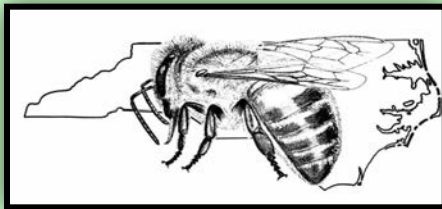


# Bees as Social Insects



Paperbush (*Edgeworthia chrysantha*)



North Carolina State  
Beekeepers Association  
(NCSBA)

By Dr. Geoff Leister  
Alamance County Beekeepers  
February 10, 2022





Foragers returning with pollen and water, while others take orientation flights at 12 noon, @59°F on Feb. 9, 2022



# Agenda Week 3

- ✓ What are social insects?
  - ✓ Two Castes
    - ✓ 3 types of bees
- ✓ Biology of the individuals
  - ✓ Workers
  - ✓ Queen
  - ✓ Drones
- ✓ Development & complete metamorphosis
  - ✓ Hive behaviors among workers, queen & drones

Worker ♀



Queen ♀



Drone ♂



# Agenda Week 3 (continued)

## Biology of the **bee colony superorganism**

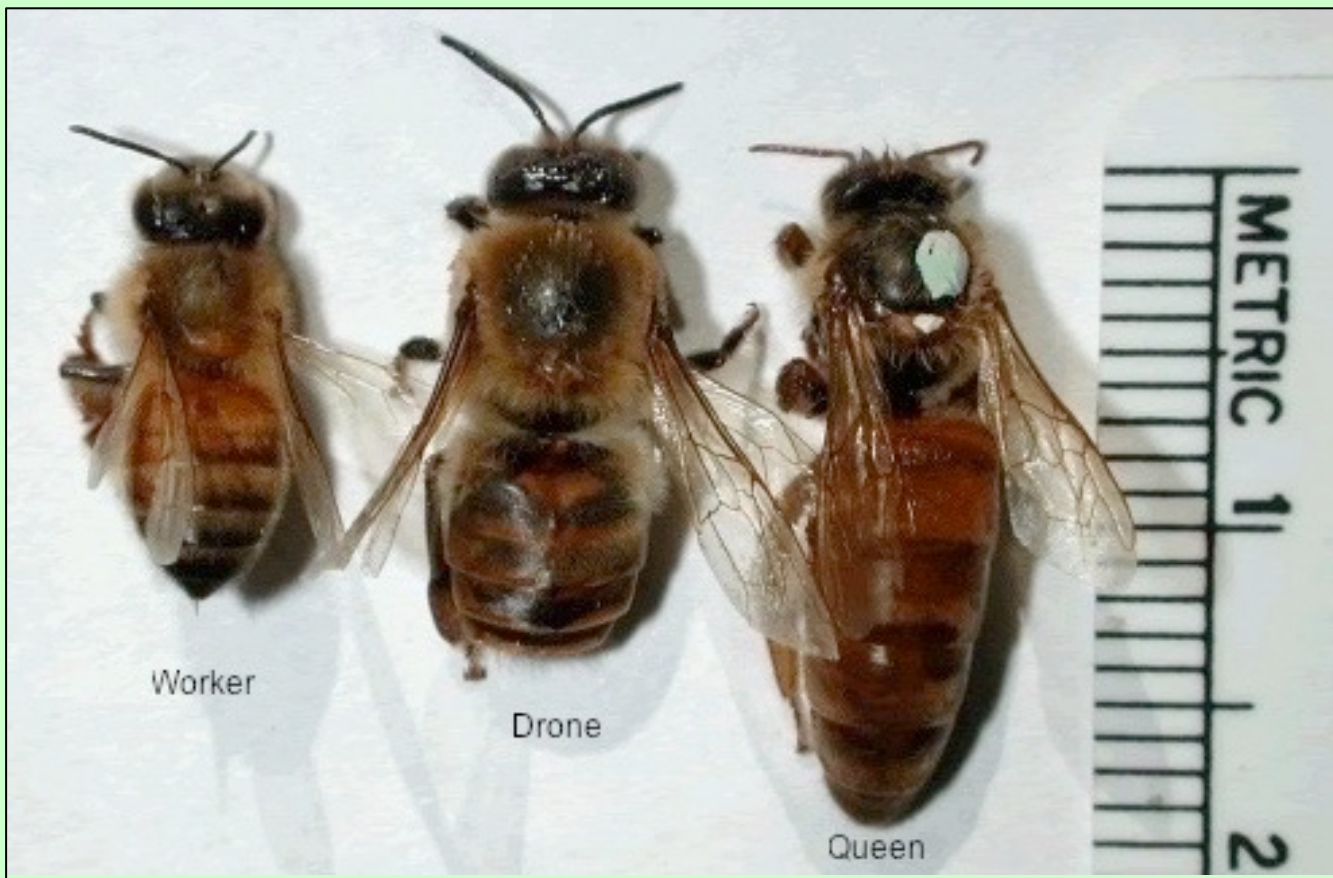
- ✓ In Hive Communications
  - ✓ Antennae
  - ✓ Pheromones
  - ✓ Hormones
  - ✓ Dances
    - ✓ Waggle
    - ✓ Round
- ✓ Bee flight activities
  - ✓ Bee Orientation
  - ✓ Cleansing
  - ✓ Foraging
    - ✓ Resources
- ✓ Mating
- ✓ Laying workers
- ✓ Colony supersedure
- ✓ Swarming
- ✓ Absconding
- ✓ Drifting
- ✓ Hive cooling (water)
- ✓ Hive heating by clustering
  - ✓ Moving air by fanning
  - ✓ Bearding
- ✓ Seasonal Cycles



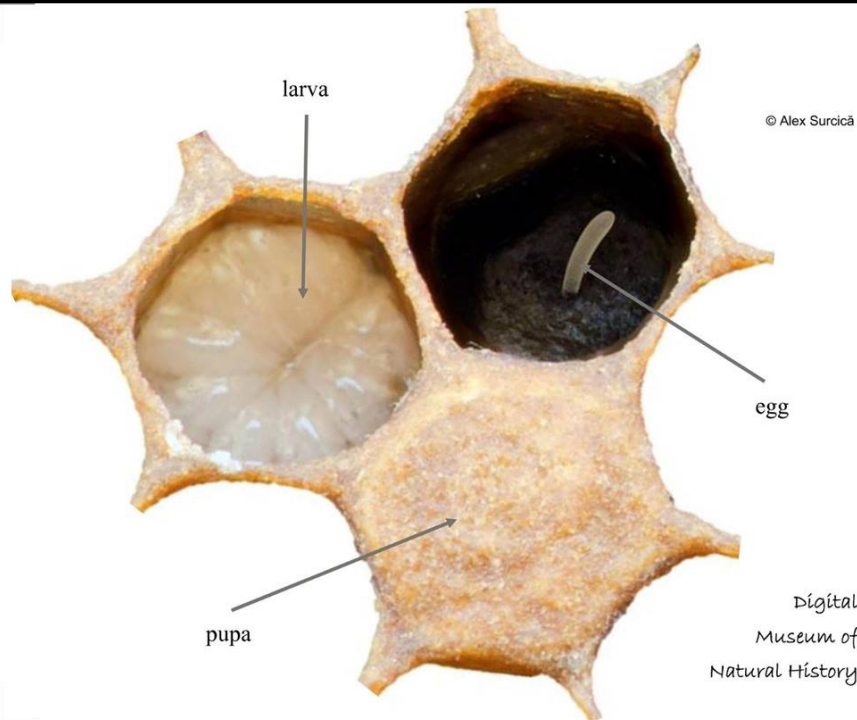
# THE BIOLOGY OF INDIVIDUALS

✓ Three types of individuals in a honey bee colony:

- ✓ Worker
- ✓ Drone
- ✓ Queen



✓ **Two Castes** – bees are divided into two sexes, male and female, and the females are divided into two castes: queens and workers



Hymenoptera: Apidae  
*Apis mellifera* - **European honey bee (worker)**



0.47 inch / 12 mm

© Alex Surcică



Digital Museum of Natural History



Hymenoptera: Apidae  
*Apis mellifera* - **European honey bee (drone)**

© Alex Surcică



Digital Museum of Natural History



0.59 inch / 15 mm



Hymenoptera: Apidae: *Apis mellifera*  
**European honey bee (queen)**

Digital Museum of Natural History

© Alex Surcică



0.75 inch / 19 mm





# Sex-determination Systems

## The X-Y System (mammals)

Sex of offspring: Does Sperm cell have an X or Y chromosome? ♀'s are XX. ♂'s are XY.

## The X-0 System (some insects)

Only 1 type of sex chromosome, the X. ♀'s are XX; ♂'s have 1 sex chromosome X0 in sperm (1 chromosome or no chromosome)

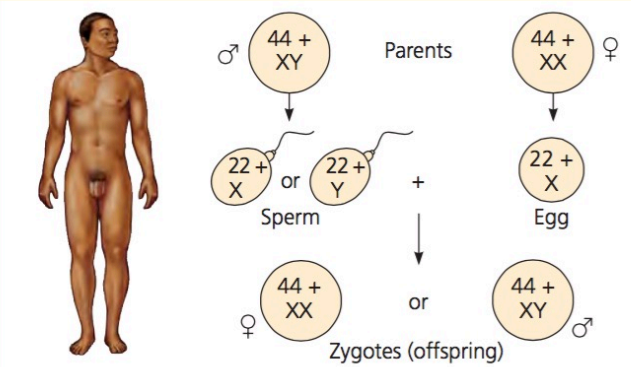
## The Z-W System (birds, fishes, insects)

Sex chromosomes in egg (not sperm) determine offspring sex. Sex chromosomes designated Z & W. ♀'s are ZW & ♂'s are ZZ.

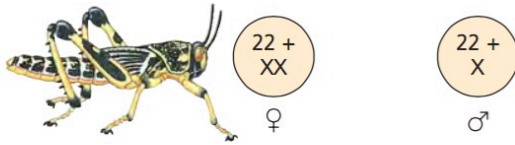
## The Haplo-diploidy system (bees, wasps, ants)

No sex chromosomes. ♀'s develop from fertilized egg and are diploid (2n).

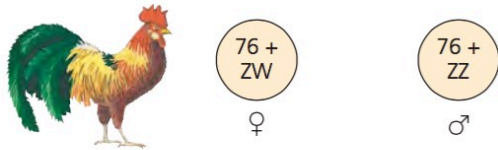
♂'s develop from unfertilized egg and are haploid (1n)



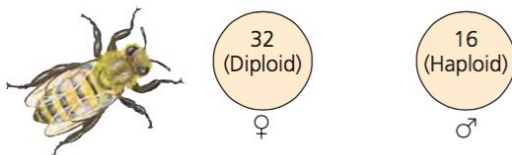
(a) **The X-Y system.** In mammals, the sex of an offspring depends on whether the sperm cell contains an X chromosome or a Y.



(b) **The X-0 system.** In grasshoppers, cockroaches, and some other insects, there is only one type of sex chromosome, the X. Females are XX; males have only one sex chromosome (X0). Sex of the offspring is determined by whether the sperm cell contains an X chromosome or no sex chromosome.



(c) **The Z-W system.** In birds, some fishes, and some insects, the sex chromosomes present in the egg (not the sperm) determine the sex of offspring. The sex chromosomes are designated Z and W. Females are ZW and males are ZZ.



(d) **The haplo-diploid system.** There are no sex chromosomes in most species of bees and ants. Females develop from fertilized eggs and are thus diploid. Males develop from unfertilized eggs and are haploid; they have no fathers.



# Sex-determination Systems

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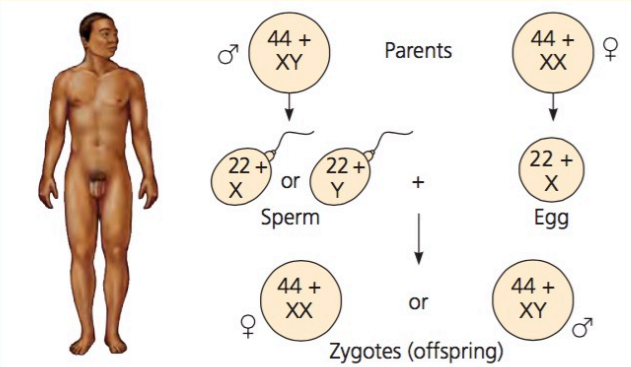
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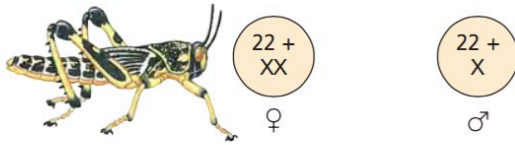
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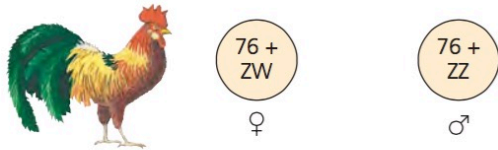
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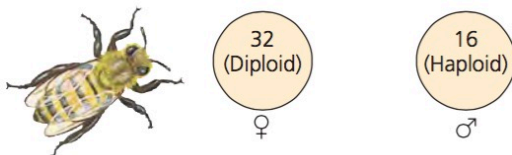
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# Haplodiploidy

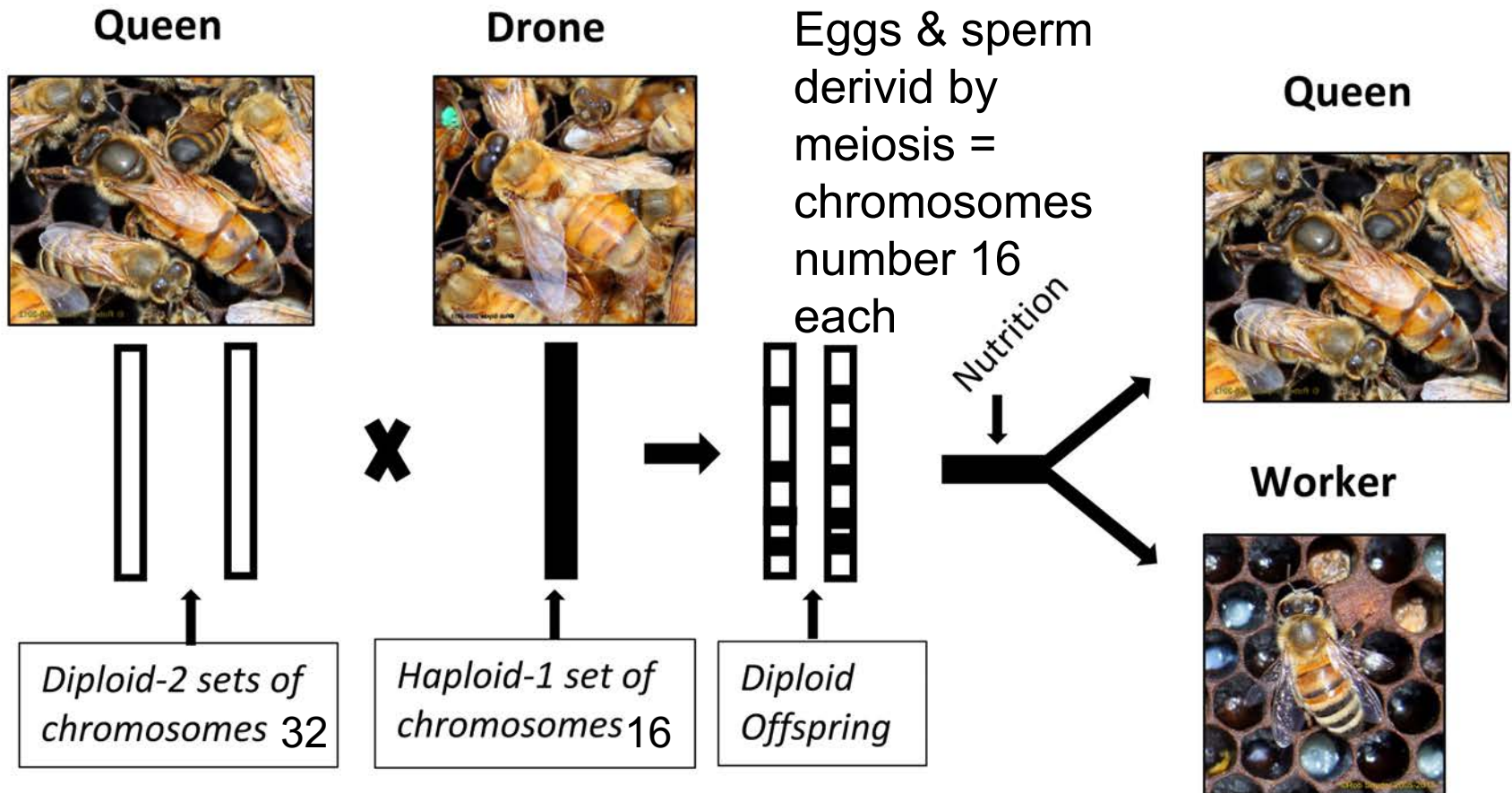
## ✓ Haploid

- ✓ Males
  - ✓ Drones are haploid ( $1N$ )
- ✓ Develop from unfertilized eggs
  - ✓  $\frac{1}{2}$  Number of chromosomes (16 chromosomes)
- ✓ Drones have no fathers (form from unfertilized egg)
  - ✓ Can have no sons
  - ✓ Does have a grandfather (queen's egg fertilized by father)
  - ✓ Drones do have grandsons

## ✓ Diploid

- ✓ Females are diploid ( $2N$ )
  - ✓ Workers
  - ✓ Queen
- ✓ Develop from fertilized eggs
  - ✓  $2x$  Number of chromosomes (32 chromosomes)

# Honey Bee Sex Determination



[HONEY BEE CASTE SYSTEMS: PART 1- HONEY BEE GENETICS](#)



# Honey Bee Sex Determination

Queen



Eggs produced  
by meiosis =  
chromosomes  
number 16



*Diploid-2 sets of  
chromosomes 32*

Unfertilized  
Egg



*Haploid 16  
Offspring*



Drone



# Honey Bees Live in Colonies

- ✓ Their agenda in life is to survive the winter on stored honey and reproduce the colony by swarming each spring.
- ✓ They make a living by gathering nectar (carbohydrates), pollen (protein), plant resins, & water.

# Some Characteristics of Honey Bees

- ✓ Social insects
- ✓ Can be managed within hives
- ✓ Exhibit unique forms of communication



Leister's Apiary April 11, 2015



# What are Social Insects?

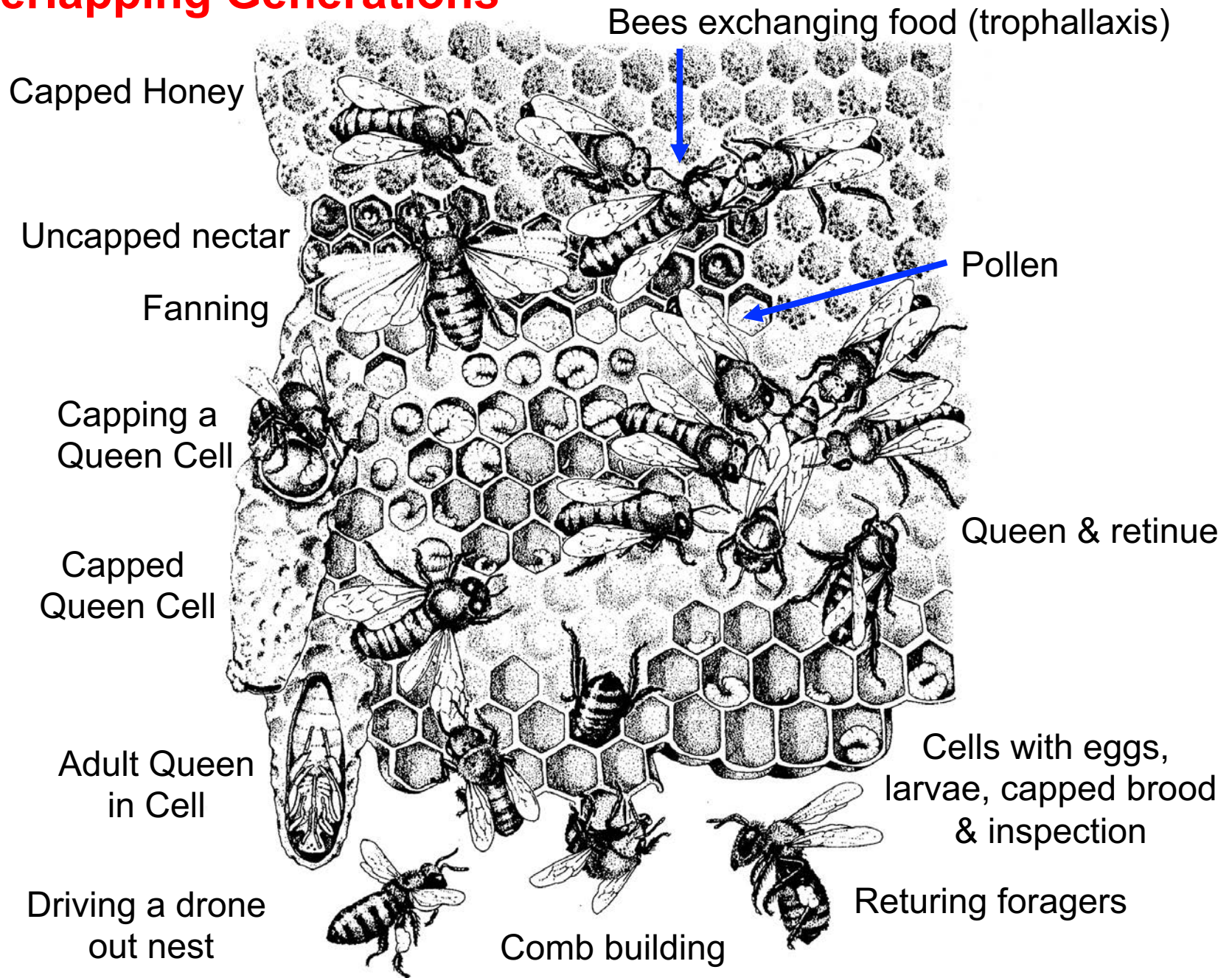
- ✓ Cooperative brood care
- ✓ Reproductive division of labor
- ✓ Overlapping generations

Species that exhibit all three of the above are termed “**eusocial**” or truly social insects (Greek “eu” = truly)





# Overlapping Generations





Capped  
Brood

# Overlapping Generations

Capped  
Honey



Pollen

Some offspring remain at the nest to help their parents rear more siblings

So more than one generation is present at any given time



# Cooperative Brood Care

- ✓ Females of the species share the burden of rearing the young
- ✓ They assist with brood care, whether it is their offspring or others



Uncapped brood

Capped brood



# Reproductive Division of Labor

Some individuals are responsible for reproduction (queen & drone), while other individuals (workers) perform other tasks (brood care, foraging, etc.)

