

# Sociality in Wasps and Bees



Photo: [wikimedia commons](#)

# Bees, Wasps, and Humans

- Culturally important to humans: folklore, fables, art, animated movies, symbols.  
Example: Utah is the 'Beehive State'
- Honey is an important food for humans and other animals
- Honey bee value to the commercial honey industry along with pollination in the agriculture industry is valued in the **billions** per year in the U.S. alone.

# Outline

- I. Degrees of Sociality
- II. Eusociality
- III. Social wasps
- IV. Eusociality in Bees
- V. Bee Communication
- VI. Inquilines and Parasites
- VII. Evolution of Eusociality
- VIII. Success of Eusocial Insects

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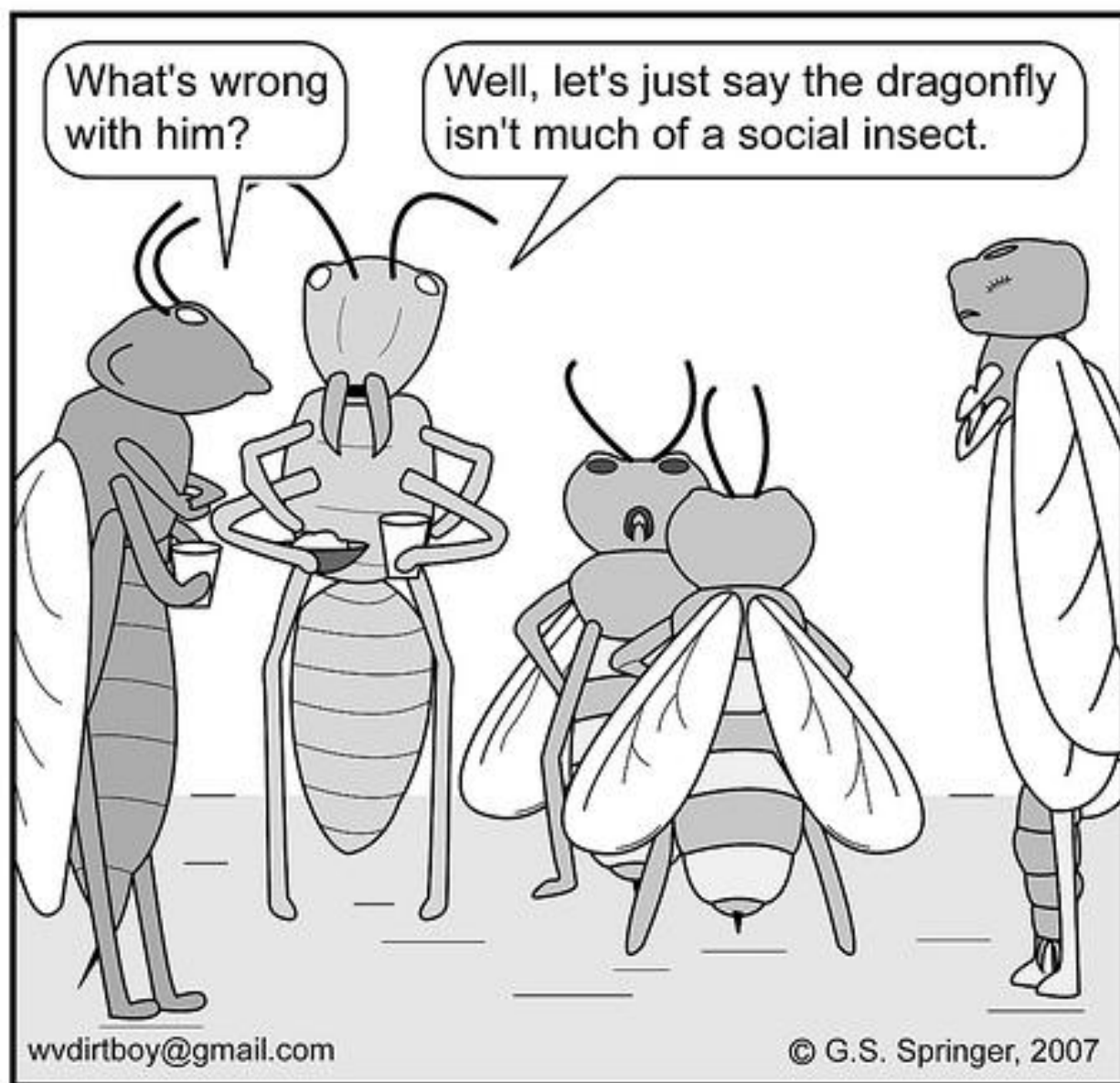
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EVEN AMONG THE SOCIAL INSECTS, SOME  
INDIVIDUALS ARE CLEARLY ANTI-SOCIAL

