


Wake County Beekeepers Association March 29, 2014

BEE BIOLOGY: THE BASICS

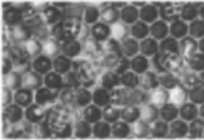
BEE BIOLOGY: THE BASICS

PRESENTATION OUTLINE

Honeybee Anatomy



Biology & Life Cycle



BASIC INSECT BODY STRUCTURE

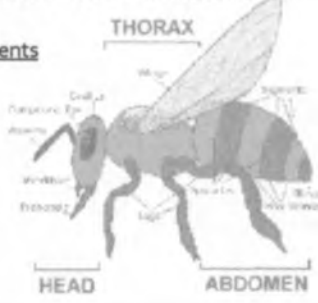
3 - Body Segments

- Head
- Thorax
- Abdomen

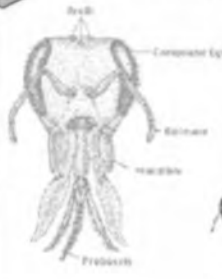


6 - Legs

2 - Antennae

4 - Wings



BODY SEGMENTS: THE HEAD

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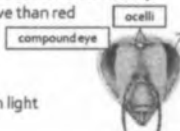
Major sensory region, includes **five (5) eyes**:

Compound Eyes (2)

- eyes with thousands of facets – detect motion better than shape
- sees ultraviolet wavelengths (UV / shortwave)
- detect depth and color; perceive some colors better, e.g. blue flowers more attractive than red

Ocelli (3)

- simple eye
- used to detect visible spectrum light



BODY SEGMENTS: THE HEAD



Major sensory region of the body

Antennae (2)

- Perception: touch & smell
- Climate: temperature & humidity

Mouth – 2 main parts

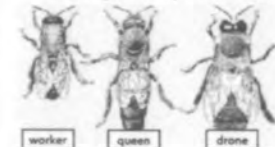

- Mandibles: teeth used for chewing
- Proboscis: tongue used for ingestion of liquids

BODY SEGMENTS: THE THORAX

Locomotion Center of a Honey Bee

- Wings
 - consist of fore & hind wings
 - held together by the **himuli**

worker queen drone

Example of deformed wings

BODY SEGMENTS: THE THORAX

Locomotion Center of a Honey Bee

Bees have six (6) legs total

1st Pair of legs:


- locomotion
- antenna cleaner

2nd Pair of legs:

- stability when walking
- tibial spur for wax grabbing

3rd Pair of legs:


- **pollen baskets** used to carry pollen



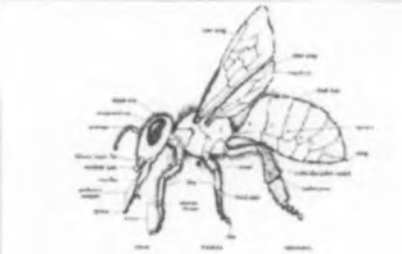
BEE HAIR & POLLEN BASKETS

Pollen Collection

- Pollen baskets – located on **rear legs**
- Carries both pollen and propolis
- Bee hair traps and distributes pollen from one flower to another
- **MAIN SOURCE OF PROTEIN FOR BEES**




BODY SEGMENTS: THE ABDOMEN



BODY SEGMENTS: THE ABDOMEN


Site of digestive & reproductive organs

- **Nasonov Gland**
 - located at the apex of the bee's abdomen
 - emits pheromones to orient foragers to their colonies
- **Spermatheca**
 - where queen stores accumulated semen from drones

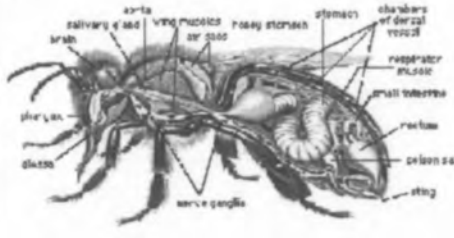


BODY SEGMENTS: THE ABDOMEN

- **Wax glands**
 - active only on young "nurse" bees only (workers)
 - 9 grams honey needed to produce 1 gram wax
- **Spiracles: air intake organs**
 - tiny holes used for breathing
 - located laterally along both sides of abdomen
- **Stinger: protective organ**
 - venom gland & barbed stinger
 - drones lack stingers




