Chapter 3.1 - 3.3

Division of Labor and Task Allocation

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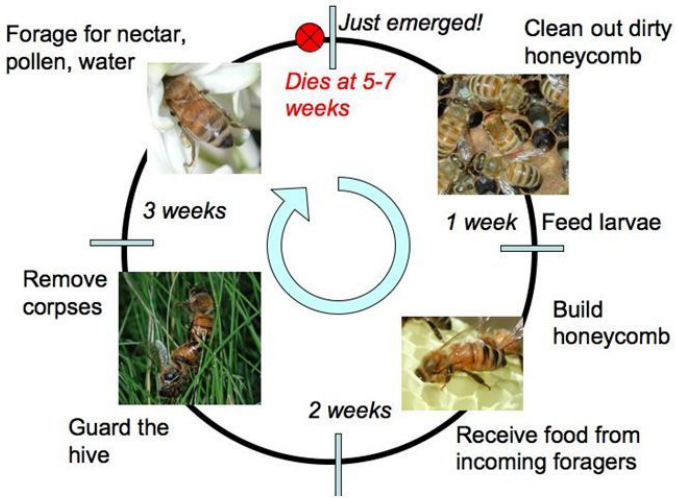
Division of Labor in Social Insects

Plasticity

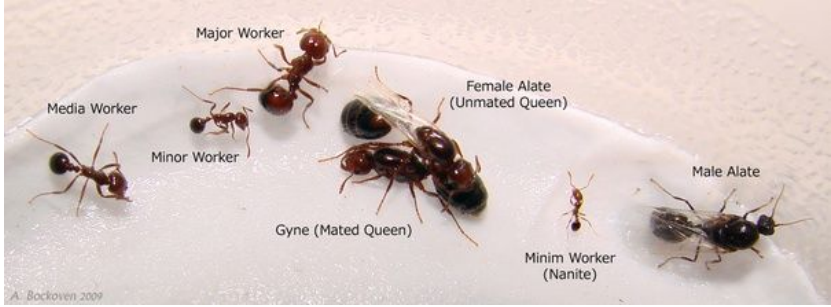
- Division of labour is rarely rigid
- Ratio of workers performing different tasks vary with changing conditions
  - Food availability, predation, climatic conditions, time of year
- Changing conditions can be induced experimentally by altering colony size, structure, demography, or by increasing the need for nest maintenance, nest repair, defense etc.

Double reinforcement process



- Workers performing a task induce decrease of response threshold
- Not performing a task induces an increase of threshold
- Leads to emergence of specialised workers
    - Specialised workers are more responsive to stimuli associated with particular task requirements.

3 Forms of Labor Division



1. Temporal polyethism
   - Individuals in the **same age class** form an age caste.

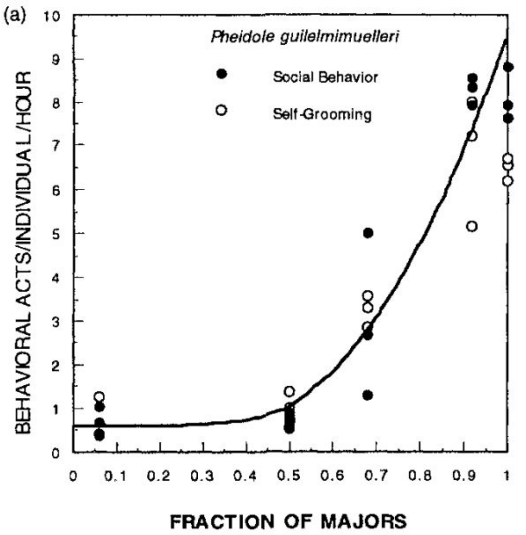
2. Worker polymorphism
   - Workers that differ in their **morphologies** belong to different morphological/physical castes.

3. Individual variability
   - Groups of individuals that **perform the same set of tasks** form a behavioural caste.

Wilson Experiment

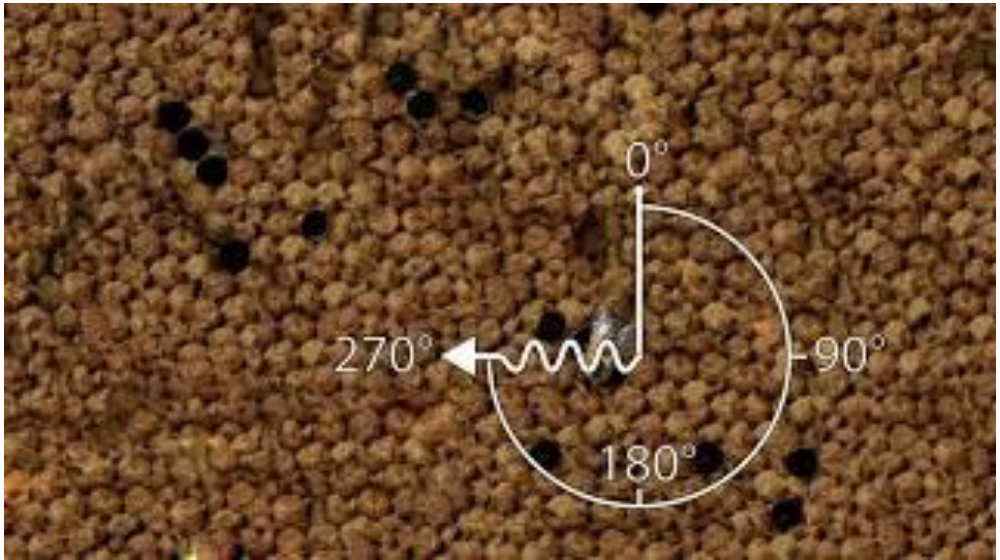
Experimentally altered structure of *Pheidole* (Big-Headed Ant) to observe labor division

