

# Caste evolution

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# Caste outline

1. Defining and describing the phenomenon of caste
2. Caste evolution and diversity
3. Castes as adaptations
4. Caste development
5. Constraints on caste evolution and diversity

# I. Defining and describing caste

- **Broad definition:**  
The evolution of different (morphological) phenotypes within an animal society
- What does 'different' mean?
  - Broad size range
  - Continuous change in shape across size range
  - Discrete morphological forms



# Types of caste: Reproductive vs. workers



*Myrmecina*



*Neivamyrmex*



# Types of caste: Worker caste diversity



*Pachycondyla*



*Eciton*

# Types of caste: Reproductive caste diversity

- Queen size dimorphism is widespread (*Leptothorax*/*Temnothorax*, *Solenopsis*, *Ectatomma*)
- Wingless queens, reproductive intercastes, and gamergates (very diverse in the poneroid ants)
- Male dimorphism, with a fighting caste (*Cardiocondyla wroughtoni*)

## 2. Caste evolution and diversity

- Four insect orders in which castes have evolved
  - Blattoidea (Termites)
  - Hemiptera (Aphids)
  - Thysanoptera (Thrips)
  - Hymenoptera (Ants, bees, free-living wasps, polyembryonic parasitoid wasps)



# Termite caste evolution and diversity

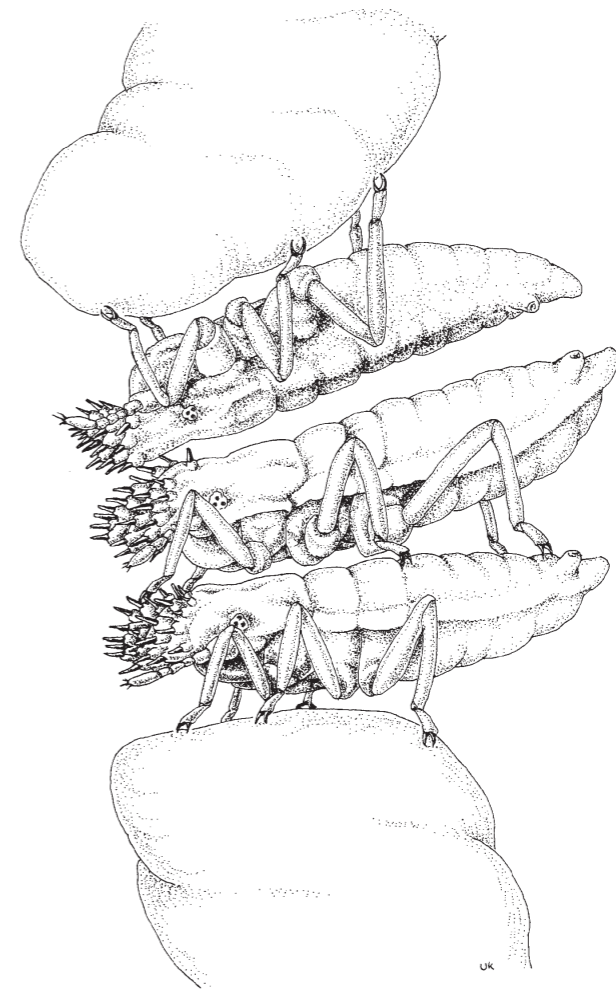
- Soldier caste evolved once and early - substantial diversification
- More than one origin of a true worker (forager) caste





# Aphid caste evolution and diversity

- At least four independent origins
- Fighting and blocking morphs



# Thrips caste evolution and diversity

- Single origin of fighting soldiers





# Hymenoptera caste evolution and diversity

- Multiple origins of female reproductive castes in bees and wasps, some examples of simple worker caste diversity
- Polyembryonic wasps (family Encyrtidae) have fighting and reproductive castes
- Single origin of female reproductive castes in ants, but many independent origins of worker caste diversity

# Recurrent trend: Soldier morphotypes



Active defense against vertebrates



Active defense against arthropods



Passive defense against vertebrates



# Other castes



Seed millers



Prey transport



Brood tending



Food storage



### 3. Castes as adaptations

- General assumption is that castes are adaptive traits of the colony (colony is the organism)
- Two complementary approaches to studying performance
  - Mechanistic studies of caste role within colony organization (comparisons between colony members)
  - ‘Ecological performance’ studies of how caste improves the handling of particular ecological tasks and colony fitness (interactions between caste and environment)



# Caste roles

- Test predictions about the specialization on and performance of certain tasks compared to other castes
- Work profiles of castes
- Focal castes relative efficiency of handling tasks

# Performance studies of adaptation

Environment



Phenotype



Performance



Fitness

## Adaptation:

The evolution of a beneficial fit between phenotype and environment

## General Prediction:

The interaction between common/predictable environmental conditions and mean phenotype should result in maximal performance and fitness



# Performance studies of adaptation

- Comparative evidence of a relationship between caste phenotype and environment informs performance studies
- Caste performance under range of natural conditions
- Does caste achieve maximal performance under common conditions?
- Does performance gain matter for colony fitness?

## 4. Caste development

- Example of polyphenism: different phenotypes arising from a single genotype as a result of differing environmental conditions
- Mechanisms that result in shifts in developmental pathways are diverse across taxa
- Some genetic influence in taxa that do not have clonal colonies



## 5. Constraints on caste evolution and diversity

- Developmental machinery
- Conflict
- Genetic diversity
- All may be more or less significant depending on the history of each particular lineages (phylogenetic constraints)