Laying queen



Cells with eggs & young brood

# What are some other examples eusocial Insects?

- ✓ Order Hymenoptera

  - ✓ Bees (90% live solitary lives)

  - ✓ Wasps (some live solitary lives)

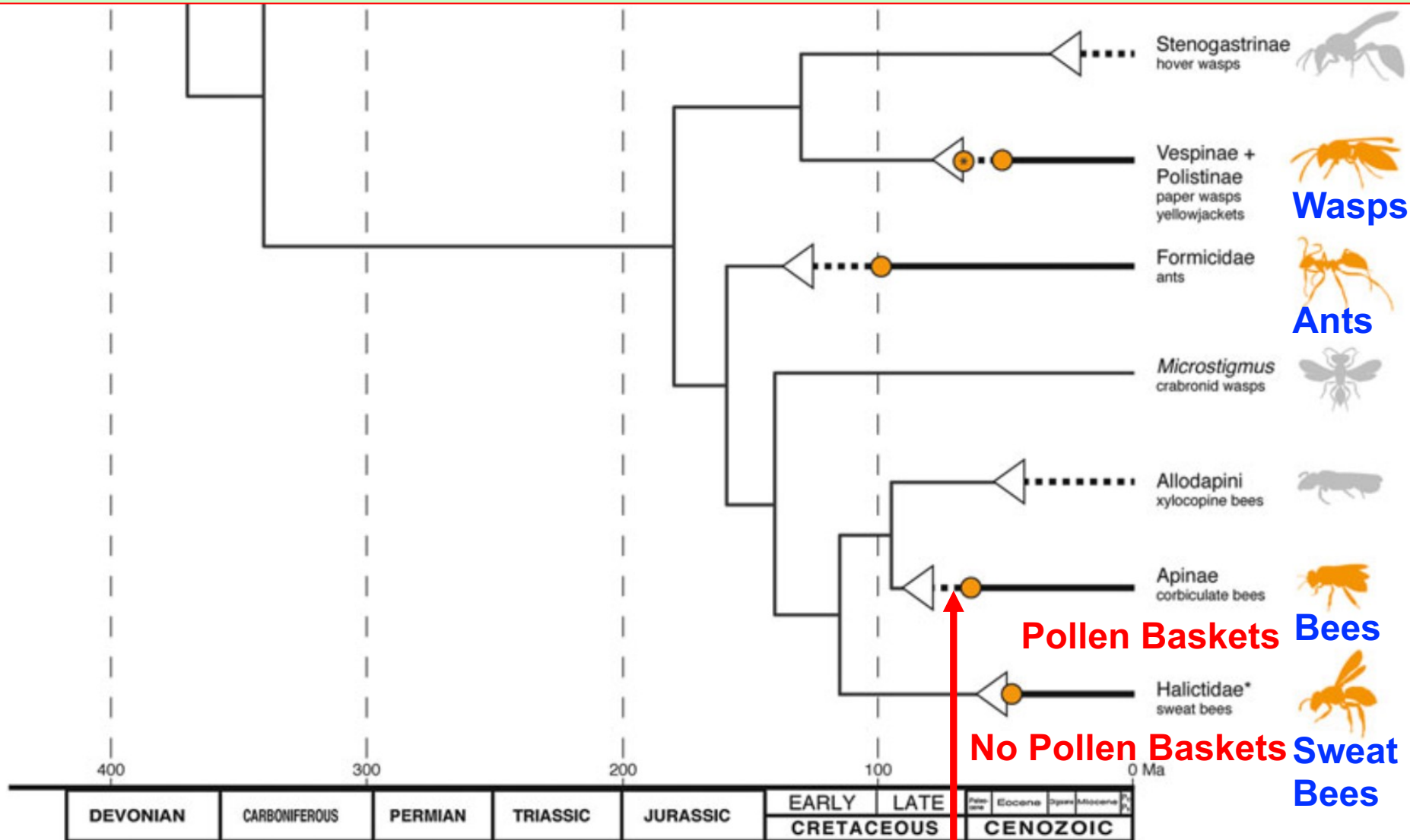
  - ✓ Ants

- ✓ Order Isoptera

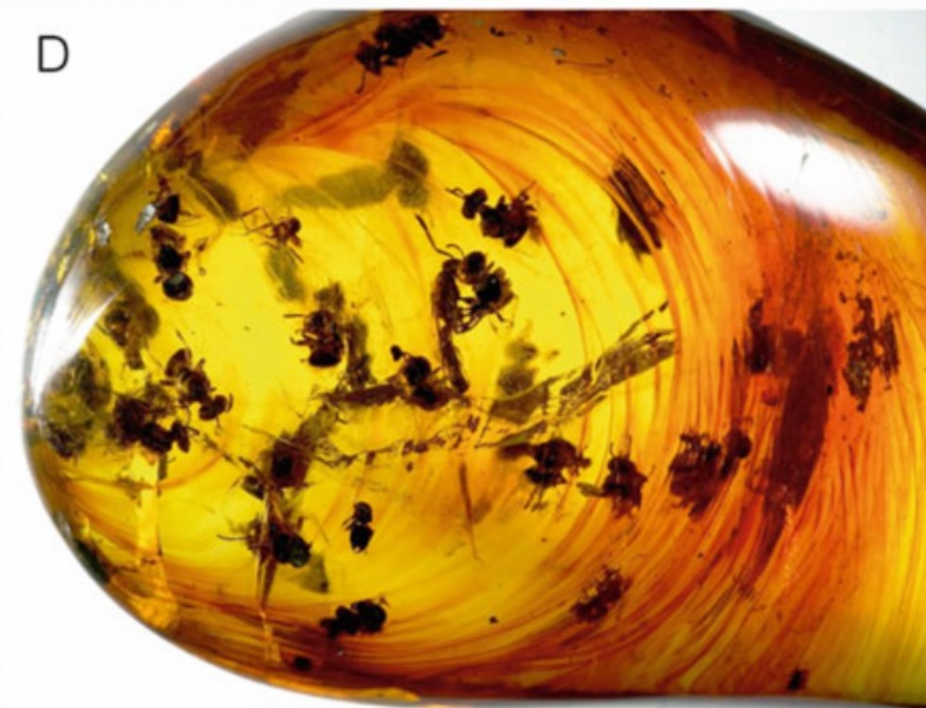
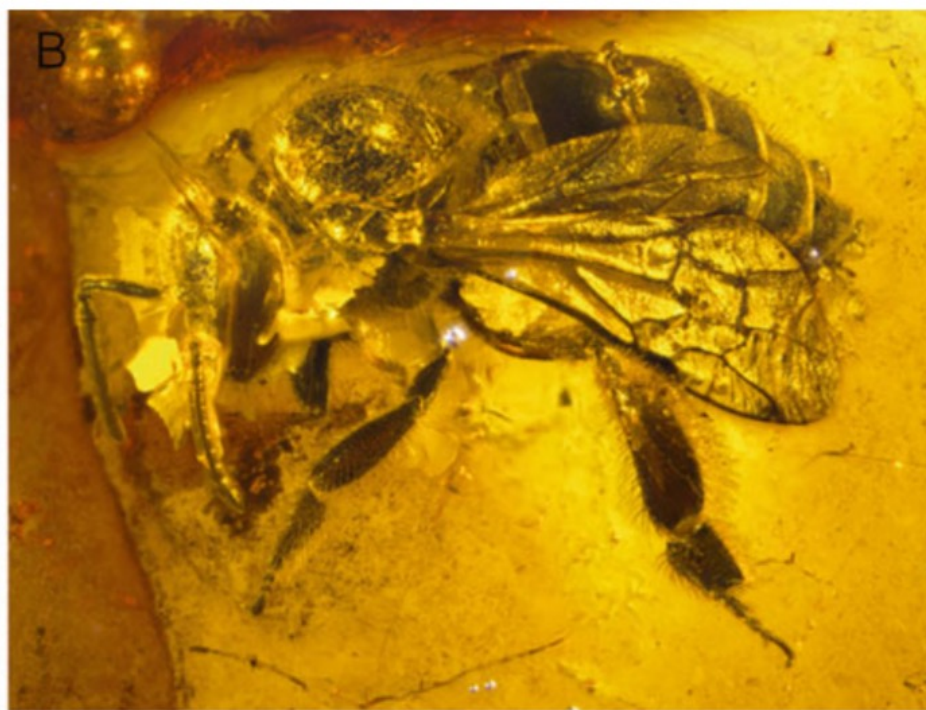
  - ✓ Termites



# Fossil Social Insects



66 mya



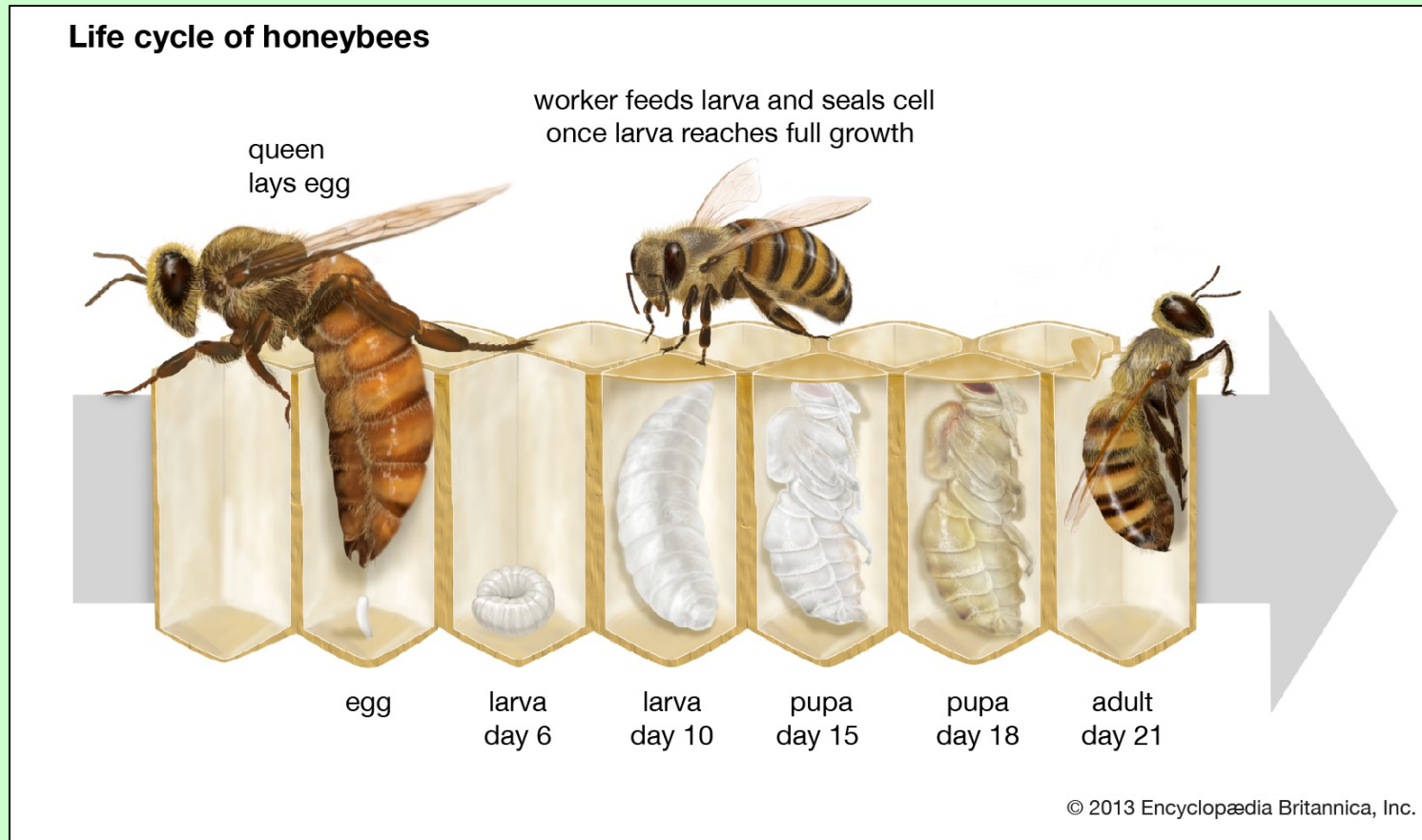


# Honey Bee Life Stages

## Development by Complete Metamorphosis

✓ Stages include:

- ✓ Egg
- ✓ Larva
- ✓ Pupa
- ✓ Adult





# The Egg Stage





# Honey Bee Egg





# Honey Bee Egg Stage in Wax Comb

✓ Egg is sausage shaped

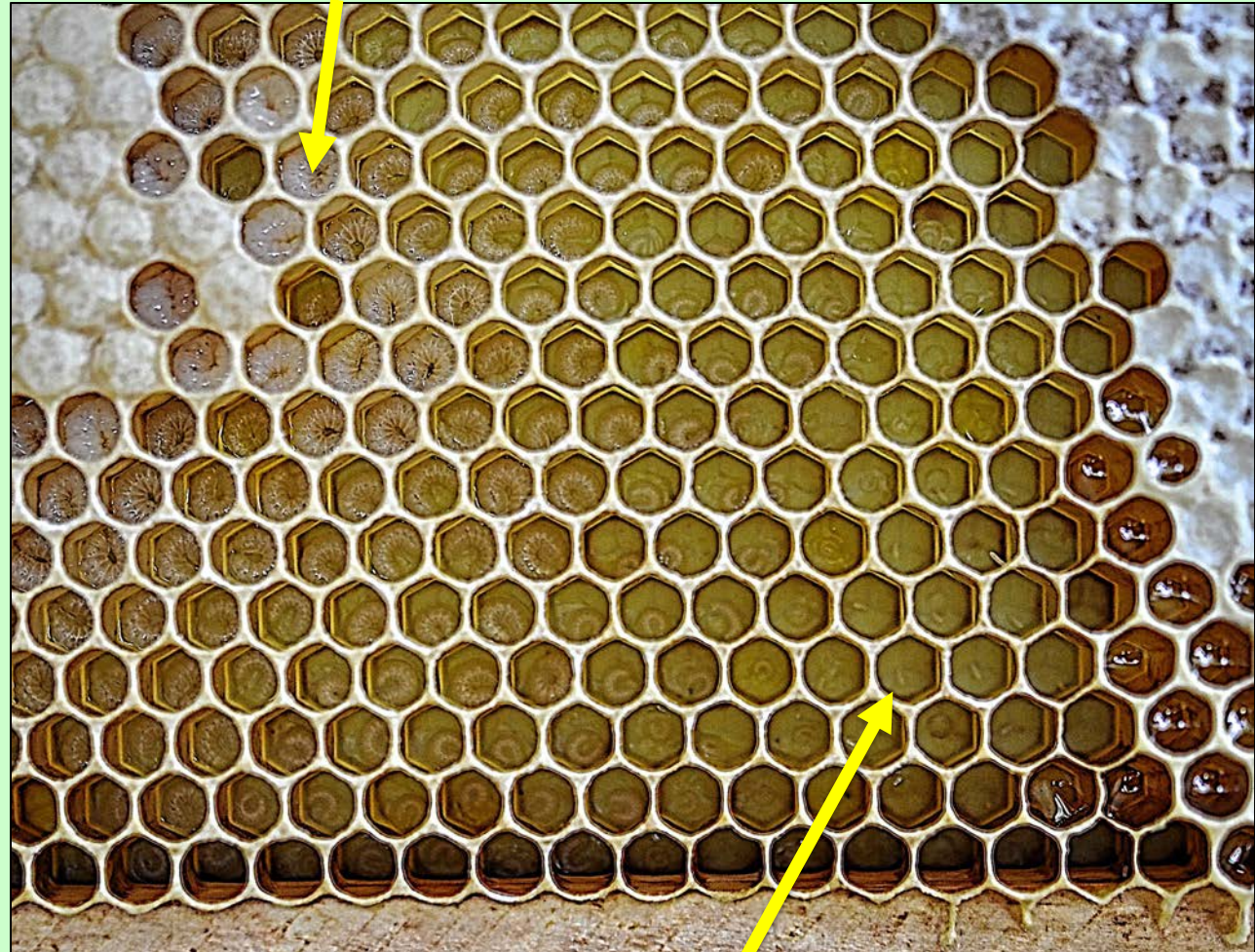
✓ Are about 1/16 inch in size

✓ They are placed individually inside of a cell

✓ Will emerge or eclose after about 3 days into a larva

## Why Are Honeycomb Cells Hexagonal?

Larva

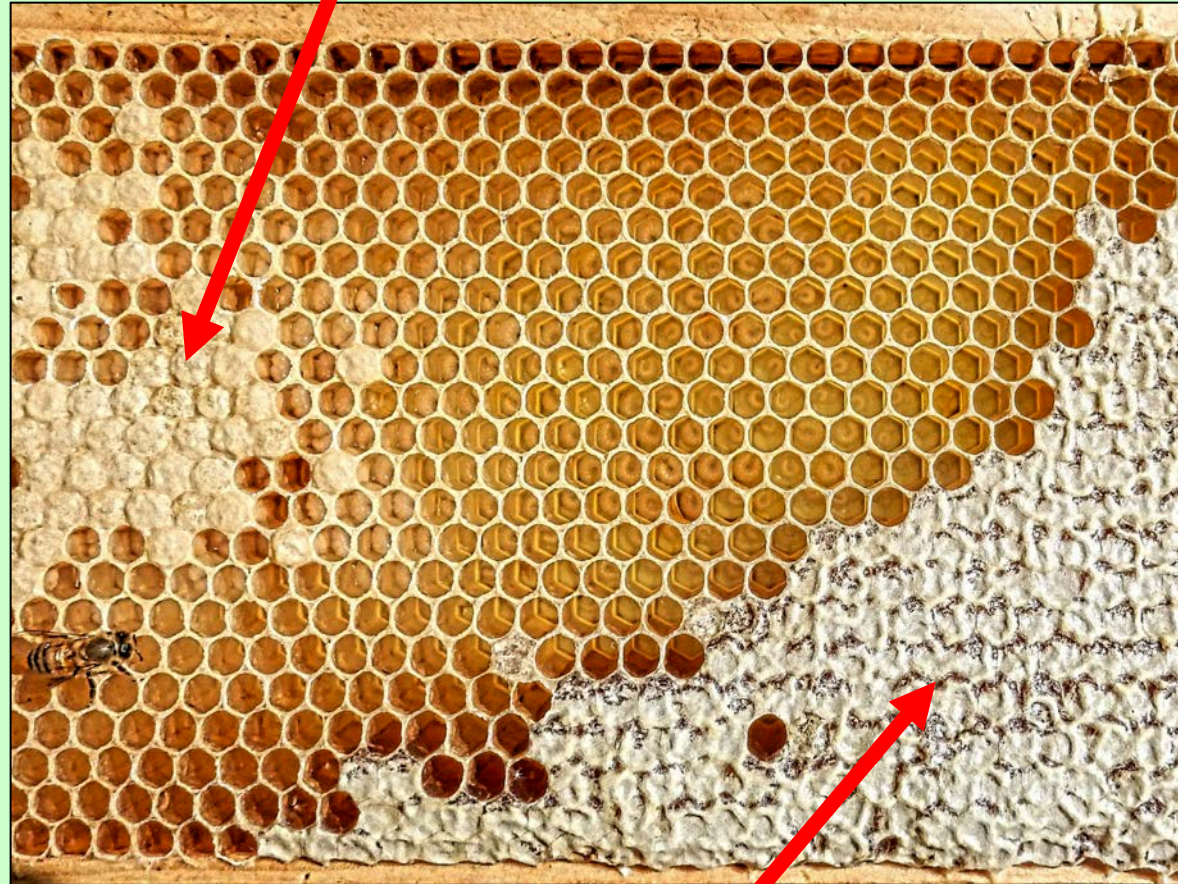


Egg



# The Larva Stage

- ✓ This is the feeding stage of development
- ✓ Are fed by worker bees placing food inside their cells
- ✓ Usually form a C-shape larvae
- ✓ When ready to form pupae, the workers will cap the cell with beeswax



**Capped Pupae**

**Capped Honey**

# The Pupa Stage

- ✓ Non-feeding stage
- ✓ Pupae stage will metamorphose into an adult bee in about 13-days



# The Adult Stage

- ✓ Adult emerges after a few days (the adult will chew through its cell capping when ready to emerge)





# Feeding emerging adult bee



Trophallaxis

# Adult Stages Life Expectancy

## ✓ Workers

- ✓ About 28-42 days (4-6 weeks during summer)
- ✓ Physiological different winter bees 3-4 months

## ✓ Queen

- ✓ Generally about 2-3 years,  
but can live up to 5-years

## ✓ Drones

- ✓ About 21-35 days (3-5 weeks during summer)
- ✓ Late fall kicked out to die or killed off



## The Developmental Stages of the European Honey Bee (In Days)

	Time spent as an <b>egg</b>	The combined time as a <b>larva</b> and as a <b>pupa</b>	Total development time: from <b>egg</b> laid until emergence as <b>adult</b>	Total Life Span of <b>adult</b> (during summer)
<b>Worker</b>	3	5 larva + 13 capped = 18 days	21 days	28 - 42 days (4 to 6 weeks)
<b>Queen</b>	3	5 larva + 8 capped = 13 - 14 days	16-17 days	1 - 3 up to 5 years
<b>Drone</b>	3	7 larva + 14 capped = 21 days	24 days	21 - 35 days (3 to 5 weeks)

# First 21-days of honey bees life in 60 seconds



[Video by American photographer, Anand Varma, presented on TED Talk in Vancouver, BC on March 2015](#)



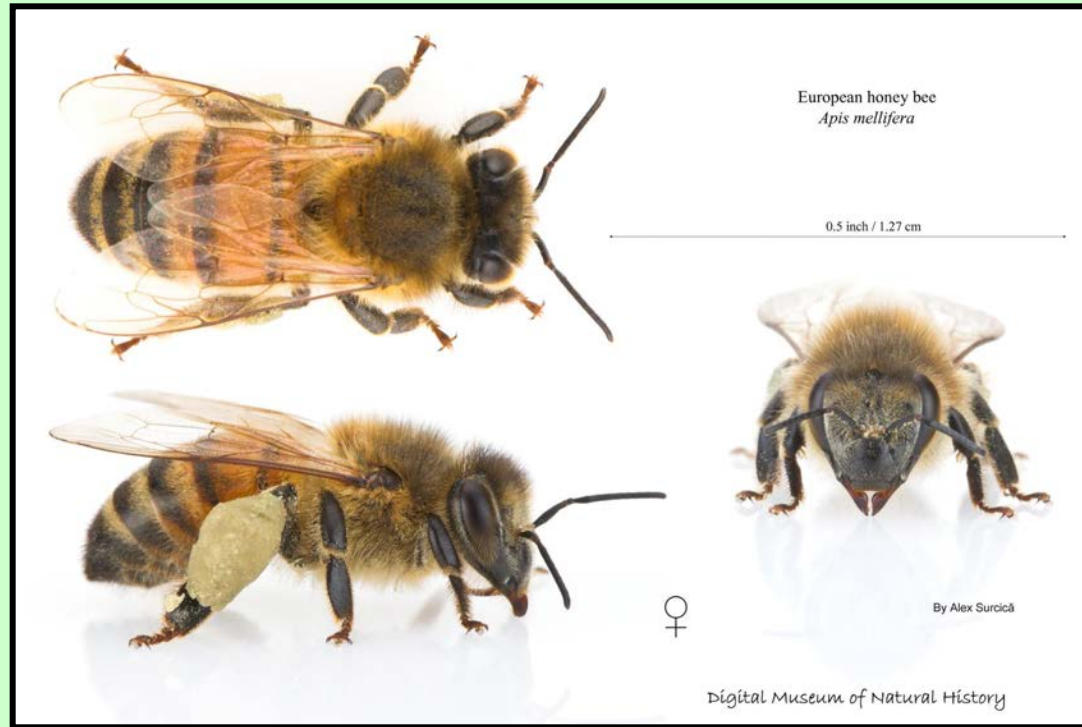
How are the workers, queen, & drones related and what are their functions in the hive?