# Degrees of Sociality

- Solitary: exhibit no social behaviors-most arthropods
- Subsocial: adults care for their own nymphs or larvae
- Communal: members of the same generation use the same nest without cooperating in brood care
- Presocial:
  - Quasisocial: members of the same generation use the same nest and cooperate in brood care
  - Semisocial: same as above plus reproductive division of labor





At An Insect Party

# Solitary Bees



[Wildaboutgardens.org](http://Wildaboutgardens.org)

# Subsocial Aggregation



- Monarch Butterflies practice gregarious overwintering
- Common among aposematic phytophagous insects



# Basic Definition of Eusociality developed by Suzanne Batra and E.O. Wilson

- overlap of adult generations,
- reproductive division of labor, and
- cooperative care of young.

# Eusociality in Hymenoptera

## Terms:

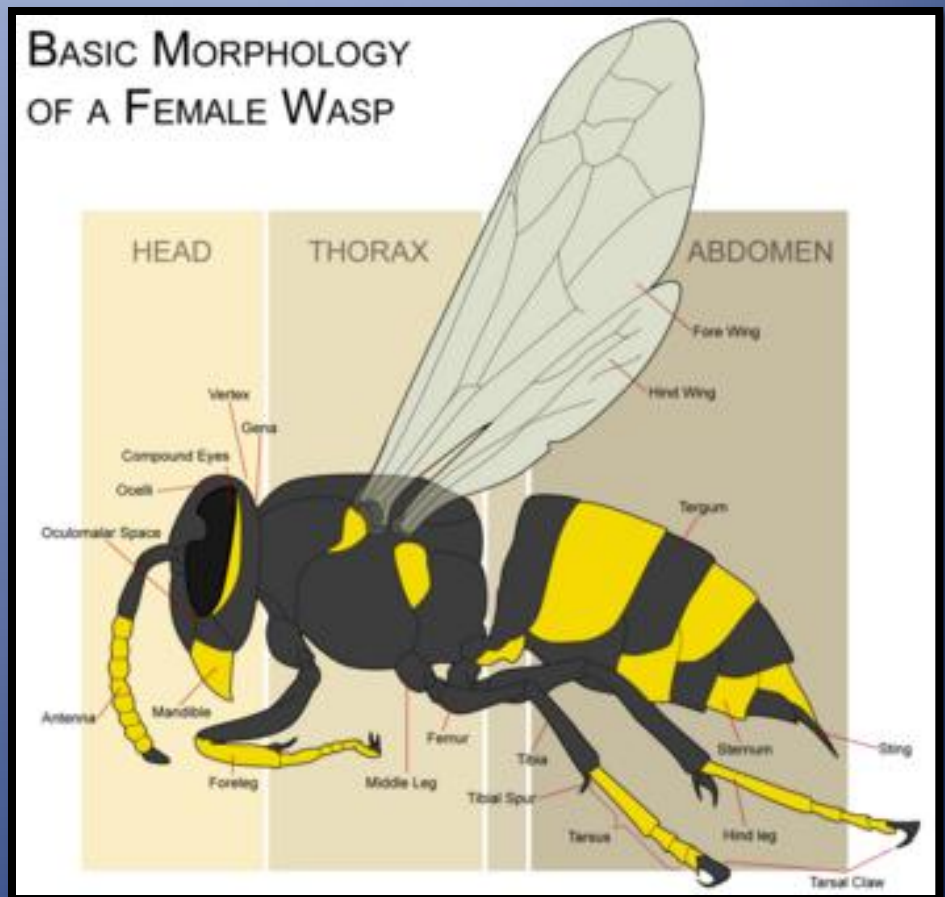
- Queen: sole reproducer(s)
- Workers: non-reproducing individuals who assist queen
- Soldiers: defensive units
- Brood: developing offspring



