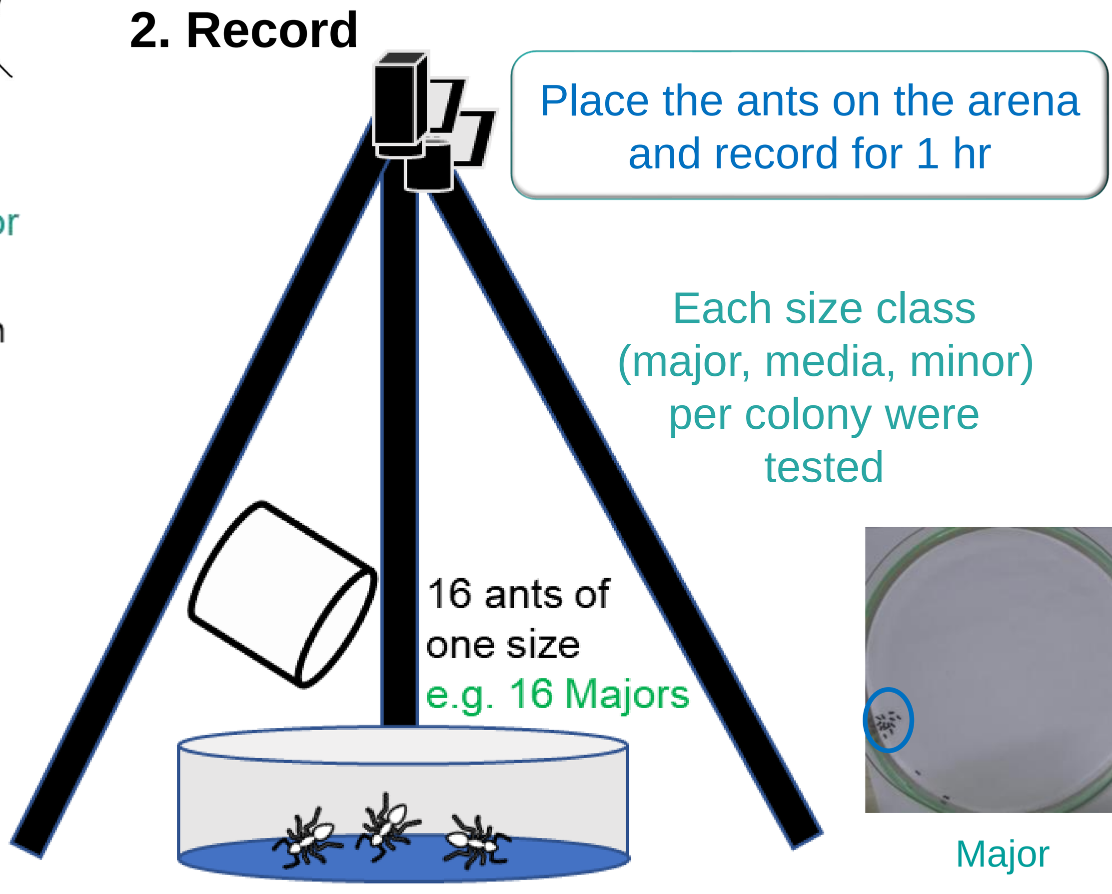


- Ants were collected from field colonies and brought indoors for the experiment
- Only foragers were tested to minimize the effect of age polyethism
- Ants were classified in three size classes