Italian Honey Bee (*Apis mellifera*)

# Workers

- ✓ Female but not fertile
- ✓ About 20,000 to 40,000 in colony





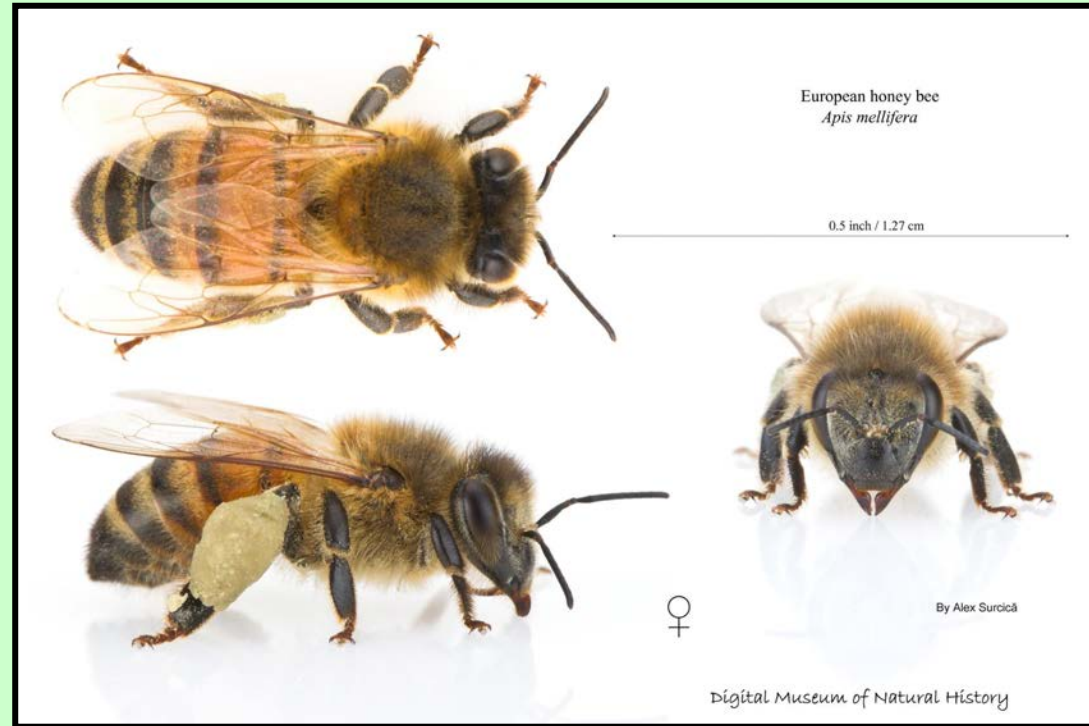
- ✓ Age related activities
  - ✓ 2 days: cell cleaning
  - ✓ 3-10 days: queen care, feed young, wax work
  - ✓ 15-20 days: wax work, nectar processing, guarding, undertaking, orientation flights
  - ✓ 21-35 days: foraging (water, nectar, pollen, resins) colony defense

# Workers



# Workers

- ✓ Lives 4-6 weeks in summer
- ✓ Lives 4-5 months in winter (winter bees)
- ✓ Stinger has barbs and stays in the skin – used to defend the hive and herself





# Worker age related activities

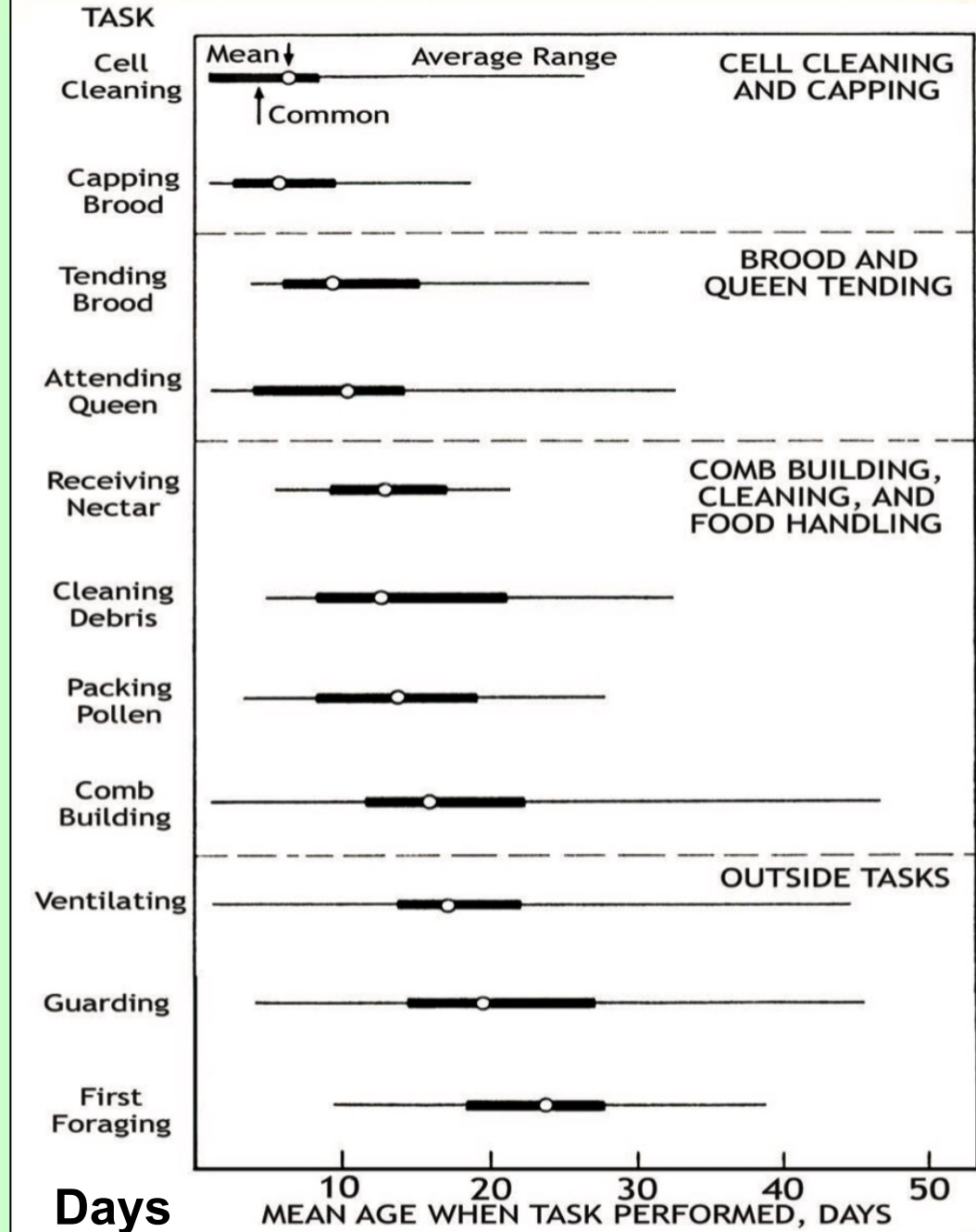


Fig. 8. Overlap of age task performance by worker bees. Data are from the references cited in Winston 1987. Reprinted by permission of the publishers from *The Biology of the Honey Bee* by Mark L. Winston, Cambridge, Massachusetts: Harvard University Press, Copyright © 1987 by Mark L. Winston.

# Drones

- ✓ Develops from unfertilized egg
- ✓ Sexually mature at 2-weeks
- ✓ Larger than Worker
- ✓ Gathers no nectar
- ✓ Gathers no pollen
- ✓ Fed by house bees





- ✓ Are responsible for mating with queen bees
- ✓ When mature, participate in daily afternoon flights
- ✓ Flights usually include males from multiple colonies
- ✓ Drone flights are often associated with permanent landmarks in drone congregation area (DCA)

# Drones



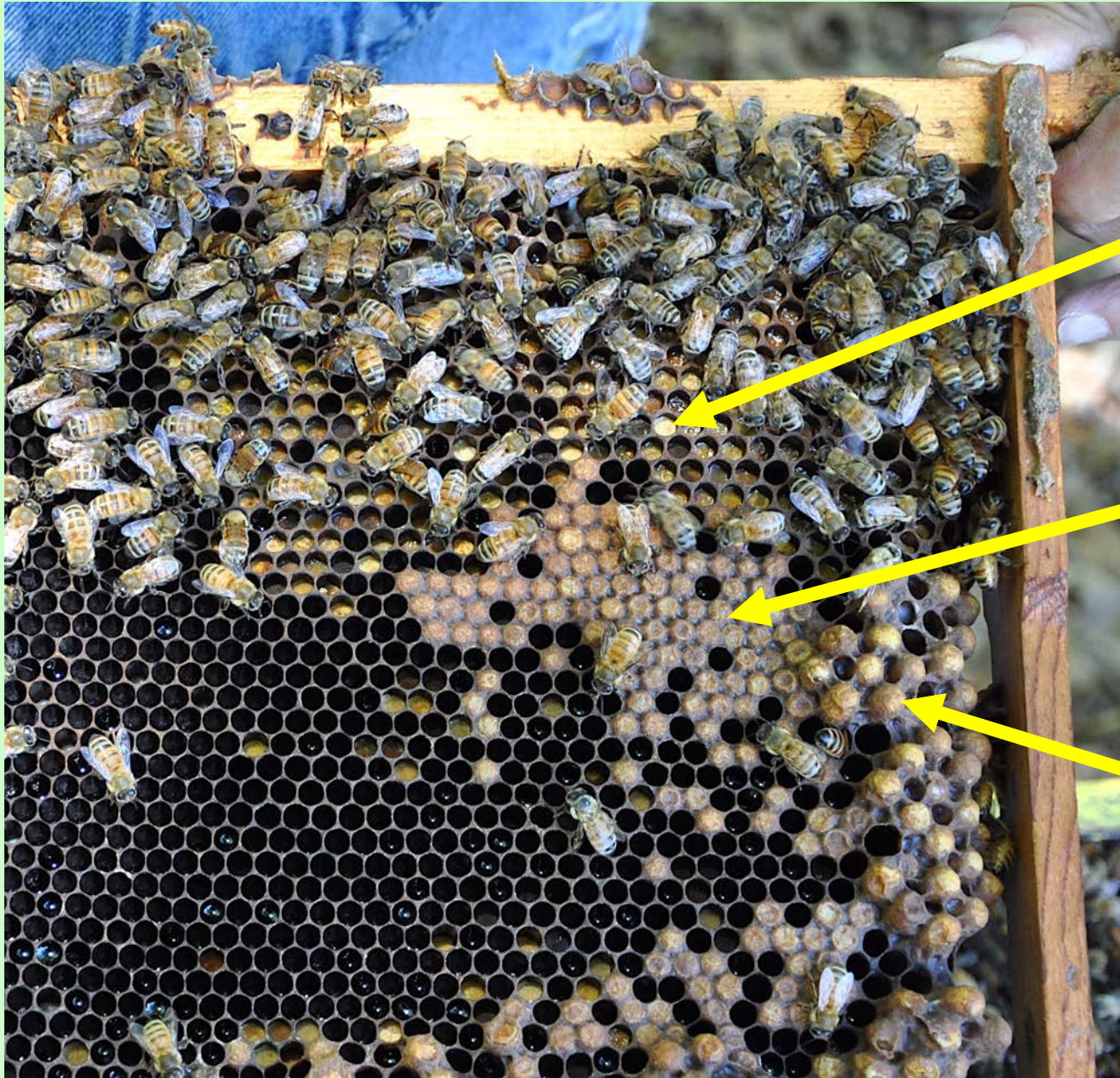
# Drones

- ✓ No stinger
- ✓ Mates with female virgin queen
- ✓ Mates with queen in flight at 20 - 30 ft
- ✓ Dies after mating
- ✓ Forced out of the hive in late fall





# Drone Brood Cells (Bullet shaped & rounded above comb)



Pollen  
(Bee bread)

Capped worker  
brood

Capped drone  
brood



# Capped Worker & Drone Brood

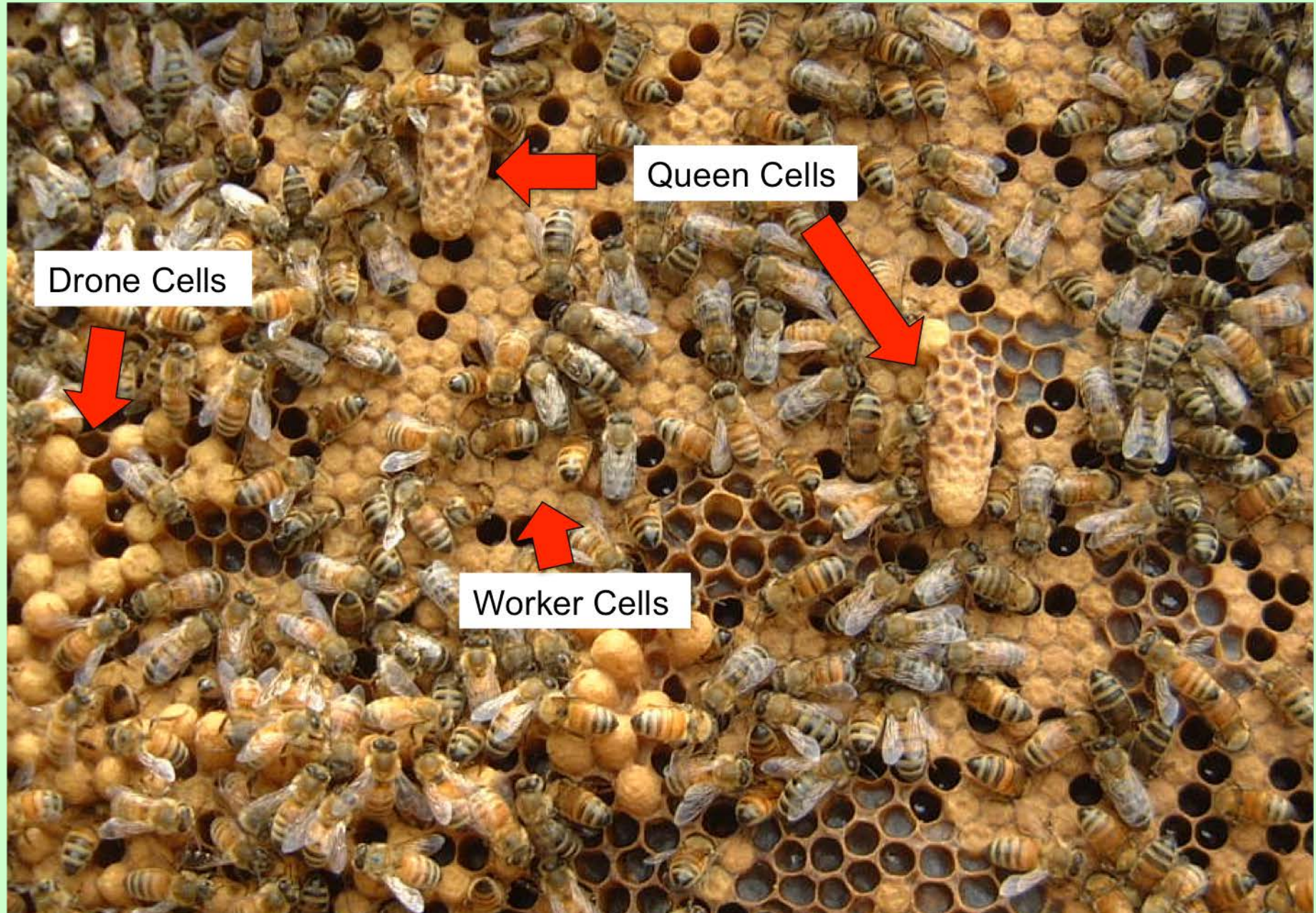


Workers

Drones



# Three types of Pupae Cells





# Queen

- ✓ One queen (normally)
- ✓ Function: laying eggs
- ✓ Can live 2 – 5 years
- ✓ Can lay 1500 eggs a day



✓ Produces air-borne pheromones (“queen substance”) that keep the colony functioning orderly, loyal, and protective to the queen

✓ Stinger is curved & does not have barbs – only uses it to kill rival queens.

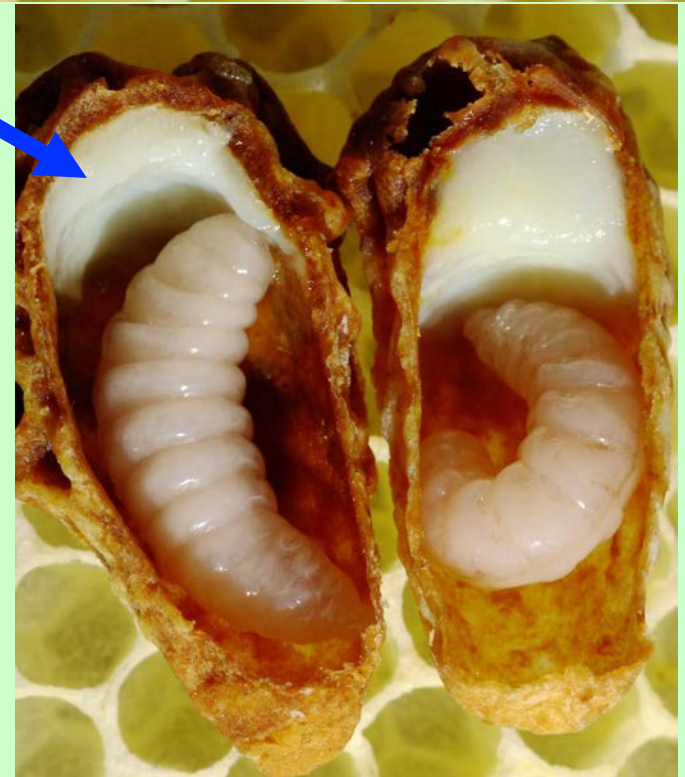
# Queen





# Queen Bees

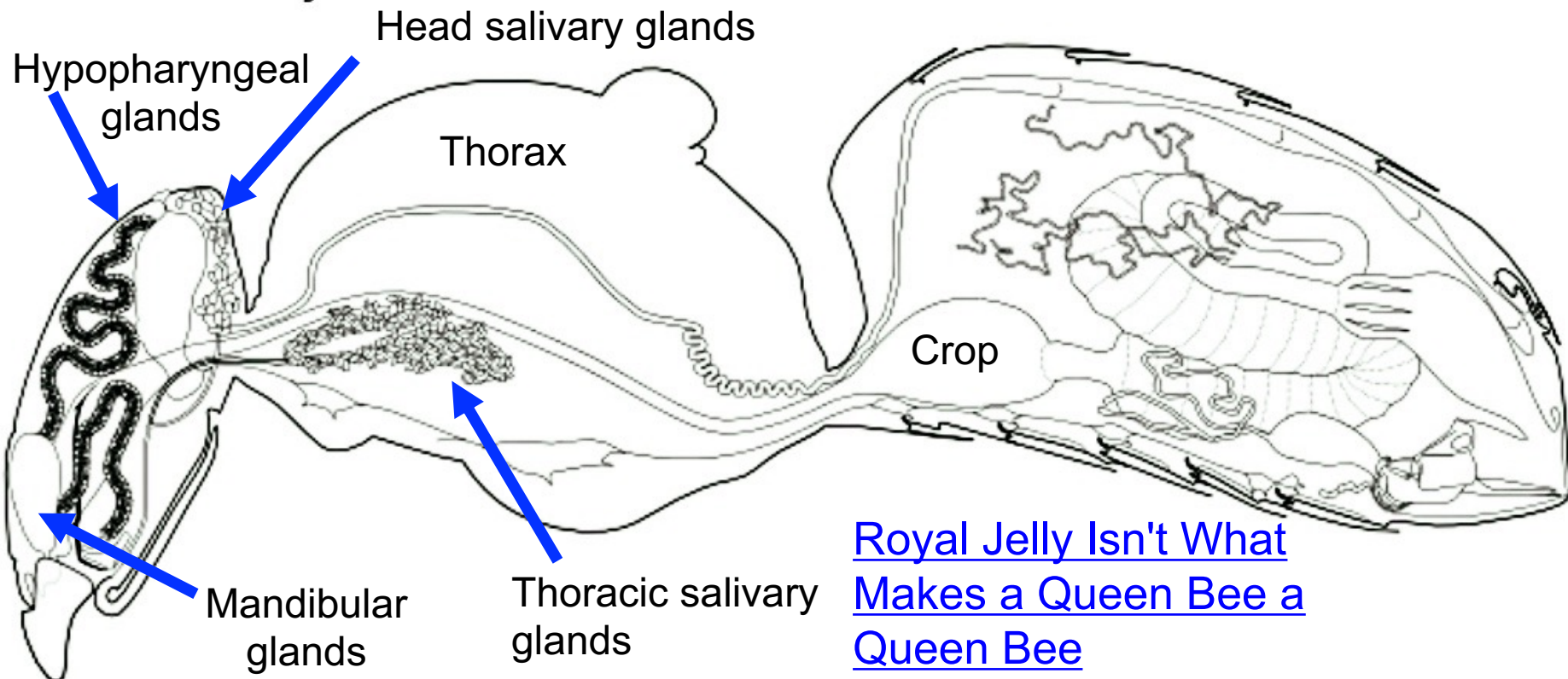
- ✓ Different larval diet than in worker bees. Larvae are fed “**Royal Jelly**” throughout their larval life
- ✓ Royal jelly is a mixture of nectar, protein, and chemicals from worker’s head glands
- ✓ Not feeding an immature queen pollen and honey is what makes her royal, not her exclusive access to royal jelly.