INTERNAL ANATOMY



INTERNAL ANATOMY

Hypopharyngeal Gland


- Produces the food
- Nurse bees have huge glands because they feed developing larvae
- Secretes invertase to make nectar into honey




INTERNAL ANATOMY

Defense: The Stinger

- Alarm pheromone smells like banana Laffy Taffy
- Sharp barbs enable the stinger to remain in attacker's skin
- Bee dies when stinger stays behind
- Made of peptotides & protein



MORPHOLOGY: WHO'S WHO?

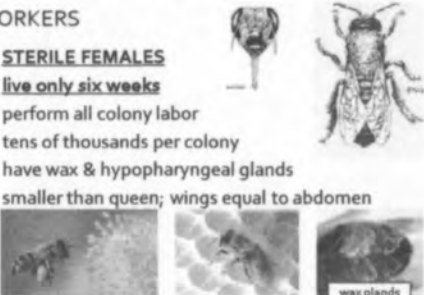


The Worker The Queen The Drone

MORPHOLOGY: WHO'S WHO?

WORKERS

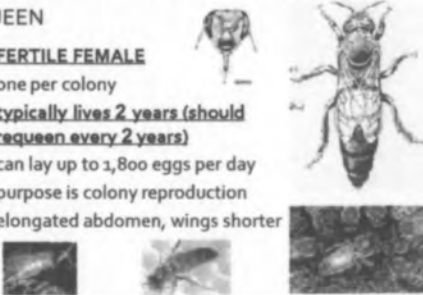
- **STERILE FEMALES**
- **live only six weeks**
- perform all colony labor
- tens of thousands per colony
- have wax & hypopharyngeal glands
- smaller than queen; wings equal to abdomen



MORPHOLOGY: WHO'S WHO?

QUEEN

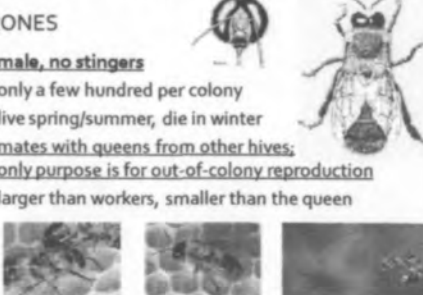
- **FERTILE FEMALE**
- one per colony
- **typically lives 2 years (should requeen every 2 years)**
- can lay up to 1,800 eggs per day
- purpose is colony reproduction
- elongated abdomen, wings shorter



MORPHOLOGY: WHO'S WHO?


DRONES

- **male, no stingers**
- only a few hundred per colony
- live spring/summer, die in winter
- **mates with queens from other hives; only purpose is for out-of-colony reproduction**
- larger than workers, smaller than the queen




LIFE CYCLE

Biology of individuals



Biology of a colony



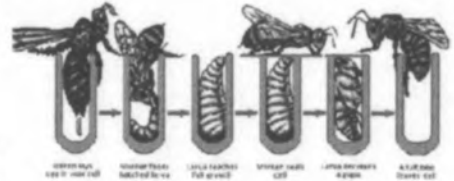
LIFE CYCLE

Biology of individuals

- All individuals undergo complete metamorphosis
- Stage 1: Egg
- Stage 2: Larva – stage where bees grow in size
- Stage 3: Pupa – full-sized larva are capped
- Stage 4: Adult – emerge as worker, drone or queen

- Length of time from egg to adult emergence varies for worker, queen and drone
- 2 sexes (female / male)
- 2 female castes (queen / worker)

LIFE CYCLE



EGG (1-3 days) LARVA (3-6 days) PUPA (5-7 days) ADULT (21 days)

ADULT: QUEEN (2-5 years), WORKER (4-6 weeks), DRONE (3-4 months)

LIFE CYCLE

eggs


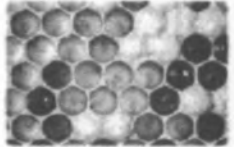



Figure 5. Mature honey bee larvae




Figure 6. A honey bee pupa (1,000 magnification) and pupae (10x)