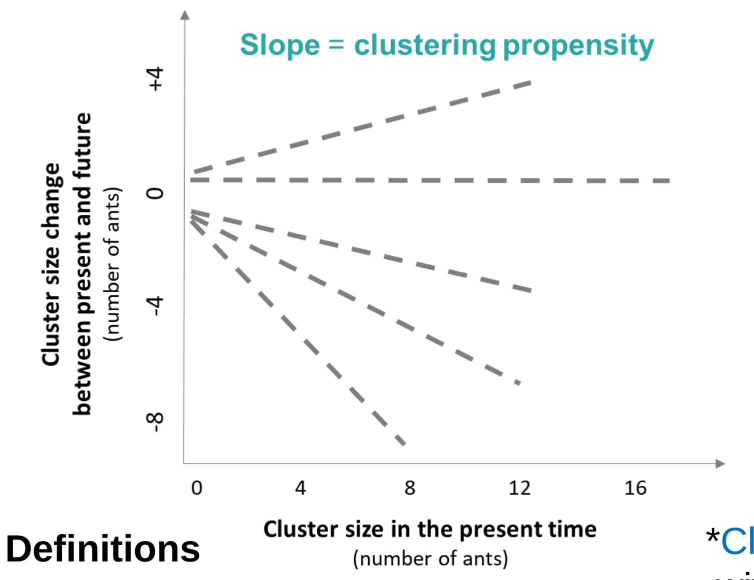
Arena

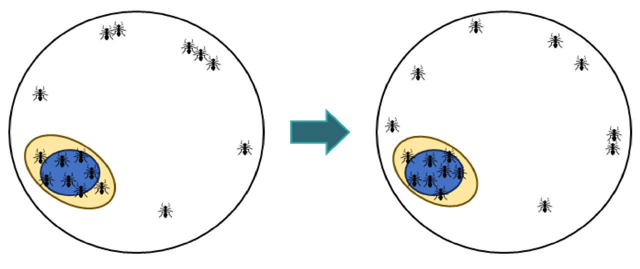
2. Record



Each size class (major, media, minor) per colony were tested

3. Analysis





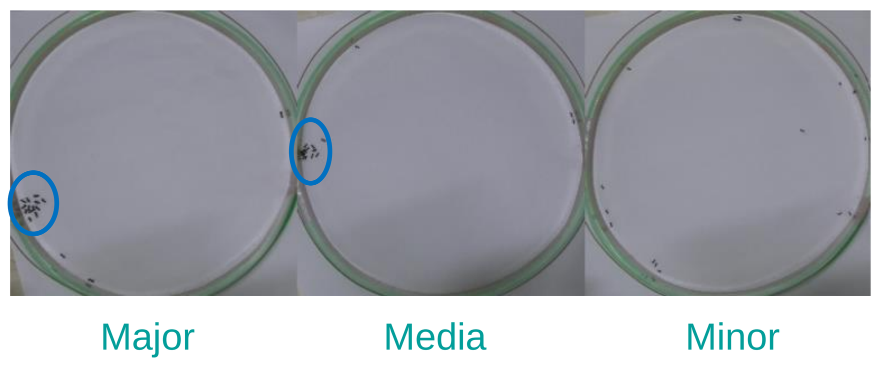
(= present time +10sec)

Videos were analyzed every 10 seconds by linear modeling

Definitions

*Cluster = analyzed only the *largest cluster* at the time.

*Cluster size = number of ants within the radius of 5cm of the cluster



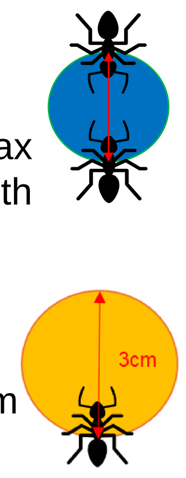
*Cluster = 2 or more ants being within the interactable distance.

*Interactable distance = when thorax to thorax distance ≤ ant body length (without antennae) * 2