- Population divided to Majors and Minors
  - Minors - Smaller in size; take care of mundane daily tasks
  - Majors - large headed; specialize in seed milling, abdominal food storage, or defense
- Changed ratios of Majors and Minors → led to observation that Majors ‘filled in’ when minors were less available
- Inspired response threshold models by Bonabeau et al.

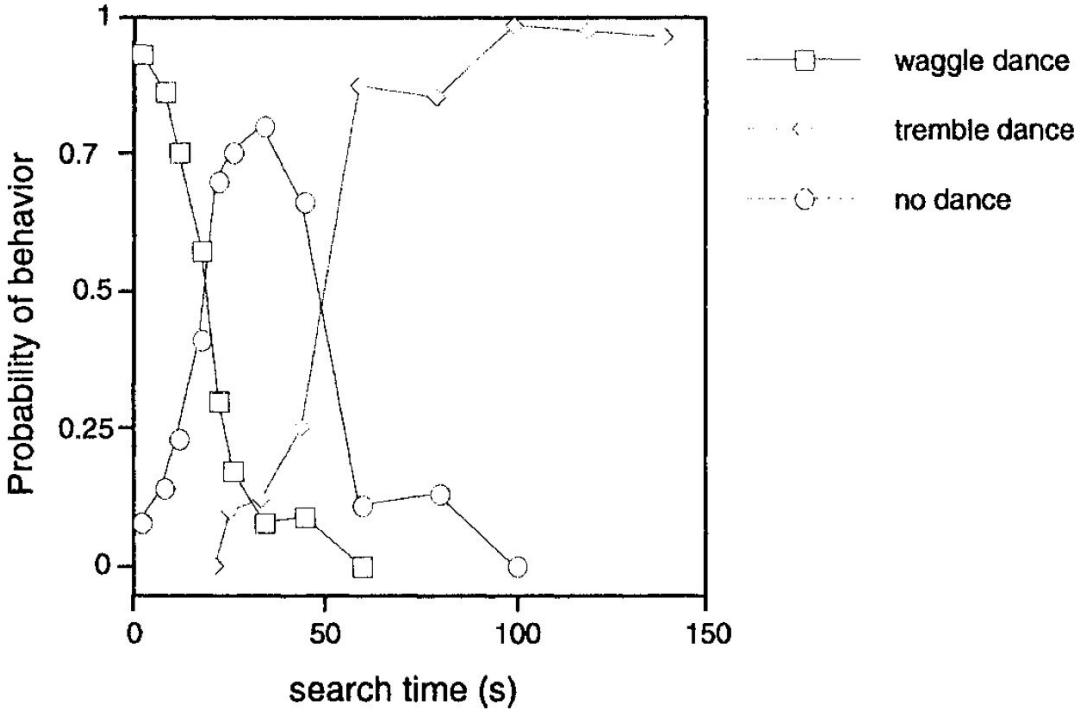


Response threshold, θ

- Likelihood of reacting to task-associated stimuli
- Low-threshold individuals perform tasks at a lower level of stimulus than high-threshold individuals
- Example of response threshold: honey bees performing a “waggle dance”



Response threshold, θ



- The graph shows probabilities of performing a waggle dance and a tremble dance against in-hive search time for foragers visiting the nectar source
- Stimulus of the honey bee waggle dance: communicate the location of a food source to other forager bees in the colony.

Response threshold, θ

Eqn 1: Threshold response function

$$T_\theta(s) = \frac{s^n}{s^n + \theta^n},$$

$T_\theta(s)$ - probability of performing task
s - intensity of stimulus associated with task
θ - individual response threshold
n - defines ‘steepness’ of threshold, set as 2

Response threshold, θ

Eqn 2: General Exponential response function

$$T_\theta(s) = 1 - e^{-s/\theta}$$

$T_\theta(s)$ - probability of performing task
s - intensity of stimulus associated with task
θ - individual response threshold

Common response threshold model to be aware of! Good for tasks where stimulus is encountered with fixed probability of processing the item (Like bees removing corpses)

Thank You! Questions?