## Comparison between Royal jelly fed to queen larvae and worker larvae

	<b>Queens</b> All royal jelly	<b>Worker-Under 3 days</b> Royal jelly	<b>Workers-Over 4 days</b> No royal jelly
Protein	45.14% Not beebread	53.38%	27.87% From beebread
Fat	13.55% Not beebread	8.38%	3.69% From beebread
Sugars	20.39% Not from honey	18.09%	44.93% From honey

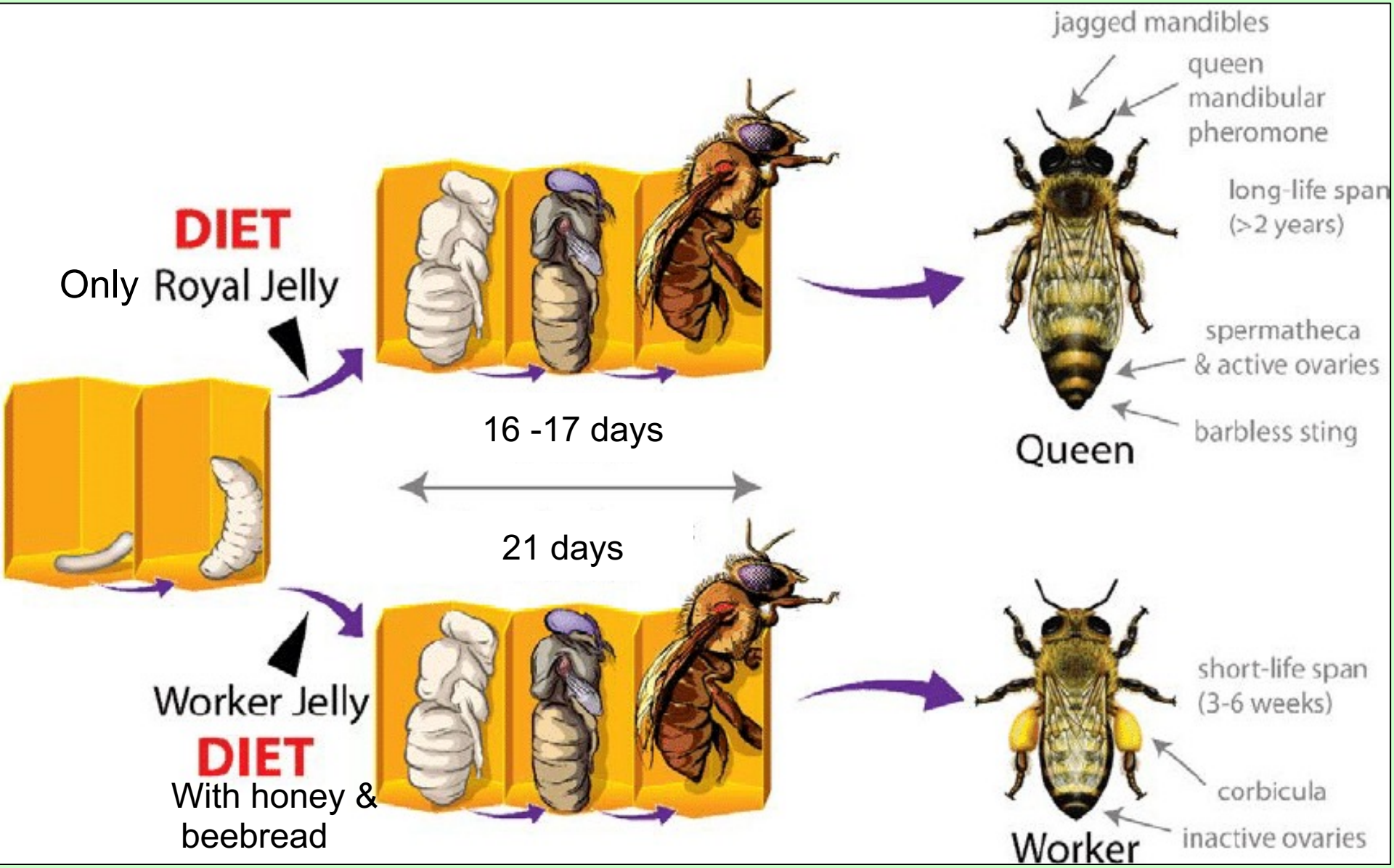
### Internal anatomy



[Royal Jelly Isn't What Makes a Queen Bee a Queen Bee](#)



# Honey Bee Queen vs Worker Diet



# Queen Mating

- ✓ Newly emerged take orientation flights (2-5 days)
- ✓ Take a succession of mating flights to drone congregation areas for 5-30 min
- ✓ Queen emits sex pheromone attracting drones
- ✓ During mating flights, she mates with about 14 -19 drones at 32 to 60 feet in the air (a 5-sec event each)
- ✓ The queen then stores the sperm from the males in a “**Spermatheca**” (an organ that holds sperm)
- ✓ Queen can start laying 2-3 days after mating



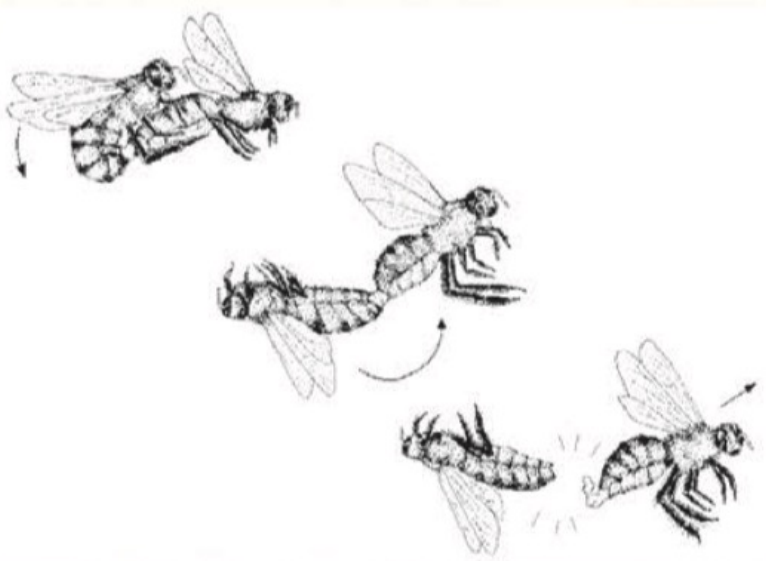
**Timing: 2 to 3 weeks (14 to 21 days) is a good rough estimate from when virgin queen emerges-to-laying**



# Mating Flights



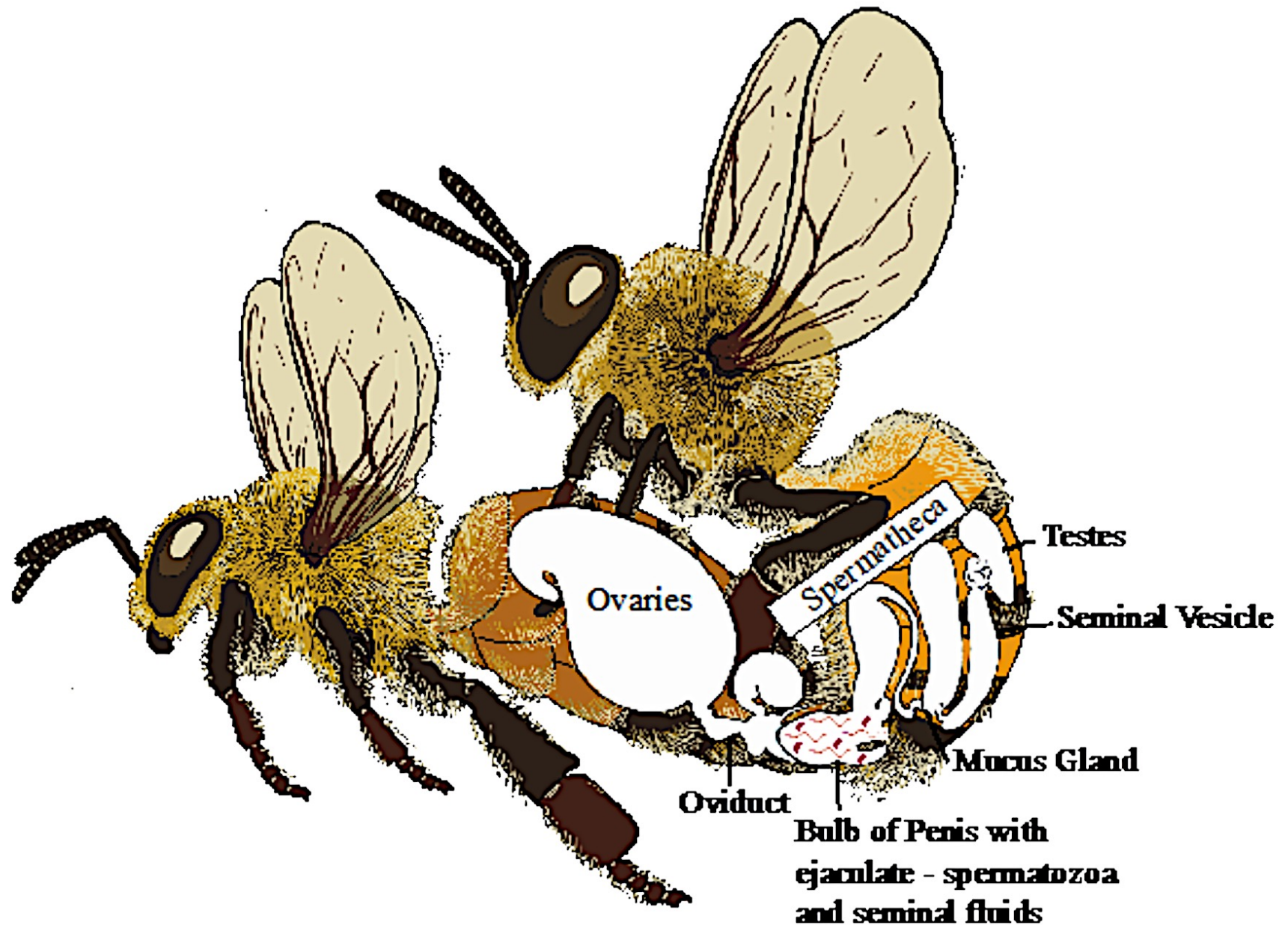
**Fig. 10. Honey bee mating behavior. Virgin queens fly through a drone congregation area and copulate with up to 14 different drones. When the drone everts his penis, he is paralyzed and drug behind the flying queen. Upon ejaculation, the penis may separate from the drone's body, ultimately killing him. The penis and mucus secretions left behind in the queen's mating chamber are called the "mating sign" (lower photo).**



**Mating sign  
UV reflective**



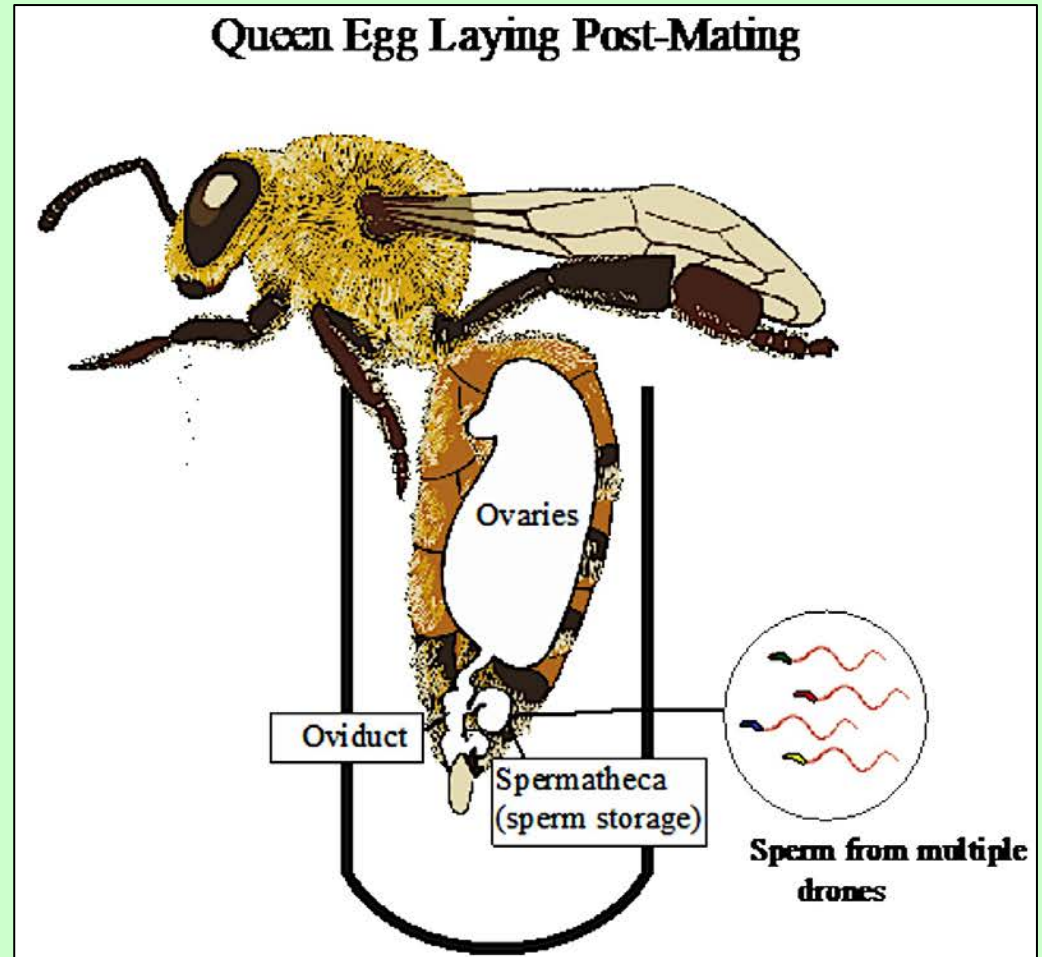
# Mating Flights





# Egg Laying

- ✓ As an egg passes down the oviduct it becomes fertilized with sperm (resulting in female workers or queen)
- ✓ In the absence of fertilization, the result will be a male drone
- ✓ Most queens can lay up to 1500 eggs per day



Slightly larger comb cells may receive an unfertilized egg and if the opening and cell size is large enough to accommodate a male larva.

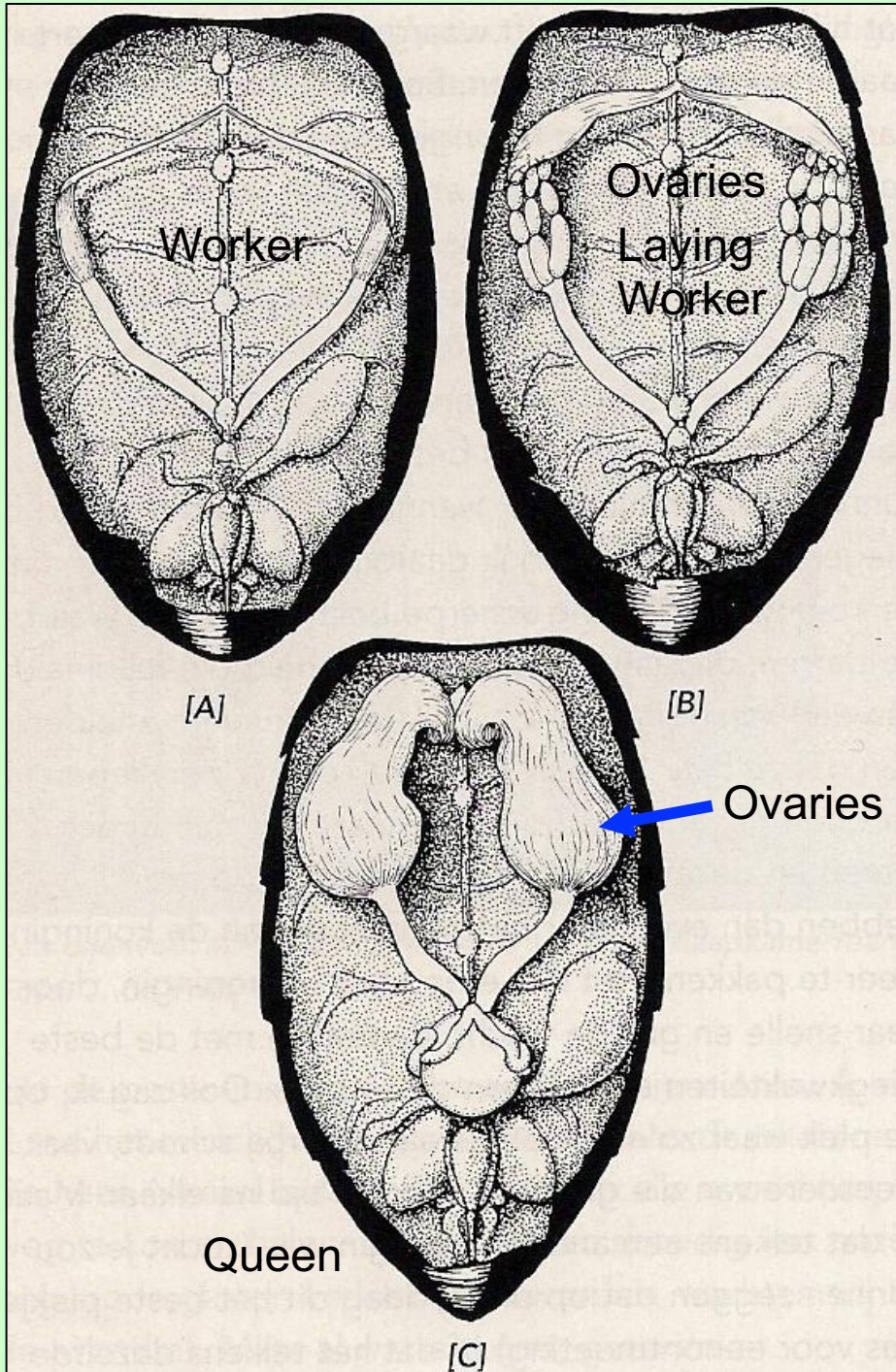


# Laying Worker



Multiple eggs ... Item 3 of 3

Multiple unfertilized eggs in each cell





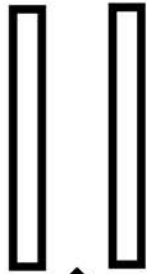


Capped & Uncapped Drone Brood



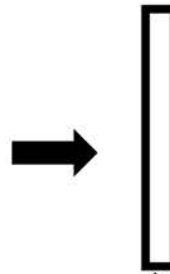
# Honey Bee Sex Determination

Laying Worker



*Diploid-2 sets of  
chromosomes 32*

A laying worker has underdeveloped reproductive traits, so they cannot mate with drones.