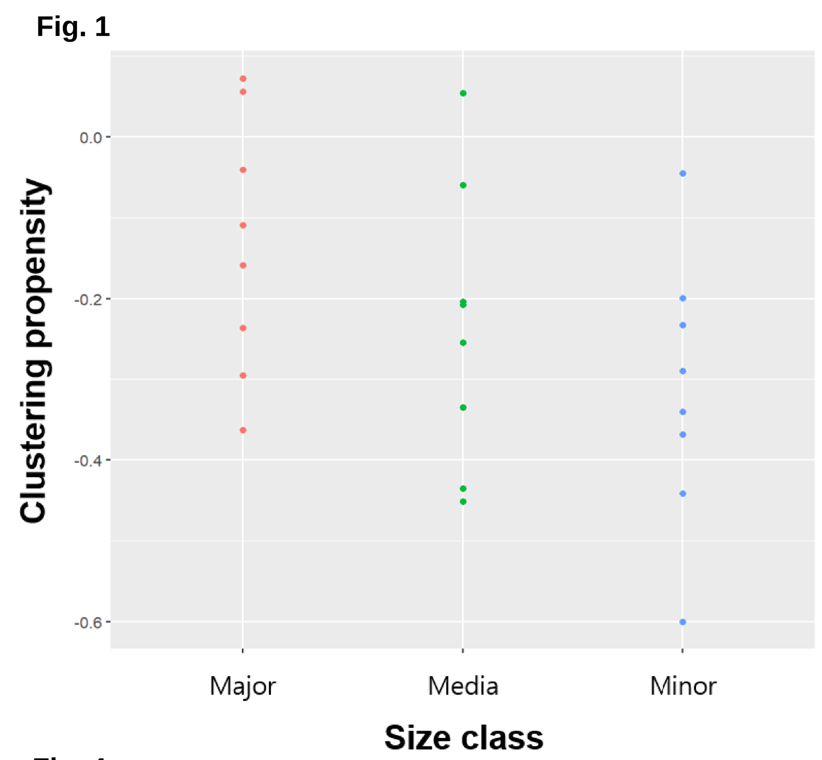
*Clustering propensity = slope of cluster growth on the cluster size

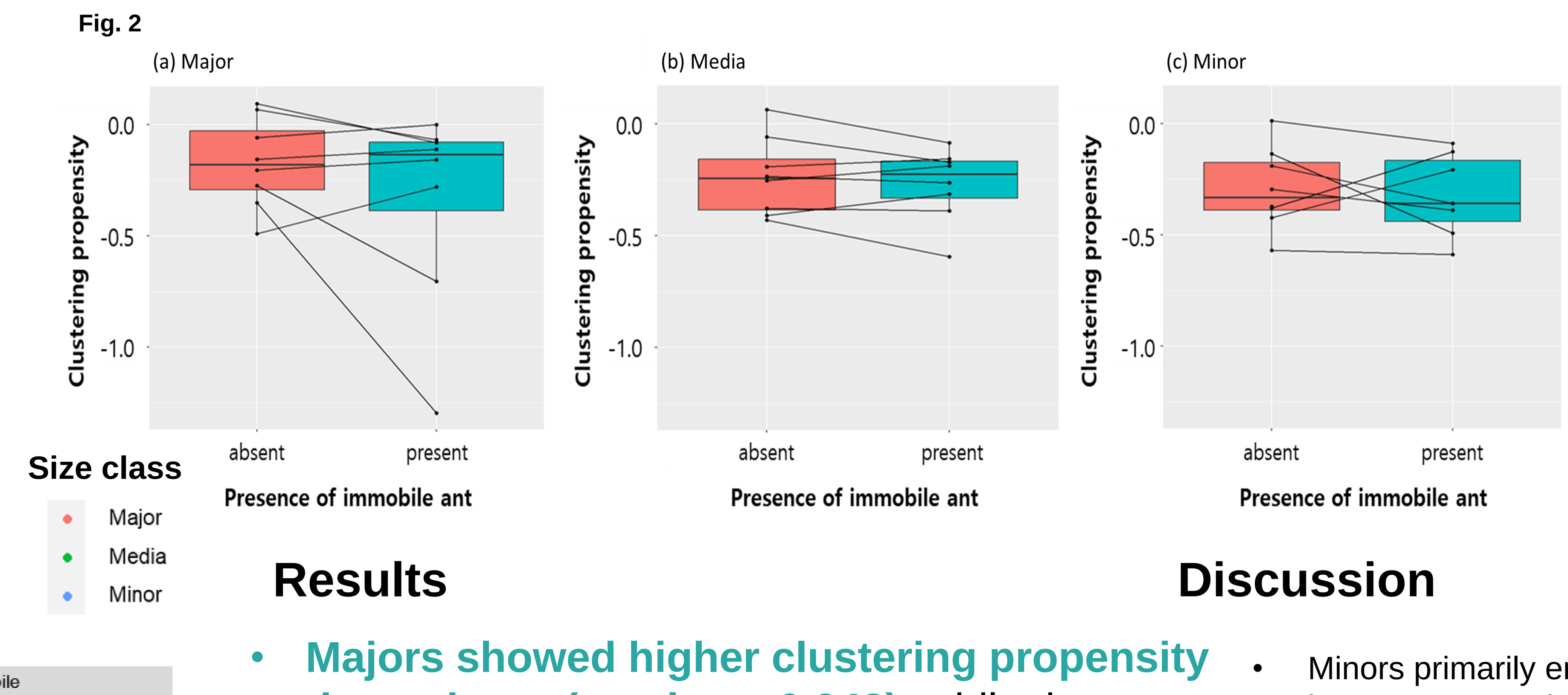
*Immobile = Moving less than 3 cm per 10 seconds for 5 minutes