# Social Wasps

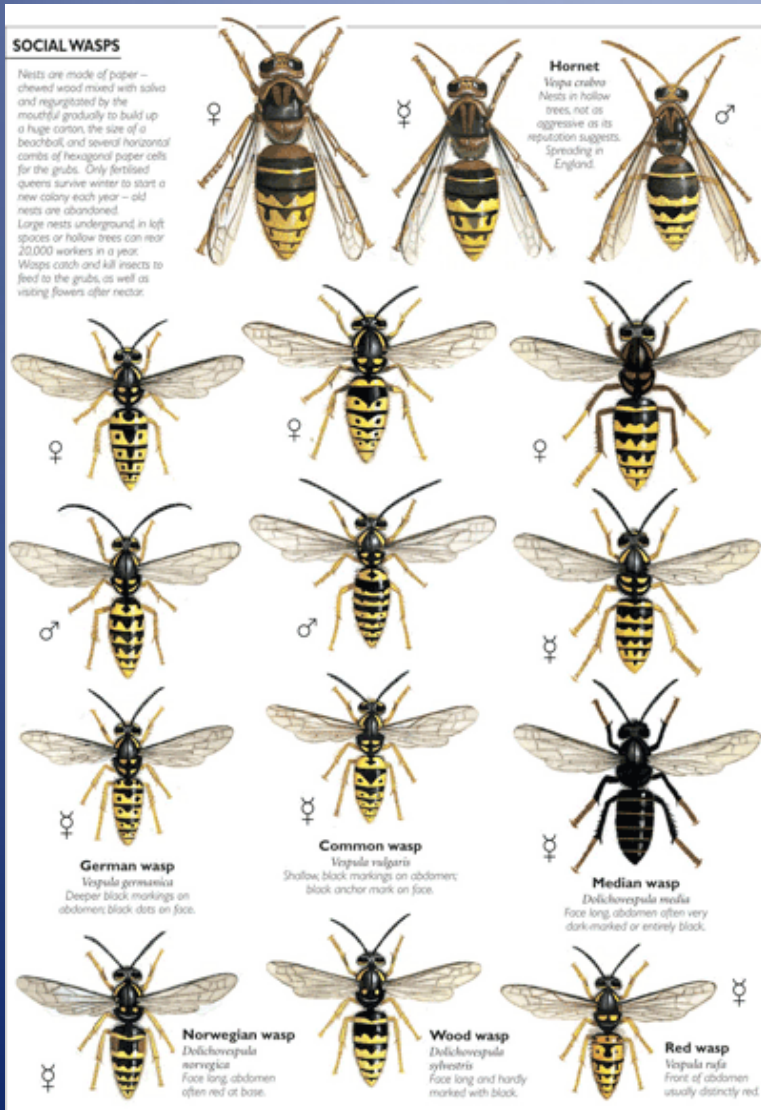


Beeremovalinflorida.com



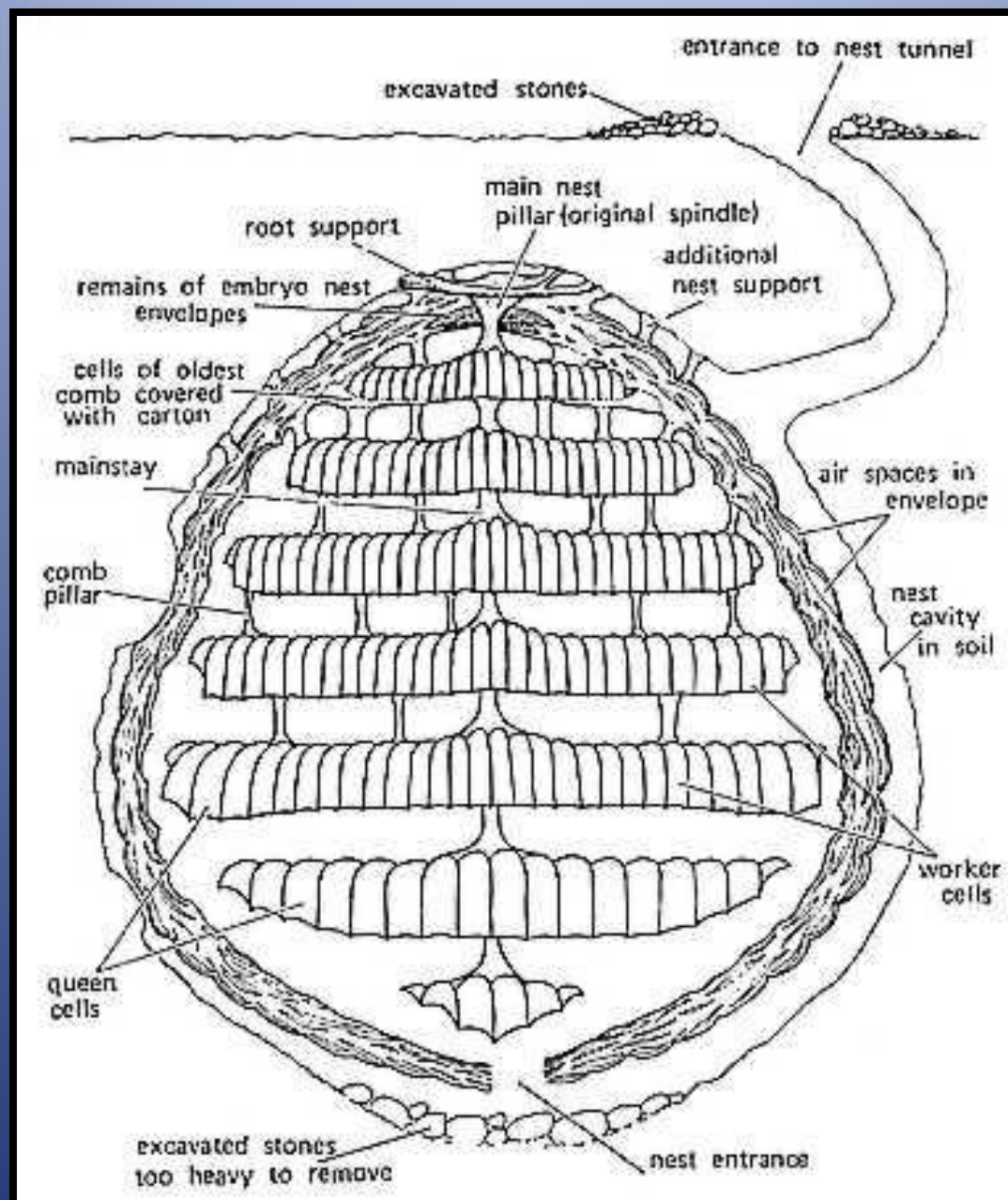
Newworldencyclopedia.org

# Social Wasp Caste Structure



- All females have the potential to become queens
- One female establishes dominance during first generation, all other females then become workers
- If queen becomes weak or dies another female can assume the role





# Wasps are Key Predators in Many Ecosystems



# Eusociality in Bees



- Dimorphic female castes
- Workers exhibit age polyethism in relation to various tasks
- Caste differentiation is trophogenic: determined by larval diet
  - i.e. Honey Bee queen gets “royal jelly”
- Queen uses pheromones to control worker’s reproduction
- Drones: males produced solely for the purpose of mating



# Caste Society in Bees

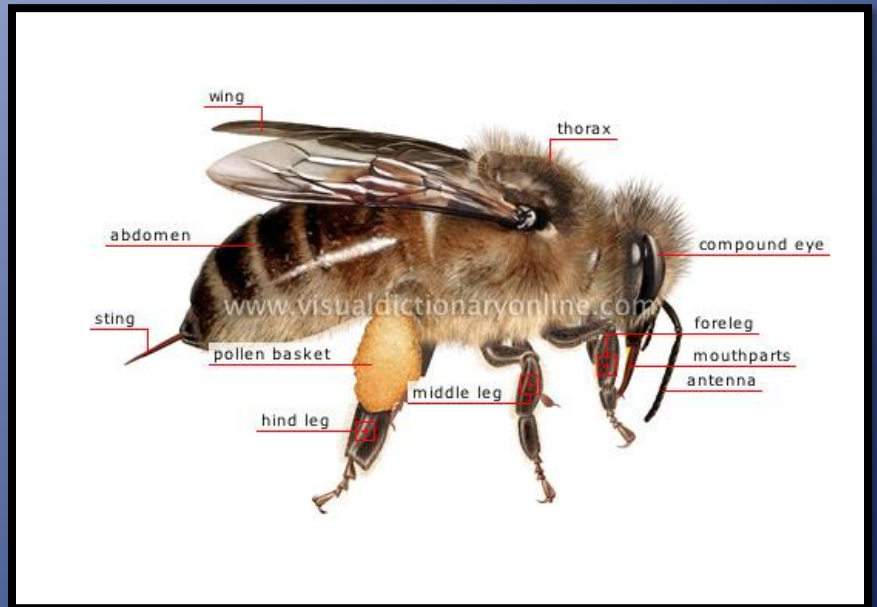
| Type of adult bee | What they do                                      | How many in a honey bee colony | How many in a bumble bee colony                | What they look like in a honey bee colony                                            | What they look like in a bumble bee colony                                            |
|-------------------|---------------------------------------------------|--------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Queen             | Lay eggs                                          | 1                              | 1                                              |   |    |
| Worker            | Take care of larvae, build and clean nest, forage | 10,000-50,000                  | Less than 50 to over 400, depending on species |   |    |
| Male              | Leave nest to mate, then die                      | 100-500                        | 0-50, depending on species and season          |  |  |