*Haploid 16  
Offspring*

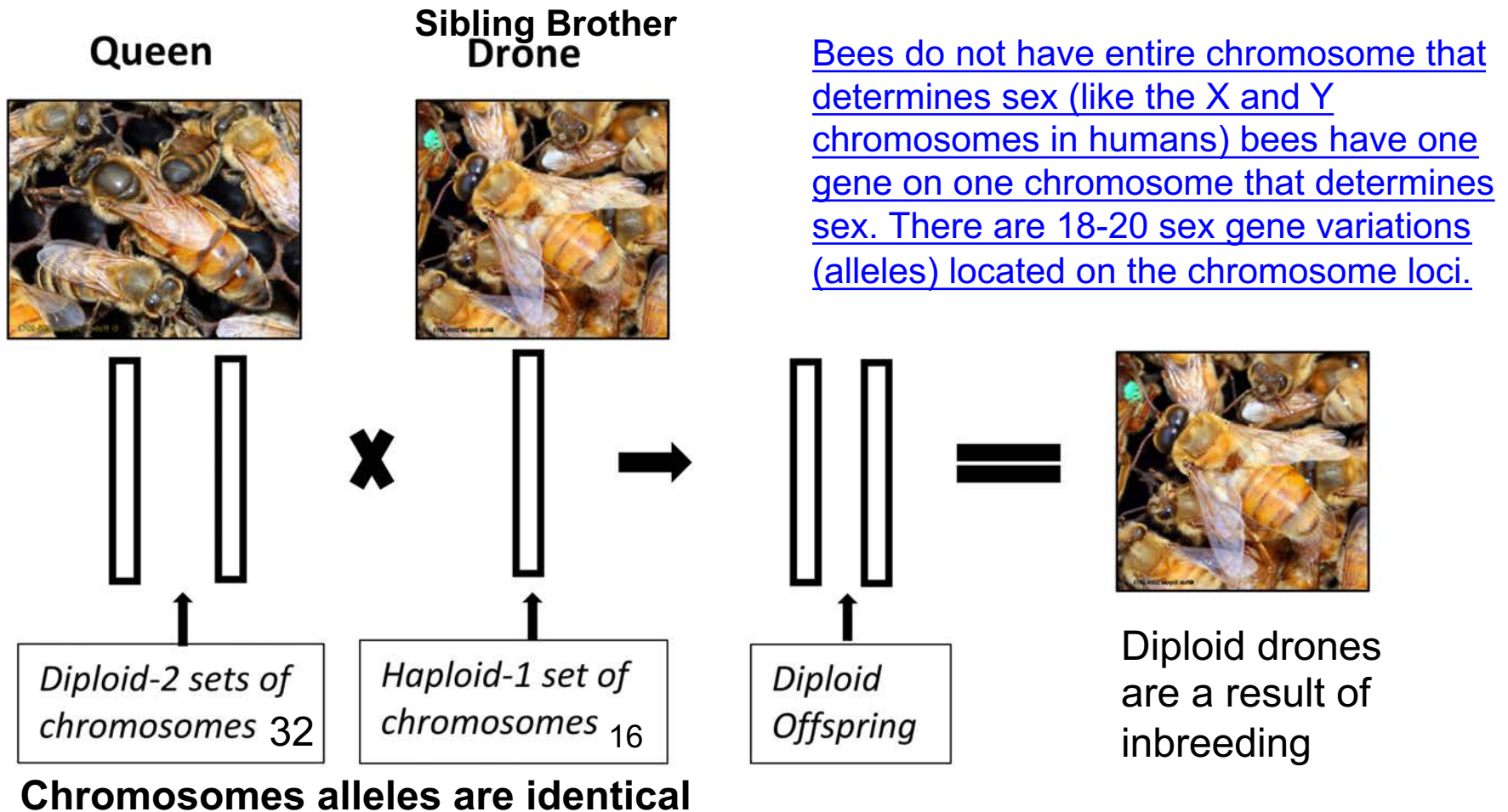
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Drone





# Honey Bee Sex Determination





# Bee Informed Partnership

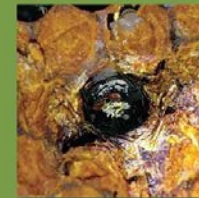
- INTRODUCTION 2
- BROOD DISEASES AND DISORDERS 4
  - American Foulbrood (AFB) 4
  - European Foulbrood (EFB) 10
  - Chalkbrood 16
  - Chewed Down Brood (CDB) 20
- PROBLEMS OF BROOD AND ADULTS 26
  - Viruses 26
  - Sacbrood Virus (SBV) 30
  - Deformed Wing Virus (DWV) 34
  - Parasitic Mite Brood Syndrome (PMBS) 38
- PARASITES OF ADULTS 44
  - Nosema 44
  - Tracheal Mites 50
- HIVE PESTS 54
  - Small Hive Beetle (SHB) 54
  - Wax Moths 60



## Diagnosis and Treatment of **Common Honey Bee Diseases**

SECOND EDITION

AUTHORS: The BIP Tech Transfer Team; Dan Aurell, Matthew Hoepfinger,  
Benjamin Sallmann, Garrett Slater, Robert Snyder, Daniel Wyns

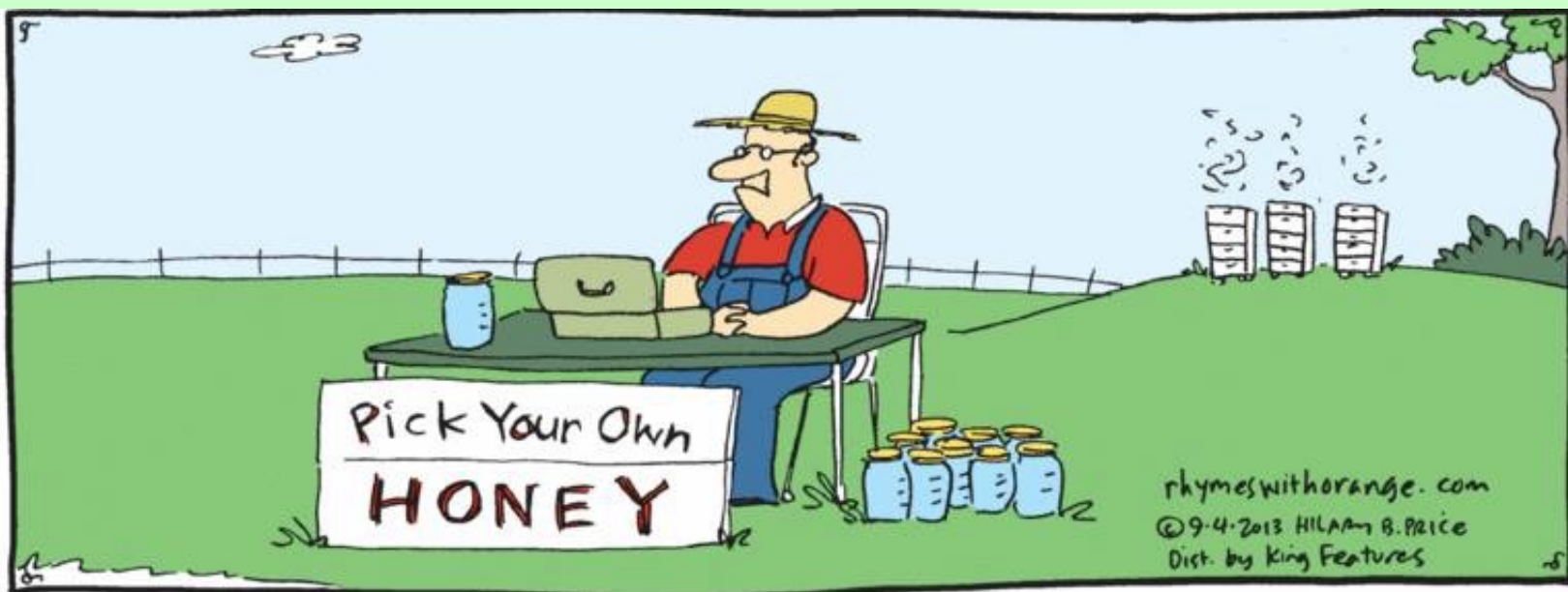


## BEE CASTE SYSTEMS: PART 1- HONEY BEE GENETICS

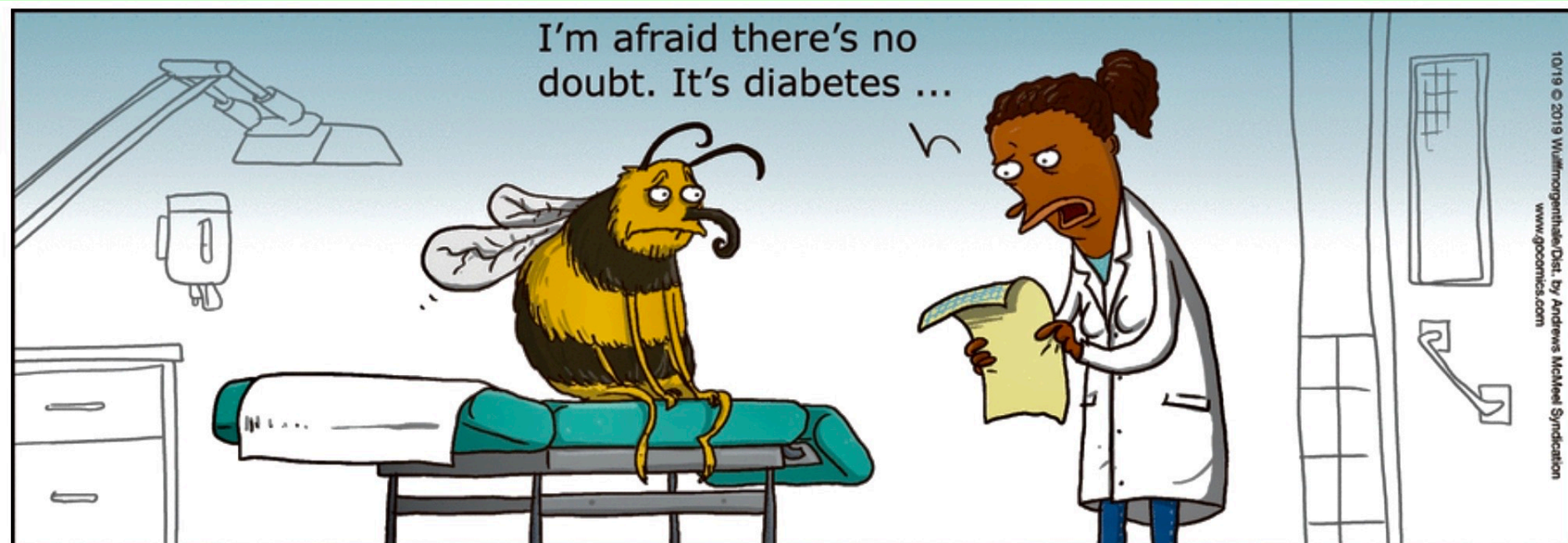
## HONEY BEE CASTE SYSTEMS: PART 2 – HOW GENETICS AND THE ENVIRONMENT SHAPE HONEY BEE WORKERS AND QUEENS



# Bee Behaviors and Sociology of the Colony



# 5 minute break





# The “Superorganism” of a Bee Colony

**Where the honey bee colony itself functions like a single organism.**

- ✓ Bees within a colony work together to perform colony level tasks
  - ✓ Reproduction
    - ✓ Swarming (resident queen and up to 2/3 of workers leave)
  - ✓ Respiration
    - ✓ Workers fan air to move air into and out of hive
  - ✓ Thermoregulation
    - ✓ Bees maintain the **brood area** of the hive at approximately 93°F. If ambient is above 93°F fan air over water droplets to cool. Ambient air below 93°F cluster vibrate indirect wing muscles and generate heat.

**In hive communications**

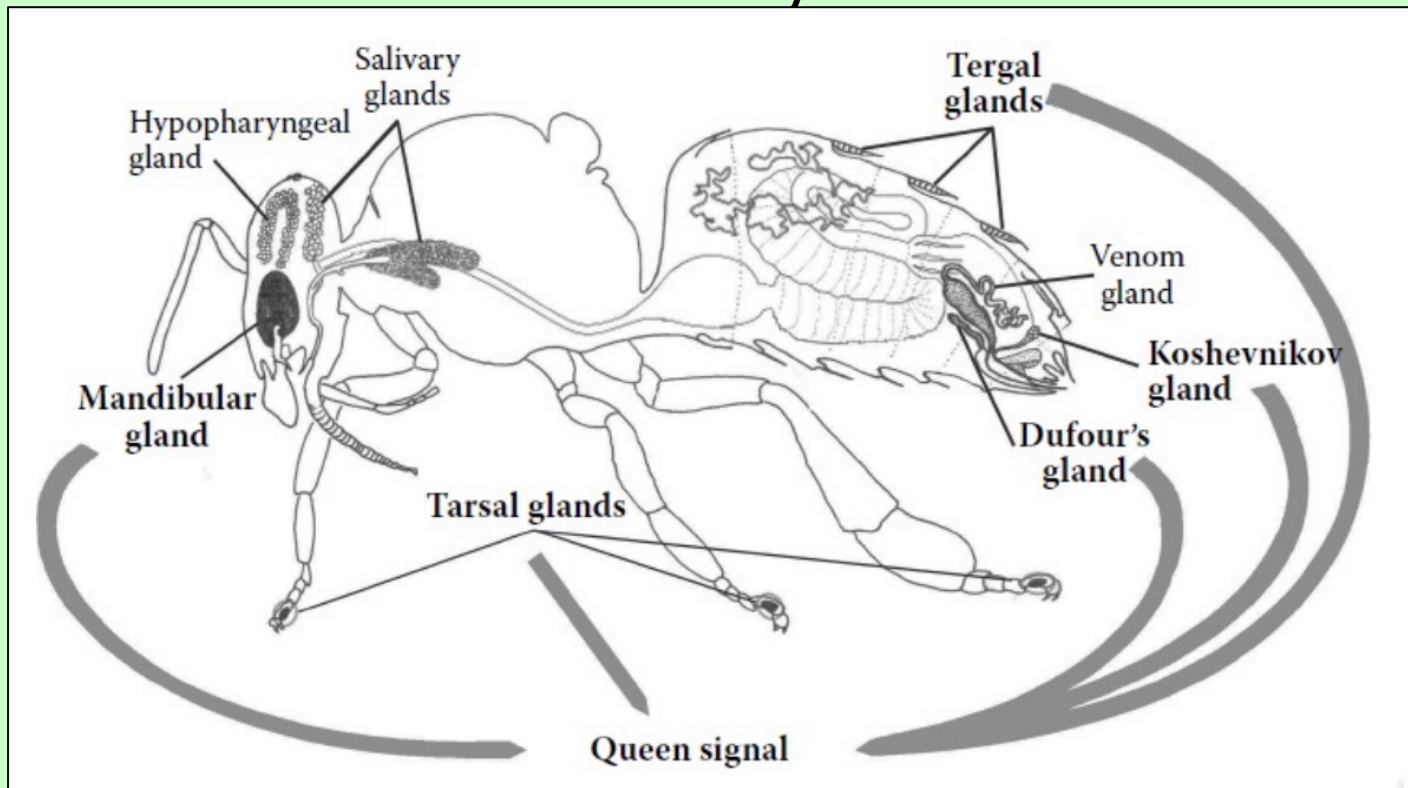


# Pheromones

## From 15 known glands

- ✓ Alarm pheromone
  - ✓ Koschevnikov gland (sting)
  - ✓ Mandibular glands (Sting)
- ✓ Brood recognition pheromone
  - ✓ Larvae & Pupae (Ovarian dev)
- ✓ Drone pheromone
  - ✓ Attracts other flying drones
- ✓ Dufour's gland pheromone
  - ✓ Eggs laid by queen or by laying worker
- ✓ Egg marking pheromone
  - ✓ Helps nurse bee distinguish
- ✓ Footprint pheromone
  - ✓ Left by walking bees & enhances nasonov pheromone
  - ✓ Oily queen secretion (tarsal gland); inhibits queen cells & swarming
- ✓ Forager pheromone
  - ✓ Released by older foragers slows the maturing of nurse bees
- ✓ Nasonov pheromone
  - ✓ Used for orientation & recruitment

# Internal Anatomy: Glands



## Hypopharyngeal Gland

- ✓ Secretes components of royal jelly food of queens & brood
- ✓ Nurse bees have huge glands since they feed developing larvae
- ✓ Secretes invertase to make nectar (sucrose) into honey (fructose & glucose)

## Mandibular Gland

- ✓ Produces secretions that are fed to the larvae + an alarm pheromone
- ✓ Nurse bees have huge glands because they feed developing larvae

## Tarsal Glands

- ✓ Trailing or Foot print
- ✓ Deposited as the bee walks

## Dufour's Gland

- ✓ Chemical marks eggs as fertilized vs unfertilized and worker's can identify

**Kosheveikov gland:** Alarm pheromone



# Pheromones

## Queen produced primer pheromone

### ✓ Queen mandibular pheromone (QMP)

- ✓ Social behavior
- ✓ Comb building control
- ✓ Swarming
- ✓ Mating behavior
- ✓ Inhibits ovary development
- ✓ Synthetic QMP has 5 components

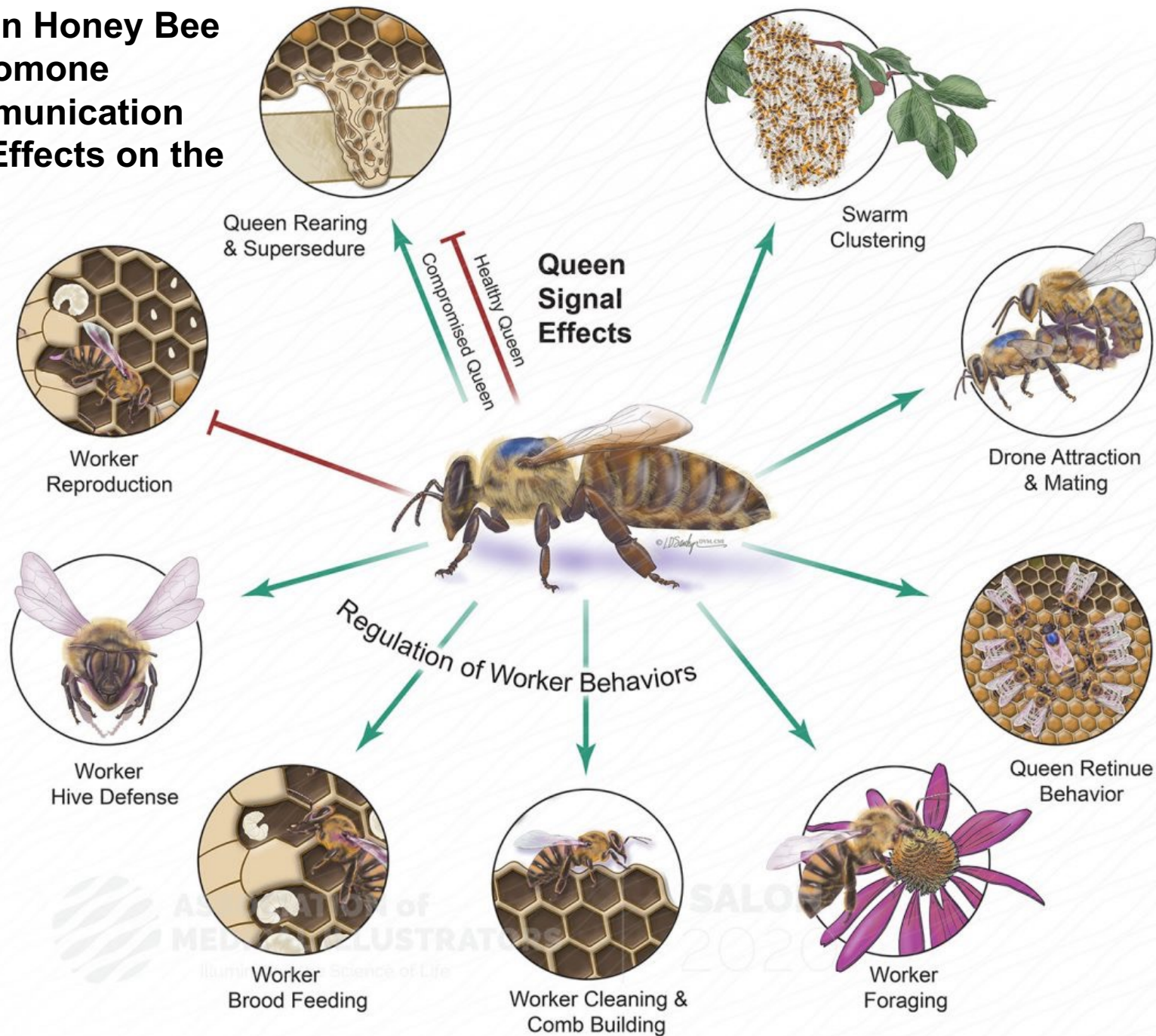
### ✓ Queen retinue pheromone (QRP)

- ✓ Behavioral effects is to attract a circle of bees (a “retinue”)
  - ✓ *Retinue pheromone* may be more accurate because the chemical mix in the pheromone comes from several glands



**TempQueen Queen Pheromone:** This synthetic QMP can be used to keep a queen less colony queenright for up to 3 weeks.

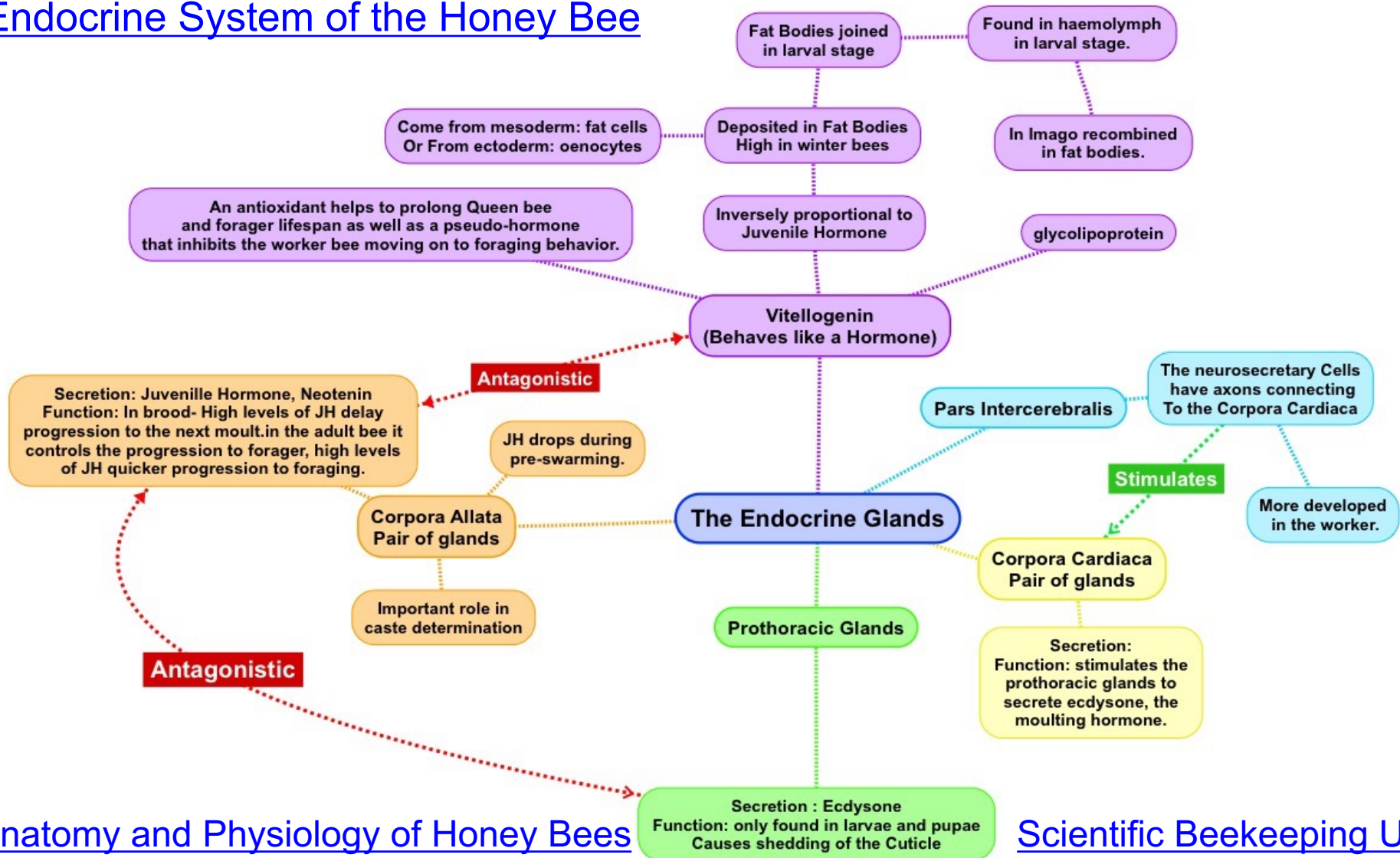
# Queen Honey Bee Pheromone Communication and Effects on the Hive





# Hormones in hemolymph: Endocrine Glands

## Endocrine System of the Honey Bee



# The behaviour of the foraging honeybee

Key facts:

Only female worker bees are foragers who collect nectar, pollen, water and resins





# What are Bees Foraging?

March 16, 2020: Spiked  
Sweetgum fruit (*Liquidambar*)

## Water

- ✓ Carried in “Honey stomach”
- ✓ Water mixed with
  - ✓ Pollen
  - ✓ Nectar
  - ✓ Saliva
  - ✓ = Sticky “Bee Bread”
    - ✓ Feed to developing larva
- ✓ Water droplets
  - ✓ Evaporative cooling
  - ✓ Hive thermoregulation



- ✓ Reacting to hive colony conditions
  - ✓ Swarm Prep
  - ✓ Brood temp too hot
- ✓ “The calm before the swarm”?
- ✓ Intense activity nearby as a few dozen scout bees come and go
- ✓ Swarming doesn't happen that often
- ✓ This hive had honey supers removed for extraction in hot mid-July and were forced to beard outside their hive.