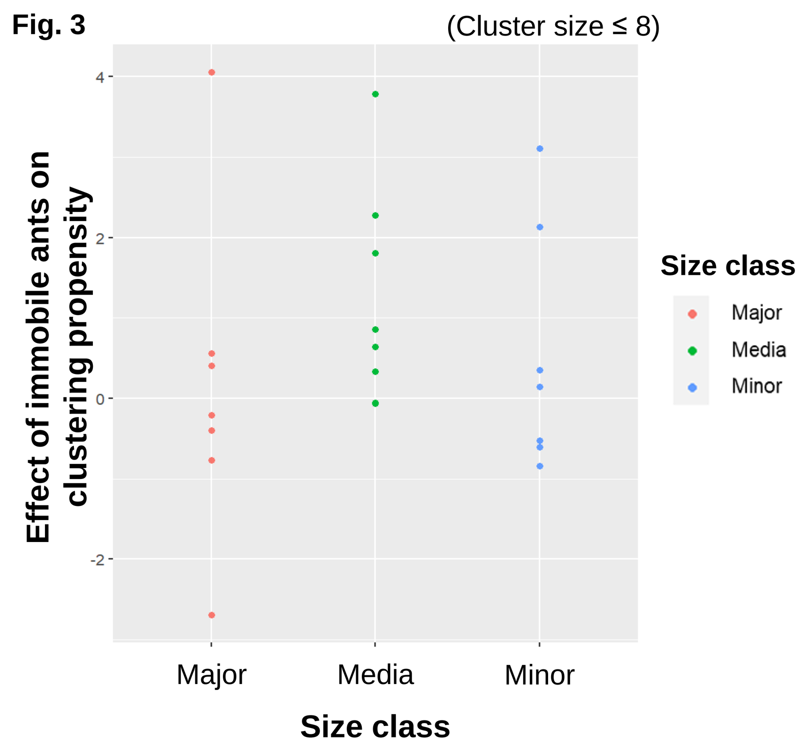
*Mean distance of ants to the cluster = Mean distance of ants from the centroid of the cluster