LIFE CYCLE

Biology of the worker

- Egg: 3 days
- Larva: 6 days
- Pupa: 12 days

Emerge after 21 days

Life Span: 6 weeks



The Worker




Figure 7. Worker bees in a honeycomb cell

LIFE CYCLE

Workers' roles change with age

Days 2 - 10: First Phase

cell cleaning – first task upon emerging

brood incubation, feeding older larvae (nursing behavior)



Days 11 - 20: Second Phase

cleaning & hive maintenance:

making wax, packing pollen, honey processing

wax glands function by day 12;

stinger by day 18





LIFE CYCLE

Workers' roles change with age

Day 21 – end of life: Last Phase
foraging for nectar, pollen, water & propolis

Other activities include providing ventilation, humidity / temperature control and guard duty.



LIFE CYCLE

Biology of the queen

- Egg: 3 days
- Larva: 5.5 days
- Pupa: 7.5 days

Emerges after 16 days total

Life Span: 2 to 5 years




Figure 3a. A queen cell in its original state.




Figure 3b. Queen cell opened to show the larva within resting on a bed of royal jelly.

LIFE CYCLE

Biology of the queen

- Peanut shaped cells oriented vertically on a frame
- Queens develop and emerge upside down
- Developing queen larvae fed a high-protein substance called royal jelly
- Smooth stinger, more venom than worker
- Spermatheca: sperm storage organ in abdomen
- **Mates once in her life, but with multiple mates (average of 12 – 18 drones if well-mated)**

LIFE CYCLE

Biology of the queen

Day 1: May kill sealed queens; colony may swarm

Days 3 – 5: Takes orientation flights

Week 1 – 3: Mating flights; mates with multiple drones (average: 12 drones)

Week 3 – 5: Starts laying 2 - 4 days after mating; will not leave hive again unless the colony swarms

LIFE CYCLE

Biology of the queen

- Produces pheromones (chemical messengers) that inform colony of her status & inhibit queen raising
- If the queen dies, is removed or is failing, workers can produce queens from fertilized eggs
- Fertilized eggs produce workers or queens; unfertilized eggs produce drones
- Queens are produced when the colony swarms
- Can be raised artificially by grafting worker brood into queen cups

LIFE CYCLE

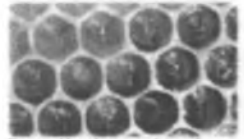


Figure 4a. Honey bee eggs and young brood in a queen cell. Eggs deposited by a normally functioning queen are laid each singly in the center of the cell. Each larva contains a C₁ shape and rests in a bed of food.

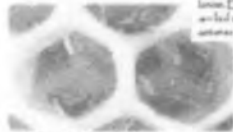


Figure 4b. Honey bee eggs deposited by laying workers. The eggs are laid in a regular pattern inside the cell.

LIFE CYCLE

Biology of the drone

- Egg: 3 days
- Larva: 6.5 days
- Pupa: 14.5 days

Emergence after 24 days total

Longer development time makes their larvae more attractive to varroa mites

Life Span: 1-2 months



Figure 4. Drone larvae in cell-shaped and extend outward from the surface of the surrounding cells.

LIFE CYCLE

Biology of the drone

- Drone cells are located on the periphery of the brood nest
- 50% larger than worker pupae
- Dome-shaped capping indicates a drone cell
- Has larger eyes because mating occurs in flight: large eyes helps them locate a queen
- Reproductive organs break off after mating and drone dies
- **In the winter the workers kick the drones out of the hive = they are too expensive for the hive to maintain during the winter months**

LIFE CYCLE

What makes insects social?