# Bees Bearding



[If your bees want to beard, let them](#)



May 18, 2018

## Bees Washboarding

- ✓ Washboarders were all worker bees and the behavior continues to be a mystery
- ✓ Studies have shown they started washboarding at 13 days old.
- ✓ And that the peak amount of washboarding occurred in workers between 15-25 days old.
- ✓ Washboarding appears to occur more frequently at the end of a nectar flow

[Washboarding bees arockin' and alickin'](#)





# Hive thermoregulation by “Fanning” (Add more ventilation)

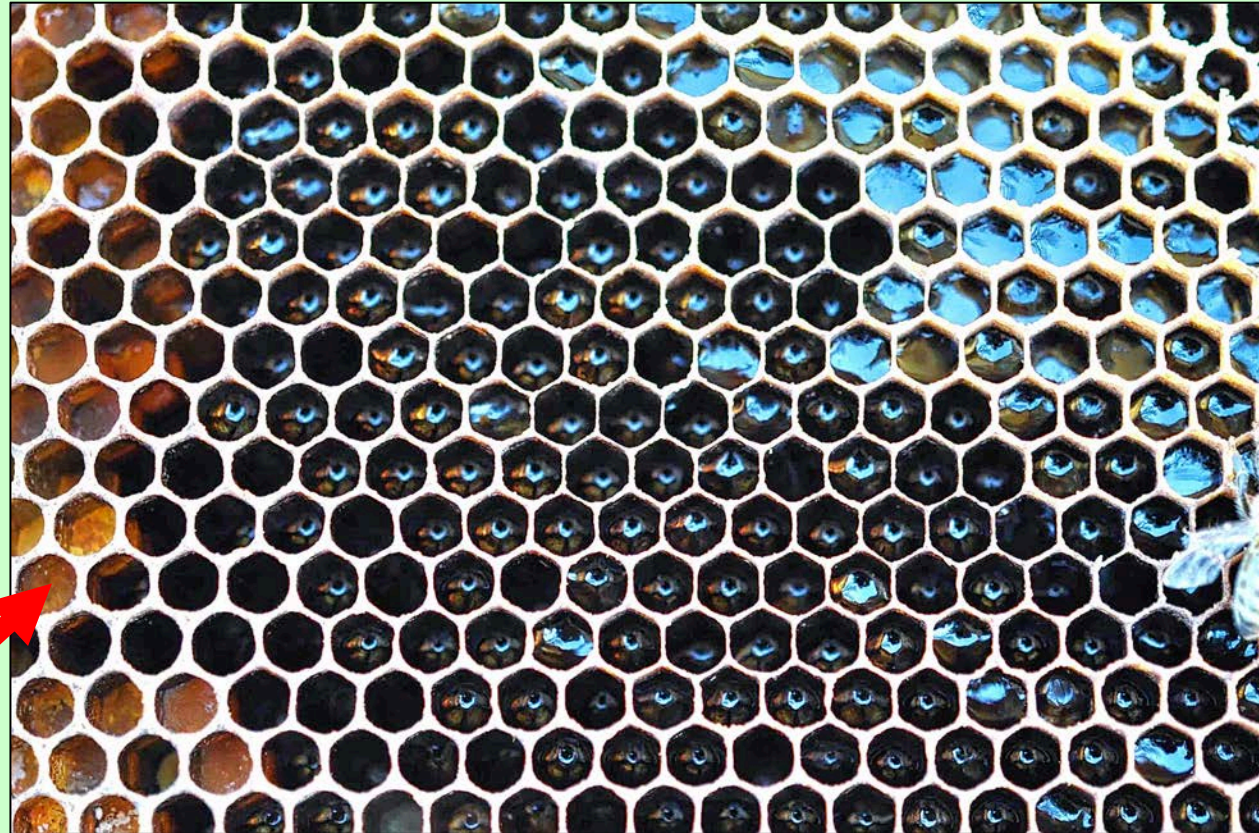




# What are Bees Foraging?

## Nectar

- ✓ Carried in “Honey stomach”
- ✓ 80% water & 20% sugars
- ✓ Honey between 15.5 & 18.6 moisture



Pollen (bee bread)

Frame with uncapped nectar

# Processing Nectar by Bees

## How Do Bees Make Honey?



Bee's Tongue

Bees forage on nectar from flowers using their short tongue (1/4 in), return to the hive and pass the solution of sugars over to house bees.



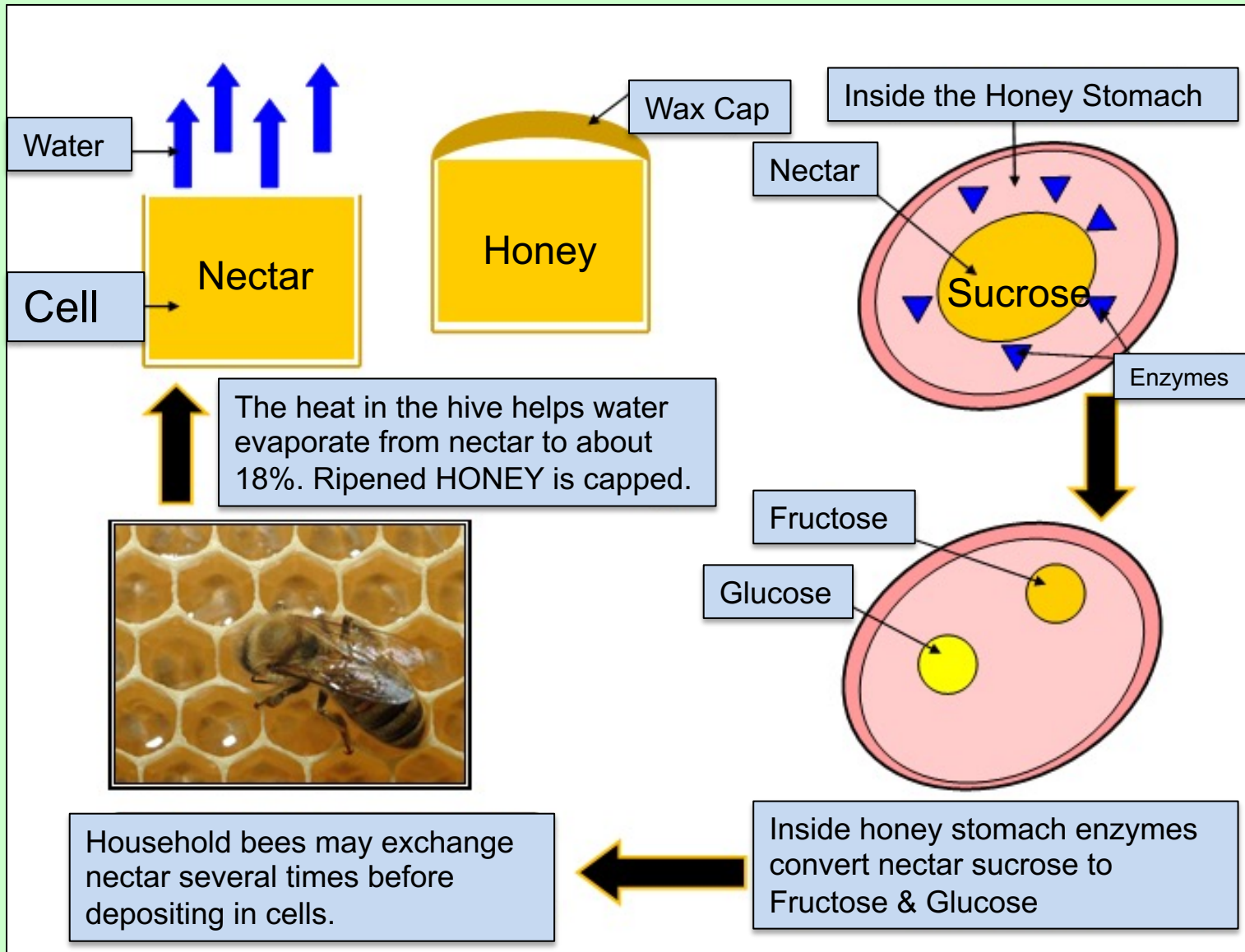
Honey stomach or crop

Bees store the nectar which is primarily sucrose in honey stomach where nectar is broken down into two sugars





# Processing Nectar by Bees



Mixed Floral Honey	Average
Fructose/Glucose Ratio	1.23
Fructose, % *	38.38
Glucose, % *	30.31
Minerals (Ash), %	0.169
Moisture, % *	17.2
Reducing Sugars, %	76.75
Sucrose, %	1.31
pH *	3.91
Total Acidity, meq/kg.	29.12
True Protein, mg/100g.	168.6

100 gram serving (3.5 oz.),  
honey provides 304 calories  
with no essential nutrients in  
significant content.

## Honey

### Nutritional value per 100 g (3.5 oz)

<b>Energy</b>	1,272 kJ (304 kcal)	
<b>Carbohydrates</b>	82.4 g	
Sugars	82.12 g	
Dietary fiber	0.2 g	
<b>Fat</b>	0 g	
<b>Protein</b>	0.3 g	
<b>Vitamins</b>		
Riboflavin (B <sub>2</sub> )	0.038 mg	(3%)
Niacin (B <sub>3</sub> )	0.121 mg	(1%)
Pantothenic acid (B <sub>5</sub> )	0.068 mg	(1%)
Vitamin B <sub>6</sub>	0.024 mg	(2%)
Folate (B <sub>9</sub> )	2 µg	(1%)
Vitamin C	0.5 mg	(1%)
<b>Minerals</b>		
Calcium	6 mg	(1%)
Iron	0.42 mg	(3%)
Magnesium	2 mg	(1%)
Phosphorus	4 mg	(1%)
Potassium	52 mg	(1%)
Sodium	4 mg	(0%)
Zinc	0.22 mg	(2%)
<b>Other constituents</b>		
Water	17.10 g	



# Beekeeper's Reward 2010 5-Gallons Honey



Jars of Honey from 18  
Medium frames of  
capped honey:

12 quart jars  
12 pint jars  
2 – ½ pint jars

## Harvest History from Leister's Apiary

2010 – 5 gallons (1 hive)  
2011 – 0 gallons  
2012 – 0 gallons  
2013 – 15 gallons (2 hives)  
2014 – 15 gallons (1 hive)  
2015 – 12 gallons (3 hives)  
2016 – 25 gallons (4 hives)  
2017 – 23 gallons (4 hives)  
2018 – 18 gallons (5 hives)  
2019 – 37 gallons (6 hives)  
2020 – 36 gallons (5 hives)  
2021 – 32 gallons (5 hives)





Satellite



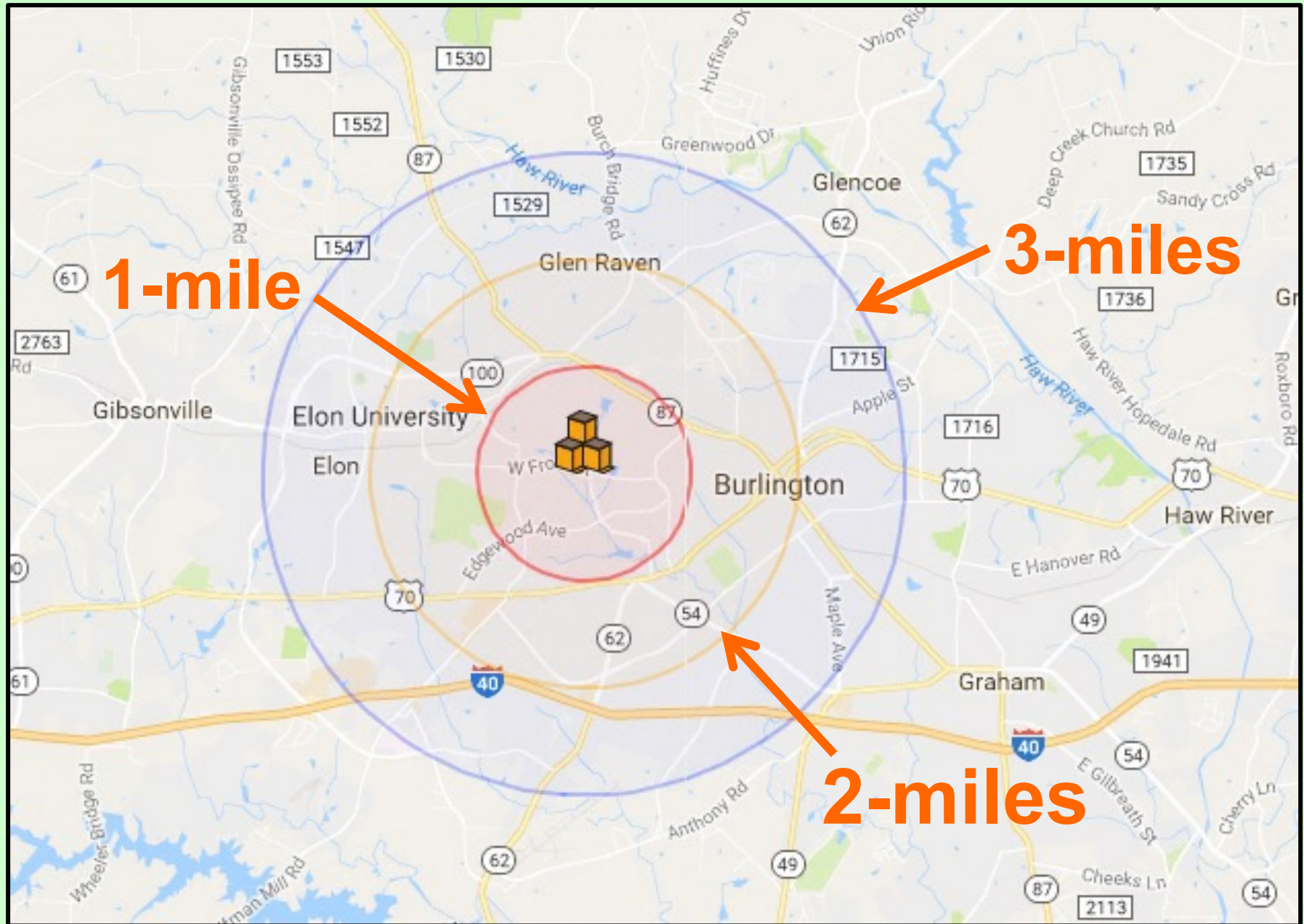
1/2 Acre

Google

Keyboard shortcuts | Map data ©2022 Imagery ©2022, Maxar Technologies | Terms of Use | Report a map error

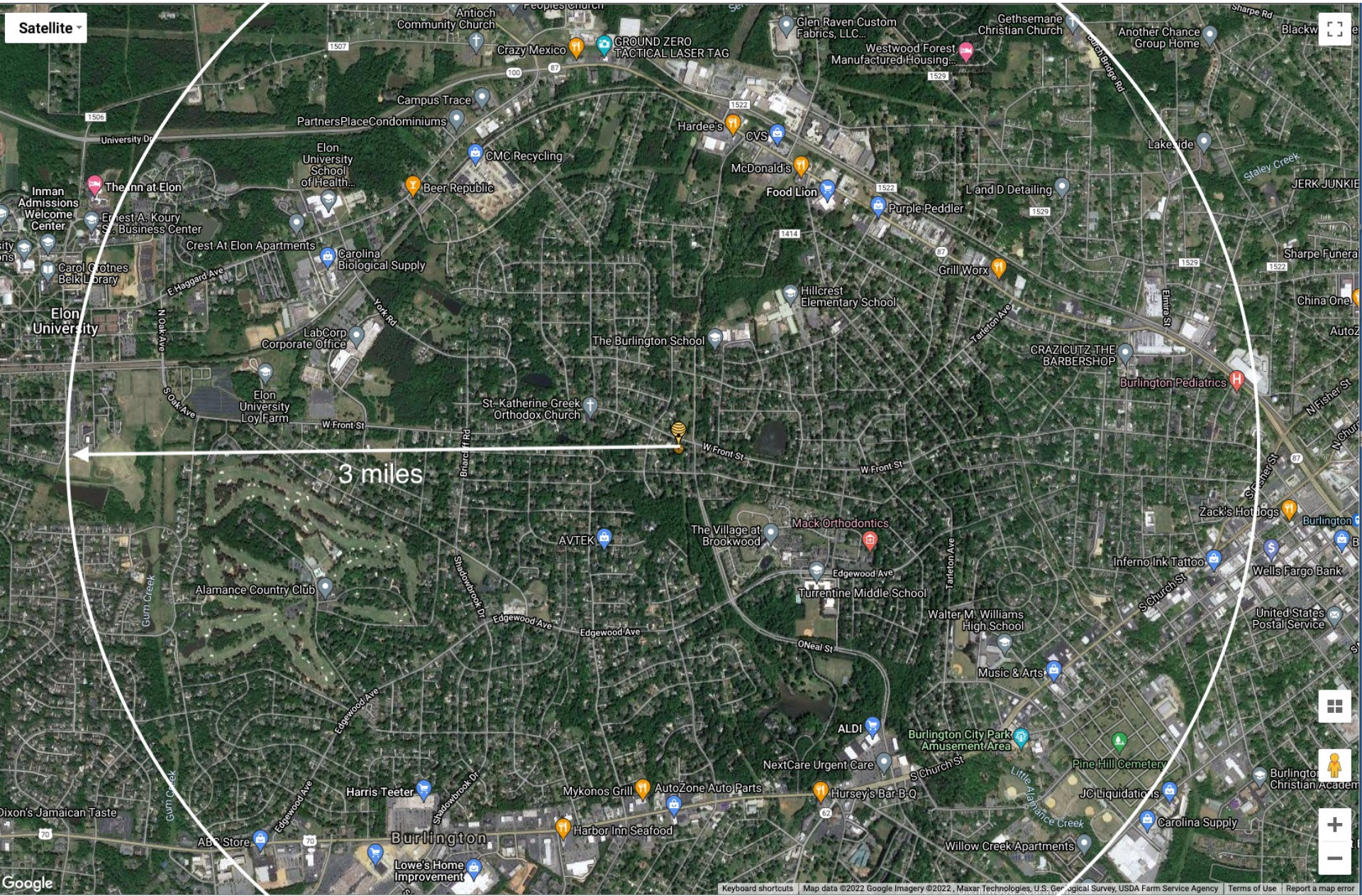


# Leister's Apiary at 2010 West Front Street





Satellite




Google

Keyboard shortcuts | Map data ©2022 Google Imagery ©2022, Maxar Technologies, U.S. Geological Survey, USDA Farm Service Agency | Terms of Use | Report a map error



[www.fieldwatch.com](http://www.fieldwatch.com)





BEEHIVES

### Hive NC-18533

Submitted 09/05/2016 Approved 09/06/2016  
Updated 01/24/2022  
Number of Hives for this submission: 6

**Site expires from map after 03/31/2023**

Information

**Producer:** Geoffrey Leister

**Email:** [geoffleister@mac.com](mailto:geoffleister@mac.com)

**Address:** 2010 West Front Street  
Burlington NC 27215

**Phone:** 1-336-380-5000

**Center:** Latitude: 36.097192  
Longitude: -79.470232

**Purpose:** Hobbyist

**Location Type:** Permanent for the Season

**Submission Approved**

Click here to purchase a "No-Drift" sign or BeeCheck flag for this site.