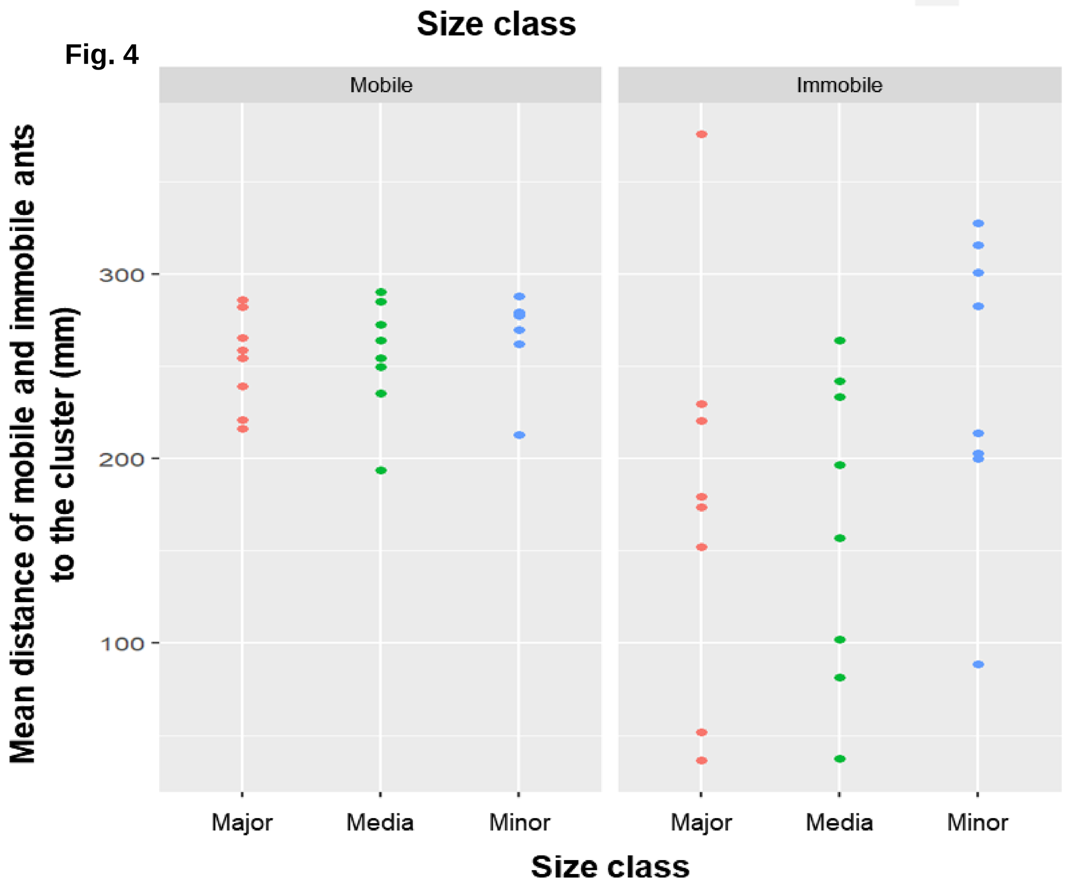


RESULTS & DISCUSSION









Results

- **Majors showed higher clustering propensity than minors (p-value = 0.043)**, while there was no significant difference between majors and medias (Fig.1).
- While there was no effect of presence of immobile ants on clustering propensity (Fig.2), **immobile ants seemed to affect (marginally nonsignificant, p-value = 0.067) clustering propensity when cluster size was below 8** (Fig. 3).
- **There were no significant differences in the mean distance of immobile ants to the cluster between different size classes** (Fig.3).

Discussion

- Minors primarily engage in foraging and exhibit agile movements, in contrast to majors and medias. Therefore, polymorphism and division of labor may correlate with aggregation behavior.
- Immobile ants are known to spend more time inside the center of the nest compared to active workers (Charbonneau et al., 2017). This behavior may serve as a cue for a nest-like (safe) place and attract other active ants.
- Understanding the mechanism of aggregation behavior in ants will **provide insights into their social organization, communication mechanisms, and decision-making processes**. Additionally, comprehending the influence of immobile ants on other individuals in this behavior will offer insights into the **spatial organization within ant colonies**. While previous studies have primarily focused on age-related differences in cluster formation (Sempo et al., 2006; Depickere et al., 2008), research based on body size has been limited. Therefore, this study may serve as a crucial link to future research on the aggregation behavior of polymorphic ants.

REFERENCES

- Charbonneau, D., Poff, C., Nguyen, H., Shin, M. C., Kierstead, K., and Dornhaus, A. (2017). Who are the "lazy" ants? The function of inactivity in social insects and a possible role of constraint: immobile ants are corpulent and may be young and/or selfish. Integrative and comparative biology *57*, 649-667.
- Depickere, S., RAMÍREZ ÁVILA, G. M., Fresneau, D., and DENEUBOURG, J. L. (2008). Polymorphism: a weak influence on worker aggregation level in ants. Ecological Entomology *33*, 225-231.
- Hölldobler, B., and Wilson E.O. (1990). The Ants. (Springer)
- Sempo, G., Depickere, S., and Detrain, C. (2006). Spatial organization in a dimorphic ant: caste specificity of clustering patterns and area marking. Behavioral Ecology, *17*, 642-650.
- Tross J., Wolf H., Pfeffer S.E. (2022). Influence of caste and subcaste characteristics on locomotion in the ant *Camponotus fellah*. Journal of Experimental Biology *225*.
- Wilson E.O. (1985). The sociogenesis of insect colonies. Science *228*, 1489–95.