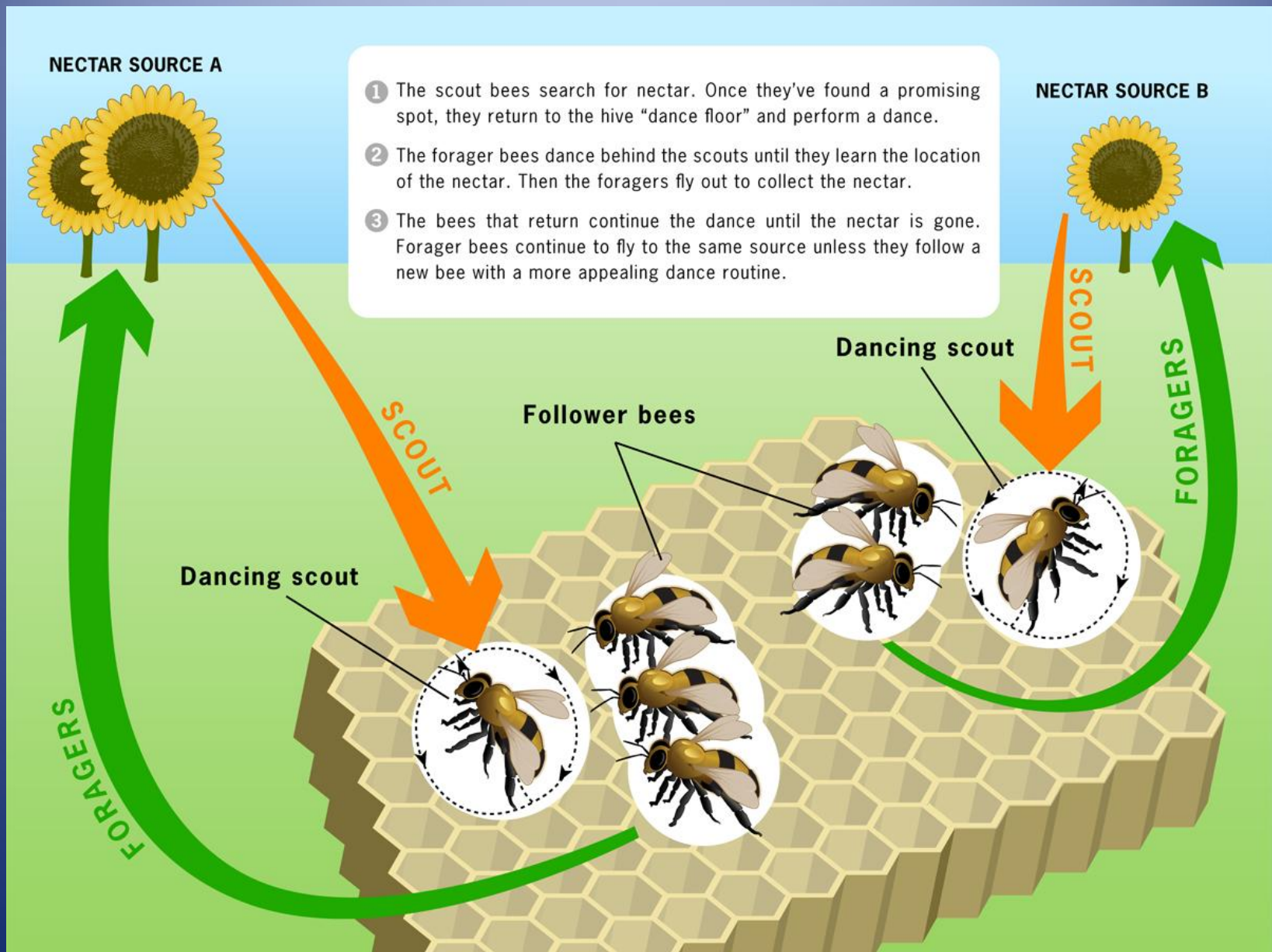
Citizen Monitoring: [beespotter.mste.uiuc.edu](http://beespotter.mste.uiuc.edu)



# Worker Caste

- Collect pollen (and pollinate flowers) using combs and pollen baskets on legs
- Produce wax from glands to form cells
- Produce honey through enzymatic digestion of nectar and honeydew
- Jobs include care of young, foraging, and defense