[Make Changes to Site](#) [Remove This Site](#) [Close](#)

# What are Bees Foraging?

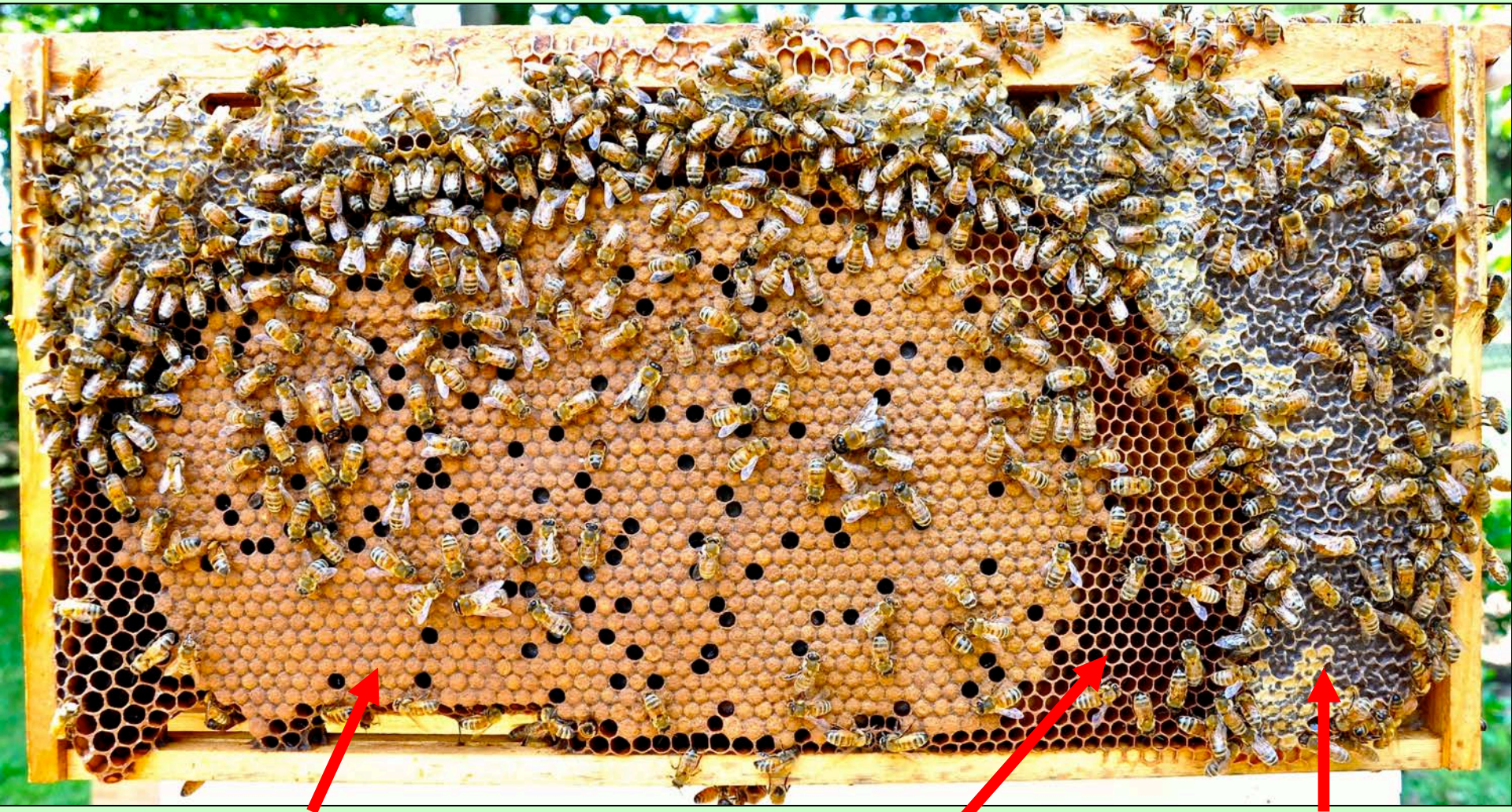
## Bee Pollen

- ✓ Negatively charged (–) pollen collects on positively (+) static-electric charged plumose hairs caused by their flights
- ✓ Pollen grains are combed with stiff hair-like structures on her forelegs, to mid-legs to hind legs & packed into pollen baskets (corbicula) on **tibia** of hind legs
- ✓ Nurse bees will retrieve the pollen pellet





# Fermented “bee bread” fed to larvae



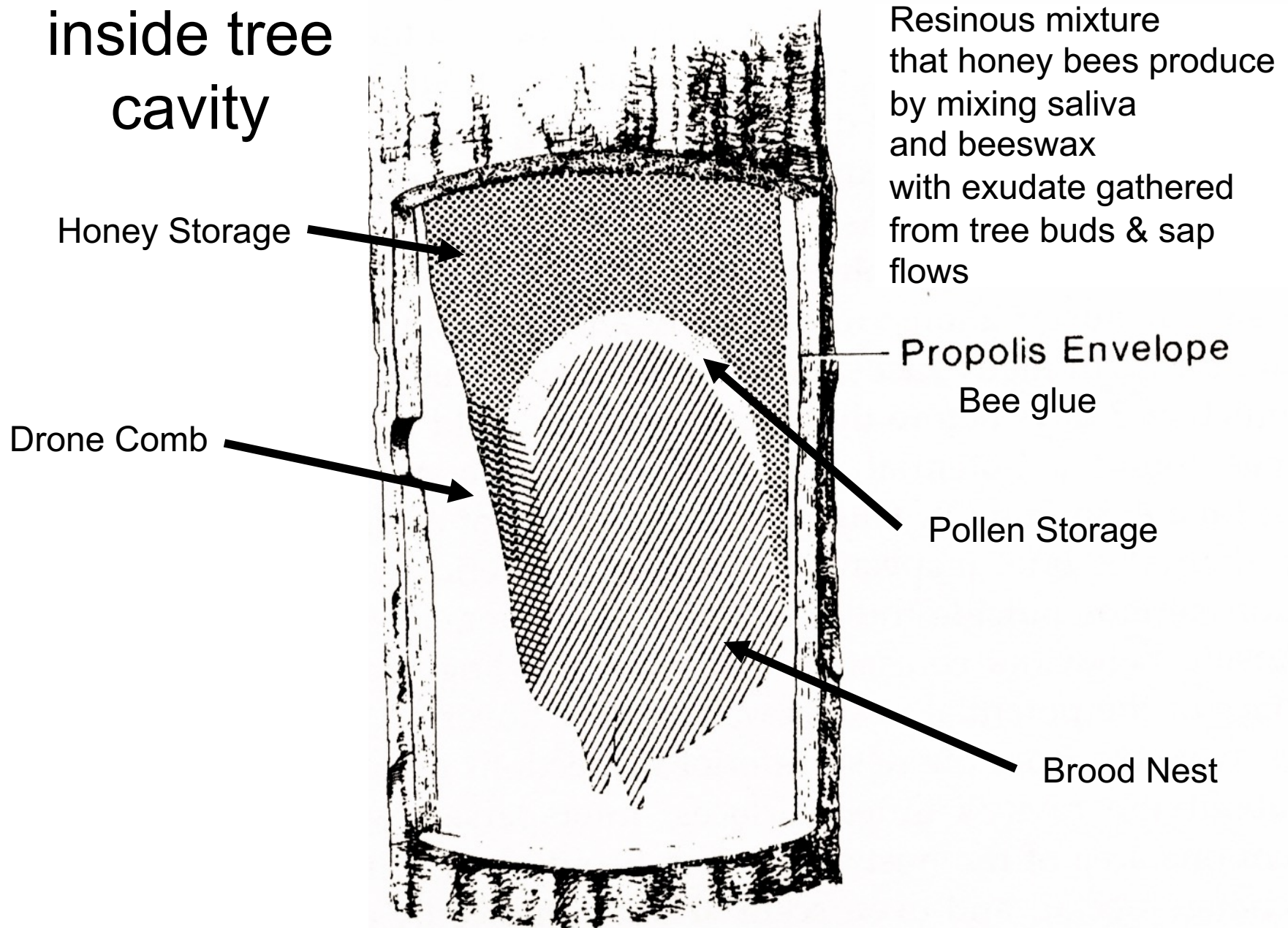
Capped worker  
brood

Pollen stores

Capped honey

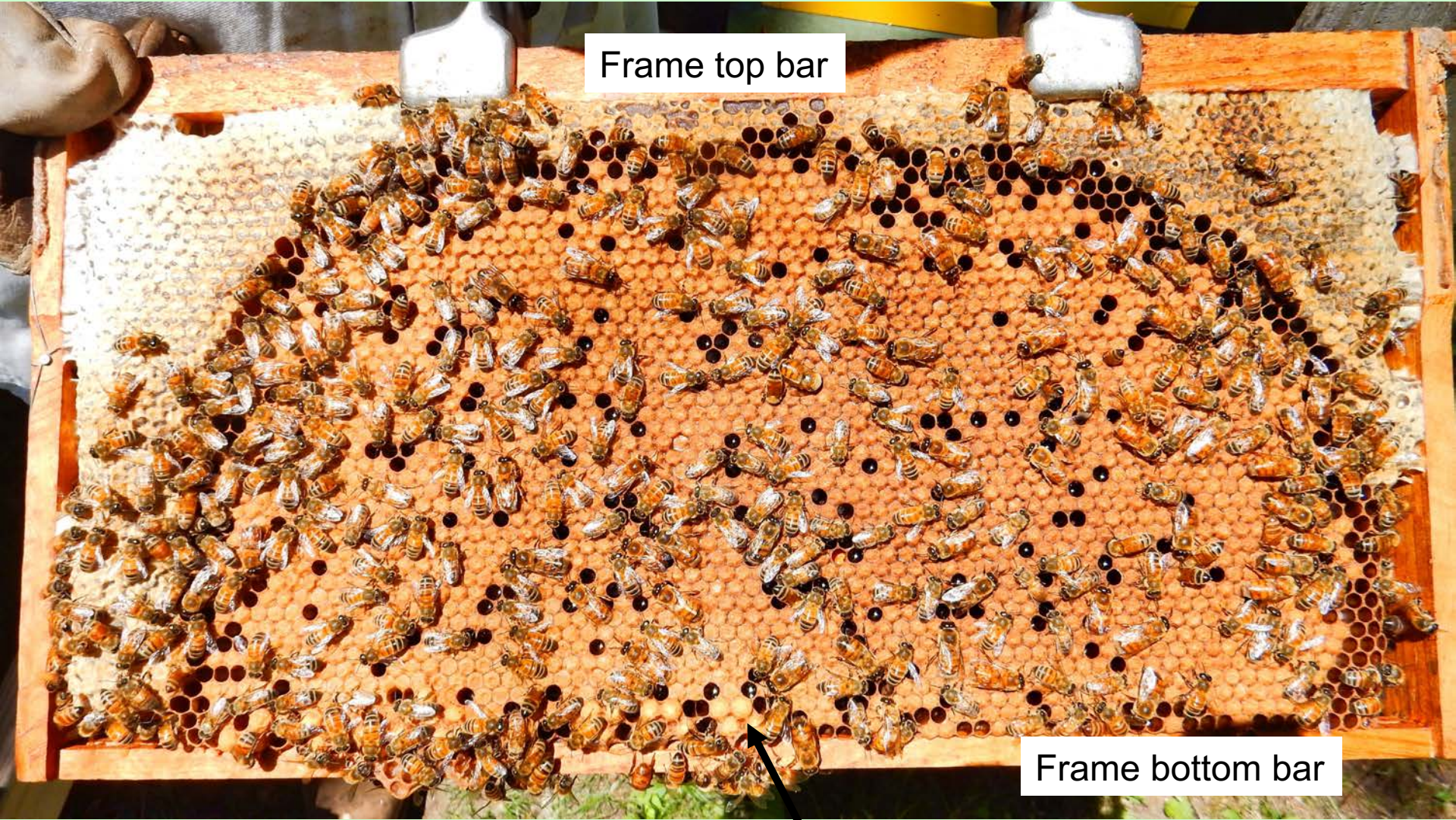


# Bee Nest inside tree cavity





# Capped Drone Brood at Edges



Frame top bar

Frame bottom bar

Capped drone brood



# What are Bees Foraging?

## Plant Resins and connection to propolis

- ✓ Collected on warm days
- ✓ Mandibles bit off resin & mixes in saliva, transfers to forelegs to corbicula
- ✓ Once in the hive, worker bees remove resin, mix in beeswax, salivary secretions, and a some pollen to produce **propolis**
  - ✓ About 50% balsams, 30% waxes, 10% essential oils, and 5% pollen



**Smear on rough surfaces, smooth over holes & cracks with waterproof & antimicrobial goo!**



# What are Bees Foraging?

## Honeydew (secretion)

- ✓ Crape myrtle aphids
  - ✓ Bees forage on honeydew
- ✓ Ants gather honeydew
- ✓ Scale insects
- ✓ Cicada nymphs suck sap from plant roots & adults from
  - ✓ Oak, Willow, Ash & Maple



# In hive foraging regulation

- ✓ Nurse bees can assess the requirements of the colonies available resources by special pheromones released by developing brood
- ✓ If colony requires carbohydrates, then the nurse bees will quickly accept nectar loads from returning foraging bees
- ✓ If the greatest requirement is water, then nurse bees will quickly assist those foragers returning with water
- ✓ Lack of help from nurse will cause foragers to switch to a different resource

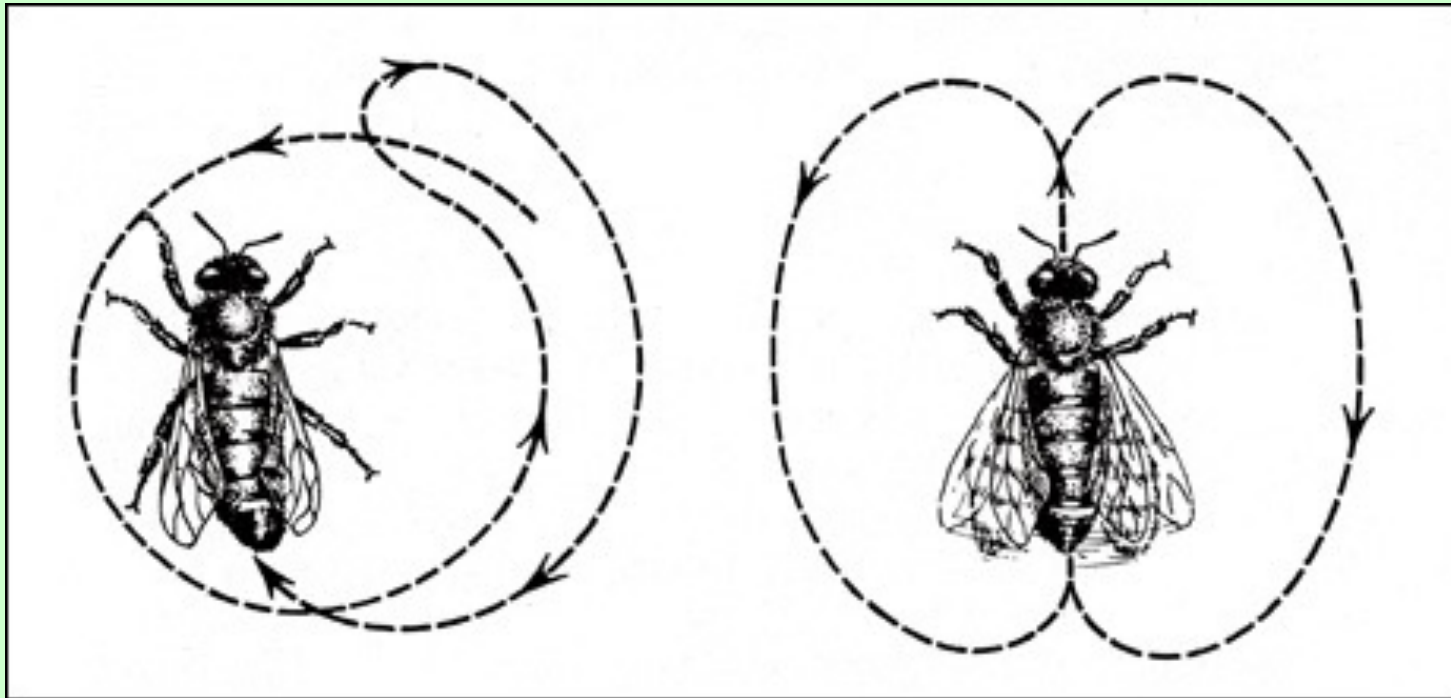


Spiny Sweetgum seed pods



# Honey Bee Colony Communication with nestmates

Honey bees share Information on direction & distance to nectar, pollen, & water sources or to new nest-site locations by “dancing in the dark.”

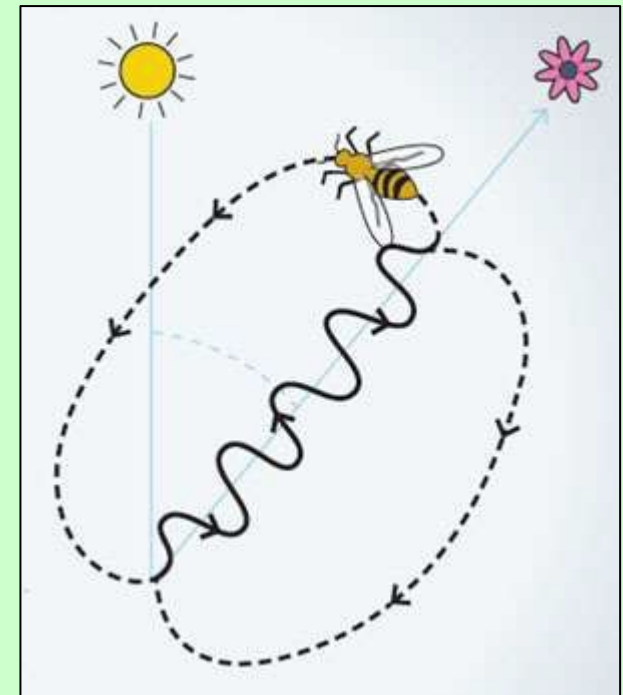
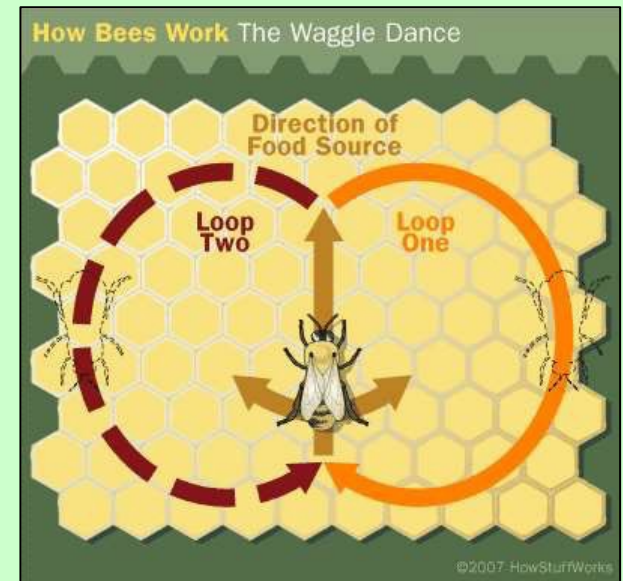


**round dance**  
Food nearby

**waggle dance**  
Food far away ■ ■ ■

# Nestmate foraging engagement

- ✓ Utilizes dance language (Waggle dance) to communicate information about resources
- ✓ Dance language includes:
  - ✓ **Distance** to the resource
  - ✓ **Location** of the resource
  - ✓ **Richness** of the resource
  - ✓ **Taste & Smell** of resource
- ✓ Bees can assess multiple dances and resources at the same time and select the most appropriate





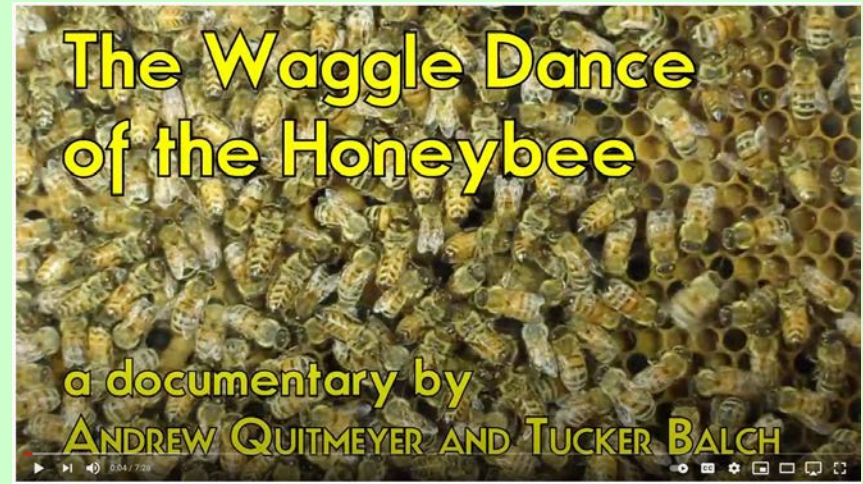
# Waggle Dance



Produced by Georgia Institute of Technology  
<https://youtu.be/bFDGPgXtK-U>

## Influences on foraging activity

- ✓ Sun's solar azimuth angle
  - ✓ UV light
  - ✓ Polarized light
- ✓ Gravity
- ✓ Bees biological clock
- ✓ Pheromones
- ✓ Sound (vibrations on wax comb)
- ✓ Old theory: distance to source based on amount of energy used as mentioned in video is incorrect. See "Optic Flow"



Georgia Institute of Technology video

<https://youtu.be/bFDGPgXtK-U>



- ✓ 1) That distance flown is estimated in terms of energy consumption(?)
- ✓ 2) The cue is visual, and is derived from the extent to which the image of the world has moved on the eye during the foraging trip
- ✓ **The honey bee's "odometer" is visually driven NOT on energy used**

# Optic Flow

## About The Cover



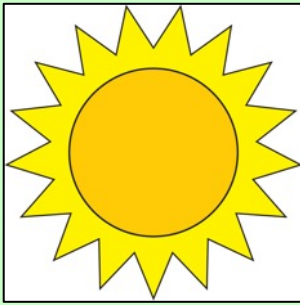
# Orientation Flights

Yesterday afternoon at 12:00 PM temperature was 59°F and these 21-day old new workers & drones hover facing their hive's entrance, as they take 5-10 min orientation flights to familiarize themselves with landmarks and void feces.