Cooperative brood care

- females share rearing of all young

Reproductive division of labor

- some individuals abandon their own reproductive efforts to contribute to their sisters'

Overlapping generations

- offspring remain in the nest to help rear more offspring

LIFE CYCLE



Biology of a colony

Two main goals:

- Colony reproduction
- Winter survival

Key elements:

- Overwintering
- Spring reproduction
- Foraging efficiency

LIFE CYCLE

Overwintering

- Bees cluster in nest center to conserve heat, with the queen at the center of cluster
- Energy-intensive heat maintenance requires large food stores
- Cluster moves up, consuming food stores
- Little brood present until after winter solstice
- If feeding in the fall, use a syrup of 2 parts sugar to 1 part water

LIFE CYCLE

Colony brood production peaks in the spring, ahead of colony population peak

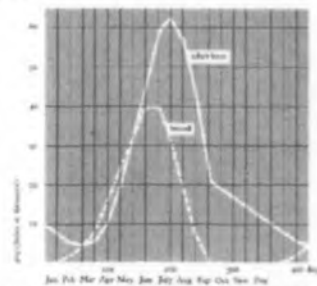


Fig. 10. The annual colony cycle shows that brood production peaks in the spring, ahead of colony population peak.



LIFE CYCLE

Spring reproduction: peak brood production

- Queen begins laying eggs after winter solstice
- Food requirements increase; mid- to late-winter is colony's highest risk of starvation / freezing
- When a colony starts to starve, it will cannibalize its own larvae, compromising future survival
- If feeding a colony in the spring, use a syrup of 1 part sugar to 1 part water.



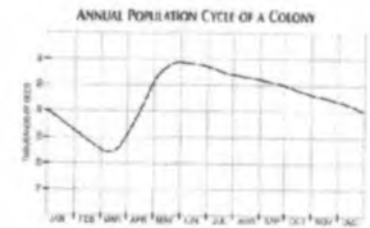
LIFE CYCLE

Spring reproduction: swarm season

- Population build-up intends to support colony fission, or swarming: creation of a new colony
- When spring forage is high, a crowded colony forms swarm cells, ready to create a new queen
- **Swarm cells found on the bottom of brood frames**
- Cutting out swarm cells or clipping the queen's wings does not prevent or control swarms



LIFE CYCLE



Colony population peaks late spring / early summer



LIFE CYCLE

Reproductive goal: a swarm

- Old queen leaves, usually on a warm afternoon, with about 1/2 the colony
- Departed swarm may linger outside near the hive for some hours, until a new location is found
- Remaining colony members rear new queen from swarm cells
- First queen to emerge kills other developing queens; queens that emerge simultaneously fight for supremacy



LIFE CYCLE

Communication within the hive

Queen's pheromones / queen substance

- Queen surrounded by "retinue" of workers who lick & fan her pheromones throughout the hive, communicating her presence
- When queen is absent or failing, reduced levels of queen substance stimulate formation of queen cells
- **Smoke calms bees by disrupting communications within the hive, confusing the bees**



LIFE CYCLE

Foraging efficiency

- Colony population ranges from 10,000 to 60,000 insects over a year
- Needs 60 – 100+ pounds of honey to overwinter
- A healthy hive should have at least 20 pounds of honey remaining in the spring
- Honey production is non-linear; one large colony will gather and store more honey more efficiently than two smaller colonies

LIFE CYCLE


Foraging efficiency

- Annual foraging period measured in weeks
- Hive's reception of foragers' offerings shifts what foragers collect
- Foragers communicate location, richness of source to recruit other foragers to same resource
- Typically collect nectar in the morning, especially in warmer months


LIFE CYCLE

Communication among foragers

Workers' dances communicate location, richness of resource (nectar, pollen)



"Round" dance indicates a nearby source



"Wagtail" dance indicates direction & distance of source

***** KEY BEE FACTS *****

- "Bee Space" is 3/8 inch
- Nutrition: Pollen provides protein, while honey provides carbohydrates
- Best hive orientation is SOUTHEAST
- Italian honeybees are the most popular breed of bee in the US
- Honeybees are NOT native to North America

***** HONEY FACTS *****

- Honey with a moisture content greater than 18.6% will ferment
- China is the largest producer of honey in the world, but the US has placed restrictions on the import of Chinese honey
- Most honey consumed in the US is extracted honey; creamed and comb honey are specialty products.
- Storing honey in plastic jars does not affect its taste