# Dance Language of Bees



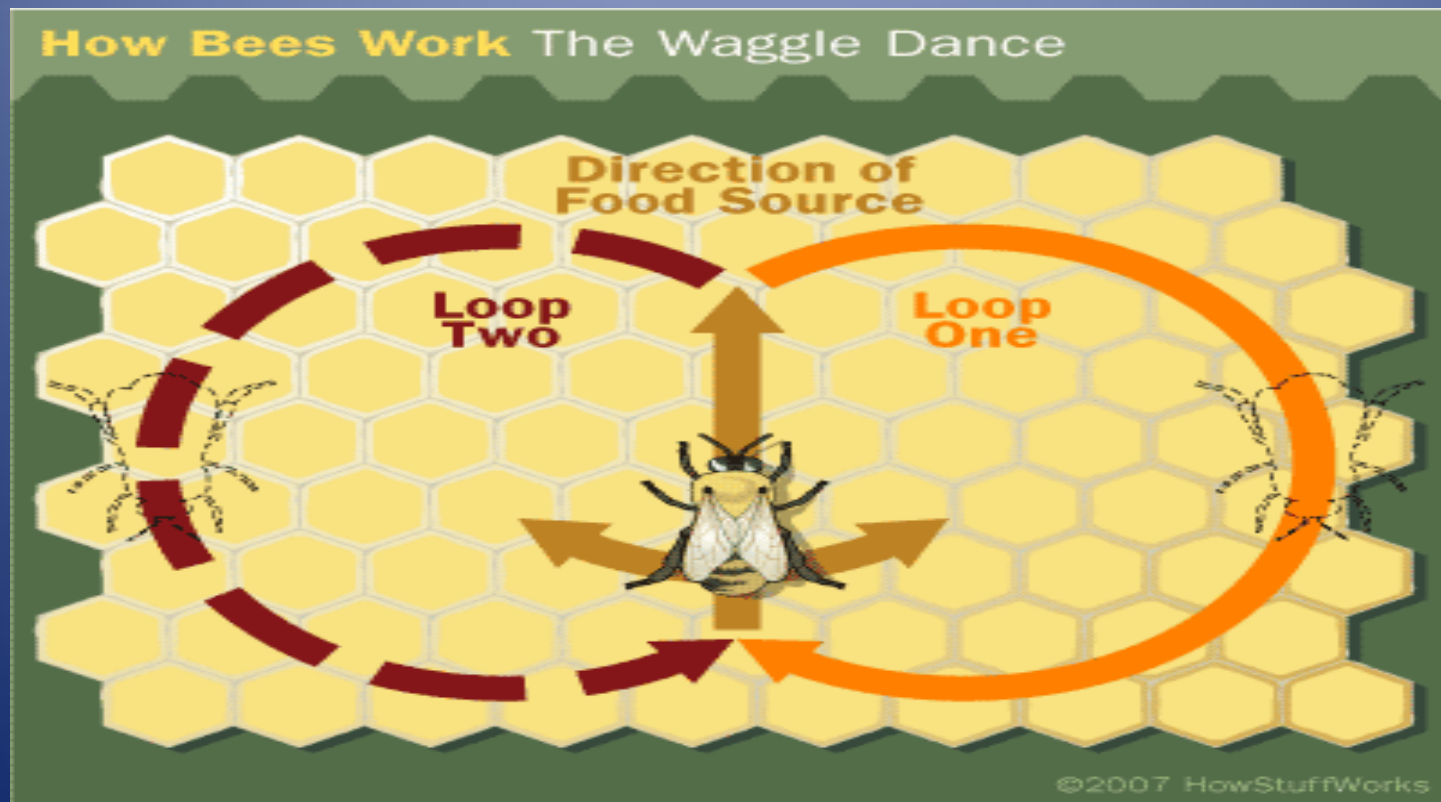
Round Dance

- Round Dance: Food is close by so they can fly around in circles until they find it
- Waggle Dance: Food is some distance away so they may need directions
- Vibration Dance: Everybody forage more



# The Waggle Dance

- Box 12.1 in Gullan & Crantson
- <http://www.youtube.com/watch?v=-7ijl-g4jHg>



# Inquilines & Parasites

- **Inquiline:** an organism that shares a home of another (usually for nutritional benefit)
  - Integrated: incorporated into their hosts' social lives by behavioral modification of both parties
  - Non-integrated: adapted ecologically to the nest, but do not interact socially with host
- **Wasmannian Mimicry:** chemical or tactile mimetic features that allow integration into a host nest
- Usually produce appeasement and/or adoption chemicals
- Multiple examples of other parasites: non-integrated
  - Hover flies, mites, bee louse

# Cleptoparasitic Bees



***Nomada flava***

- 'cuckoo bees'
- 'Look' and 'smell' like host species
- Enter nest of host bee and lay eggs in cells provisioned by host bees
- Larvae hatch and eat pollen ball and host larvae
- Some species will completely take over the nest of the host

# Evolution of Eusociality

- Altruism: Self-sacrifice in reproduction—not usually considered cause for the origin of Eusociality
- Haplodiploidy in Hymenoptera: Queens control sex of their offspring—males are haploid and females are diploid-therefore sisters share more relatedness with each other than they would with their own offspring
- **Hamilton's Rule**:  $rB-C > 0$ , if so—selection will favor altruism
- Eusociality origins furthered by: maternal manipulation & competition/mutualism (benefits of colonial life)

|        | Sister | Half-sister | Own son | Son of full sister | Queen's son (brother) | Son of half-sister |
|--------|--------|-------------|---------|--------------------|-----------------------|--------------------|
| worker | 0.75   | 0.375       | 0.5     | 0.375              | 0.25                  | 0.125              |

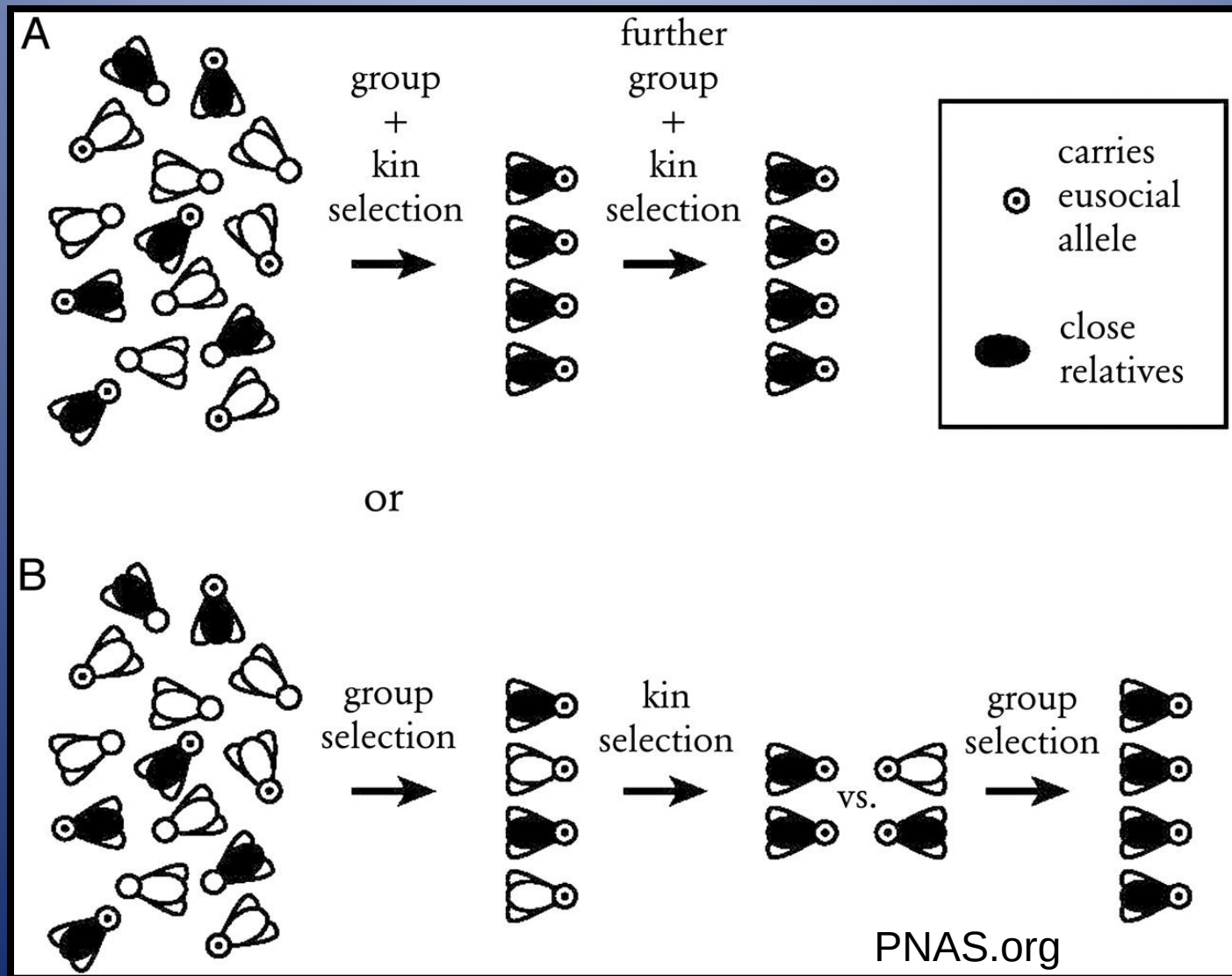


Two major types of selection pressure led to the evolution of eusociality:

**Kin selection:** Darwinian fitness including the *kinship component*—the contribution to the gene pool made by an individual that assists and enhances the reproductive success of its kin

**Group selection:** Alleles can become fixed or spread in a population because of the benefits they bestow on groups, regardless of the alleles' effect on the fitness of individuals within that group.

# Two Competing Theories on the Evolution of Eusociality





**TABLE 11.7. Eusocial Animals**

| Taxa                                                                | No.<br>Origins  | Domiciles                        | Nonreproductive<br>Caste | Sex<br>Mechanism         |
|---------------------------------------------------------------------|-----------------|----------------------------------|--------------------------|--------------------------|
| <b>Vertebrata</b>                                                   |                 |                                  |                          |                          |
| Naked mole rat <sup>a</sup>                                         | 1               | Extensive burrows                | Workers                  | Diploid                  |
| <b>Crustacea</b>                                                    |                 |                                  |                          |                          |
| <i>Synalpheus</i> snapping shrimp                                   | 3               | Inside marine sponges            | Workers?<br>Soldiers     | ?                        |
| <b>Araneae<sup>a</sup></b>                                          |                 |                                  |                          |                          |
| Various species (e.g., <i>Anelosimus</i> )                          | >2              | Silk galleries                   | Workers?                 | ?                        |
| <b>Thysanoptera</b>                                                 |                 |                                  |                          |                          |
| Phlaeothripine thrips<br>( <i>Oncothrips</i> , <i>Kladothrips</i> ) | >2              | Acacia galls                     | Workers?<br>Soldiers     | Haplodiploidy            |
| <b>Hemiptera</b>                                                    |                 |                                  |                          |                          |
| Aphidoidea aphids<br>(some Pemphigidae, Hormaphididae)              | 6               | Galls                            | Soldiers                 | Thelytoky                |
| <b>Isoptera</b>                                                     |                 |                                  |                          |                          |
| All termites                                                        | 1               | Various                          | Workers<br>Soldiers      | Diploid<br>(sex linkage) |
| <b>Coleoptera</b>                                                   |                 |                                  |                          |                          |
| Platypodidae<br><i>Austroplatypus incompertus<sup>a</sup></i>       | 1               | Subcortical galleries            | Workers                  | Diploid                  |
| <b>Hymenoptera</b>                                                  |                 |                                  |                          |                          |
| Vespidae                                                            | 1               | Paper nests                      | Workers                  | Haplodiploidy            |
| Ants                                                                |                 |                                  |                          |                          |
| All Formicidae                                                      | 1               | Various                          | Workers<br>Soldiers      | Haplodiploidy            |
| Crabronidae<br><i>Microstigmus<sup>a</sup></i>                      | 1               | Paper nests                      | Workers                  | Haplodiploidy            |
| Anthophila (bees)                                                   |                 |                                  |                          |                          |
| Halictinae <sup>a</sup>                                             | >4 <sup>b</sup> | Ground/twig cavities/rotten logs | Workers                  | Haplodiploidy            |
| Xylocopinae                                                         | 1               | Stem cavities                    | Workers                  | Haplodiploidy            |
| Apinae                                                              | 1               | Waxy/resin combs                 | Workers                  | Haplodiploidy            |

<sup>a</sup> Primitively eusocial; caste differences are slight.<sup>b</sup> In addition to origins of eusociality, there have been several reversions from a eusocial ancestry to solitary behavior.

# Success of Eusocial Insects

## Eusocial

- Simultaneous performance of necessary tasks (foraging, feeding, offspring care, maintenance)
- Force and power of numbers
- Specialization of function=homeostatic regulation

## Solitary

- Sequential performance of tasks = loss of time, higher effect of error & higher risk
- Solitary insect has less power against a large or more numerous predator or physical obstacle
- Little nest control of temperature, resource reserves, response to seasonal/climatic change