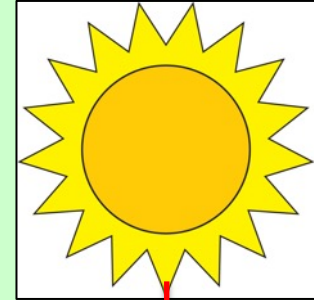




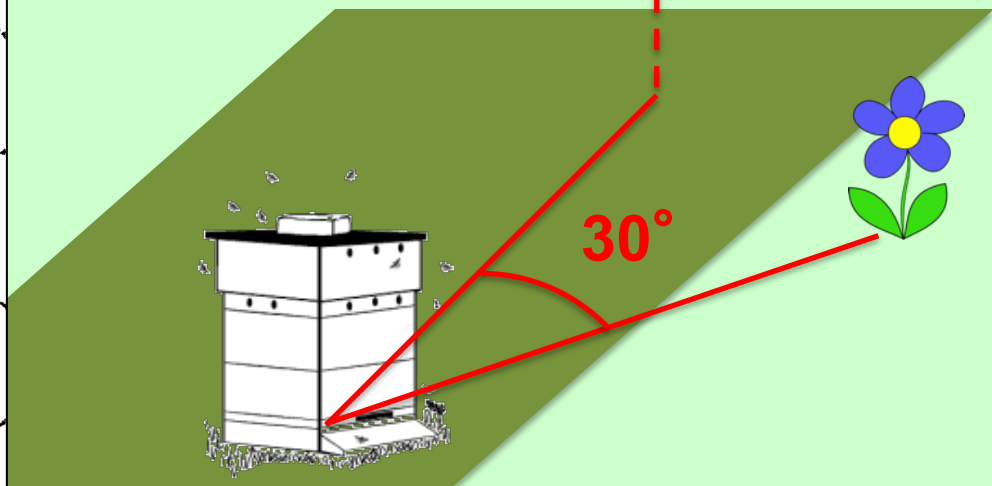
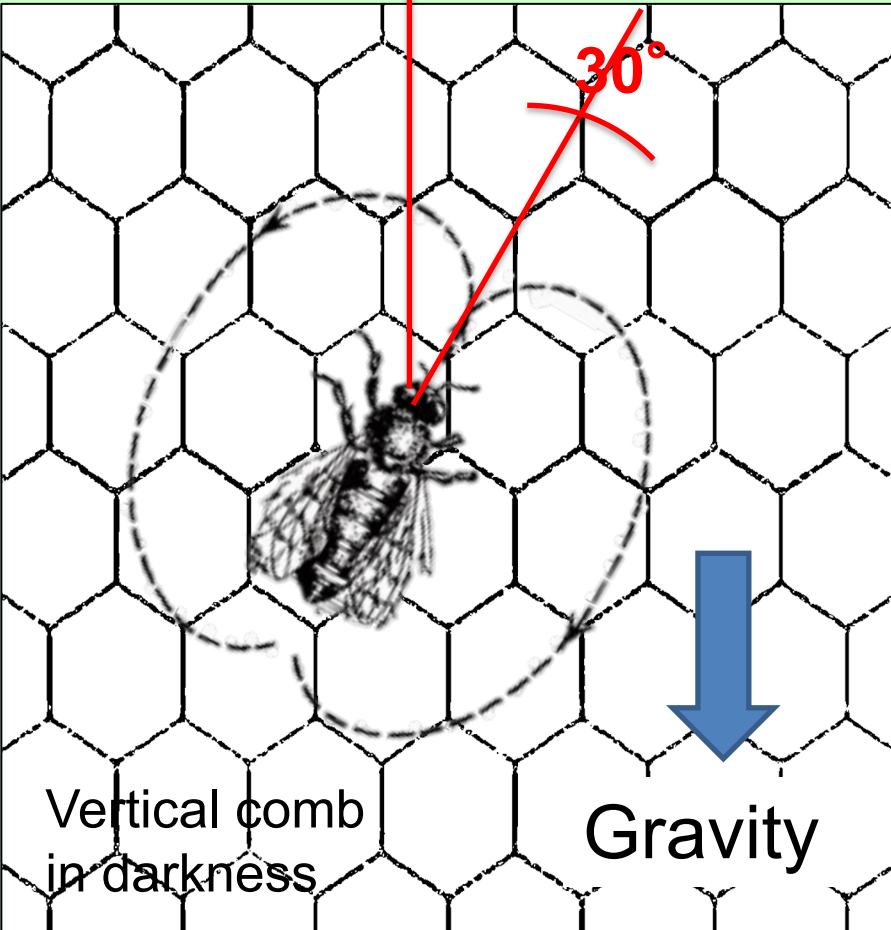
# How the dance works



The solar azimuth angle is the azimuth angle of the Sun's position, which changes during the day. But resident foragers have stored those azimuth angles at the hives location.



(During orientation flights in front of their hives)



# Seasonal Biology of the Colony

## ✓ Seasonality

- ✓ Winter
- ✓ Spring
- ✓ Summer
- ✓ Fall

## ✓ Swarming Spring

- ✓ Queen supersedure

## ✓ Communication

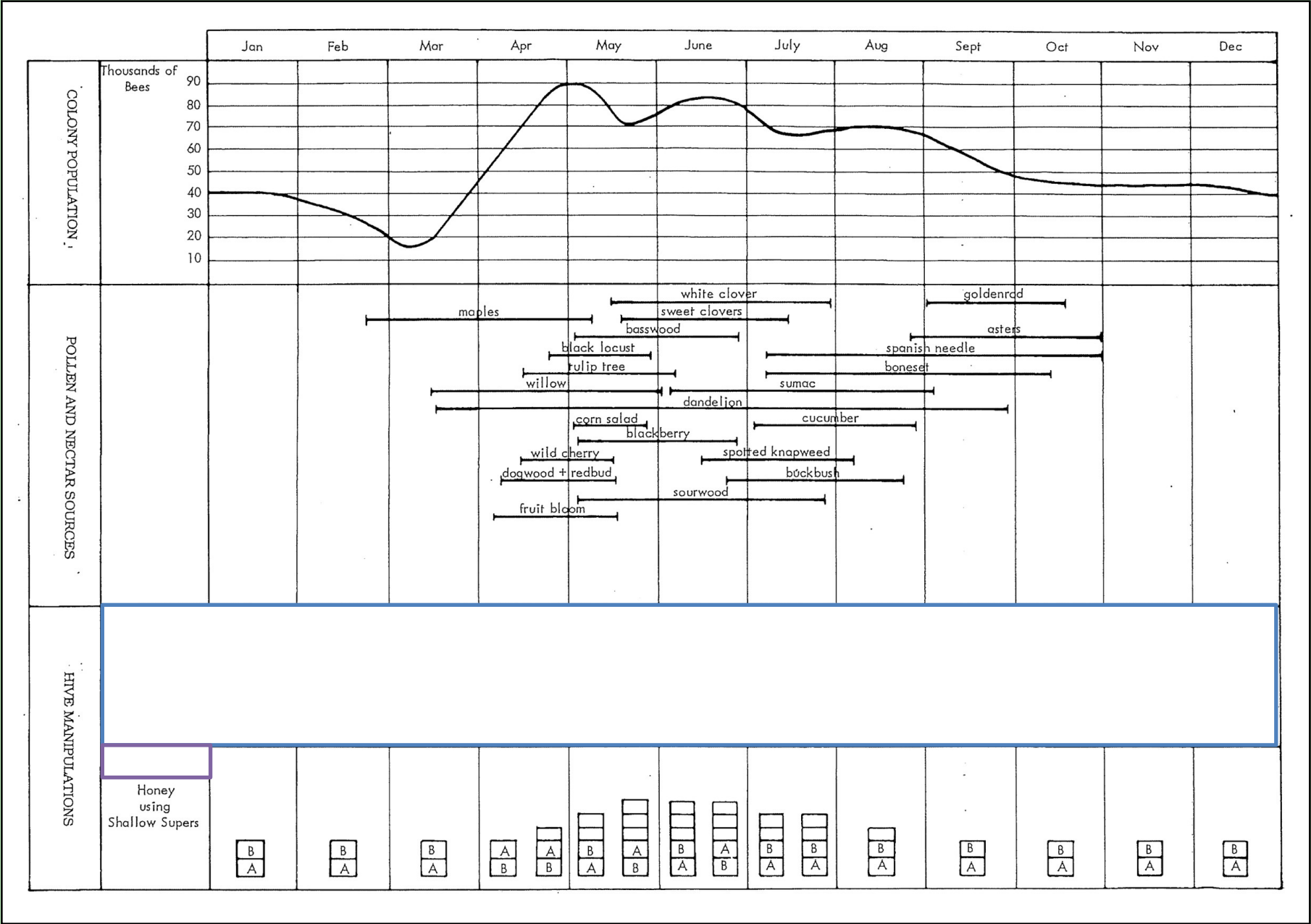
## ✓ Foraging



Leister's Front Yard Hive Inspection  
February 1, 2012 with Don Moore



# Seasonal Colony Population, Pollen & Nectar Sources, & Hive Configuration



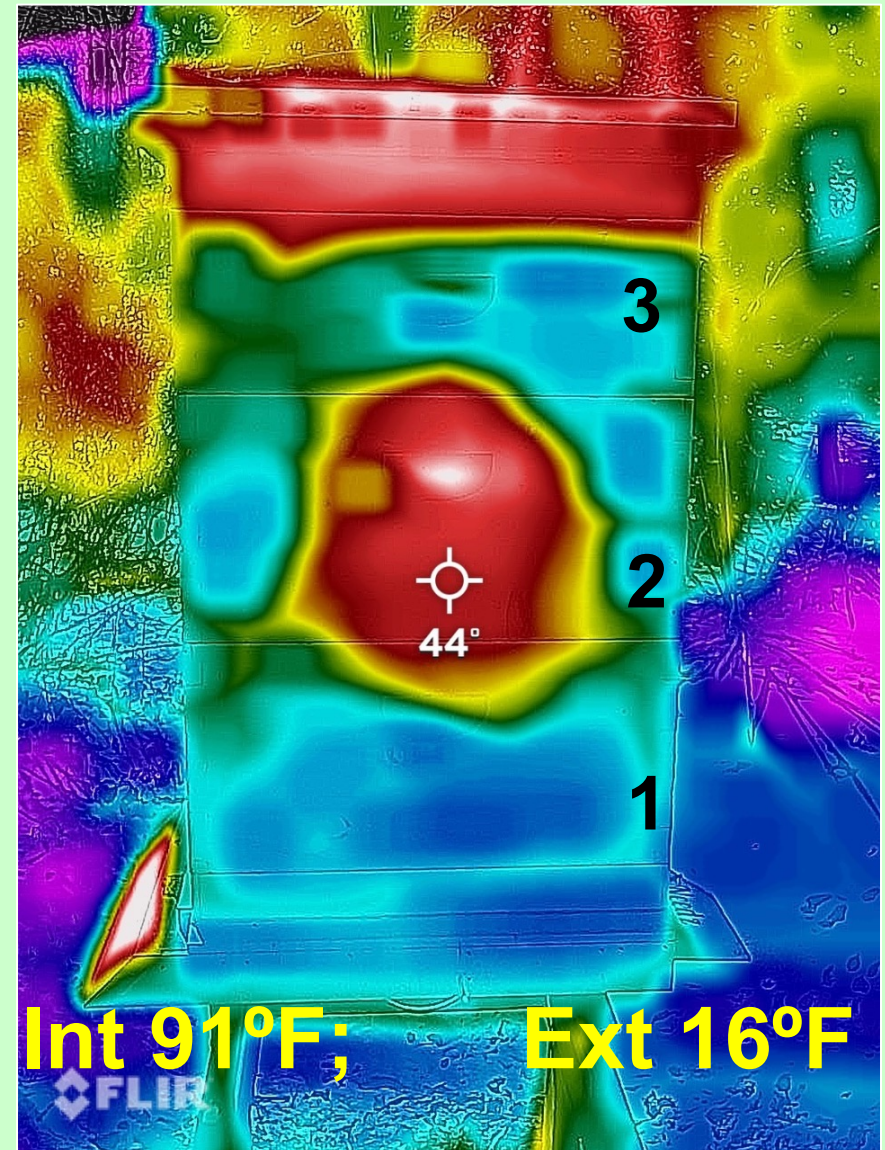
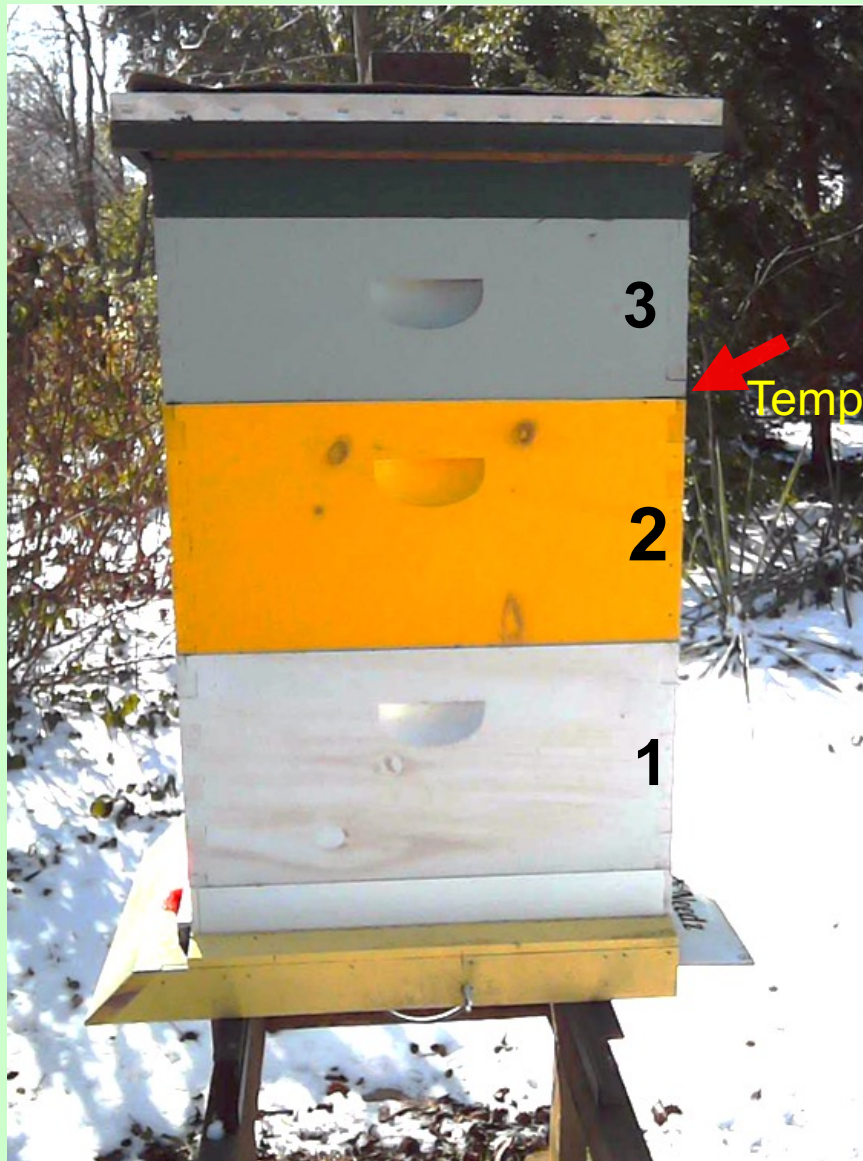
# Overwintering

- ✓ During the winter, bees cluster in the center of the nest to conserve heat
- ✓ In the middle of cluster is the queen and some workers fed on honey as they shiver their thoracic flight muscles and generate heat
- ✓ We will talk much more on winter hive maintenance later in the course



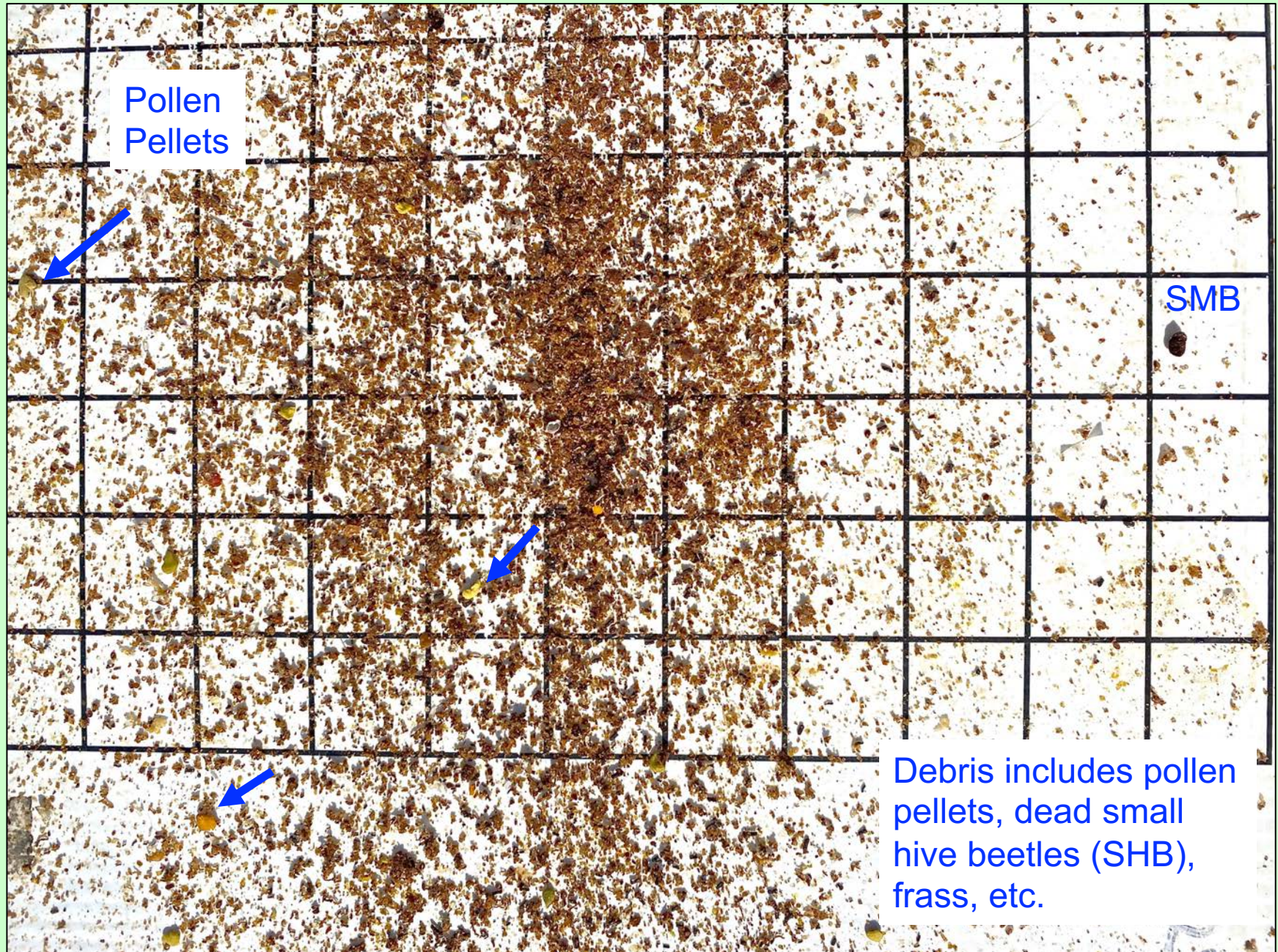


# FLIR Infrared iPhone Camera & BroodMinder Temperature Monitoring (Jan 23, 2022)





# Correx Sheet Hive#2 Feb 9, 2021





# Spring and Reproductive Cycle

- ✓ Brood rearing typically begins as the winter solstice passes.
- ✓ Colony will start to take advantage of the earliest of nectar sources
- ✓ **Swarming** may occur in mid-spring, and **queen succession** will take place



**Typical Flowering Seasons for Western North Carolina Honey and Pollen Sources: Approximately 2500 feet elevation**

[illegible]

### Other Important Beekeeping Dates:

[illegible]**Timetable Legend:**

Primary Flowering Period  
Primary Honey Flow Periods

**Note:** Microclimate issues can dramatically affect plant flowering and honey flow dates, especially in the mountains. Such issues may include plant areas protected from winds and snowfall, or having especially good solar access. Seasonal variations in rainfall, snowfall, frost, freezing and thaw dates can also have a significant influence on these typical flowering dates and durations - sometimes as much as +/- 2 weeks! Beekeepers must be ever-mindful of weather changes and unusual seasonal events that can affect plant flowering, bee activities and honey production for their specific mountain microclimate.



Swarm April 16, 2019 at 1:47 PM





# Bait Hive Swarm April 21, 2019



Bait Hive Leister's Apiary



# What is swarming?

- ✓ Colony splitting (can occur multiple times within a single colony)
- ✓ Production of drones & new queens are produced mid-spring
- ✓ Once ready, the old queen and two thirds of workers will form a cloud of bees.
- ✓ The queen will alight on an object (i.e., tree branch), and her pheromones orient the swarm to her.
- ✓ Scout bees investigated new locations before swarm departs



May 9, 2011 swarm



# Capped Swarm Cells (peanut shaped & hang vertical near lower frame edge)



Queen Cup

Capped Queen Cells



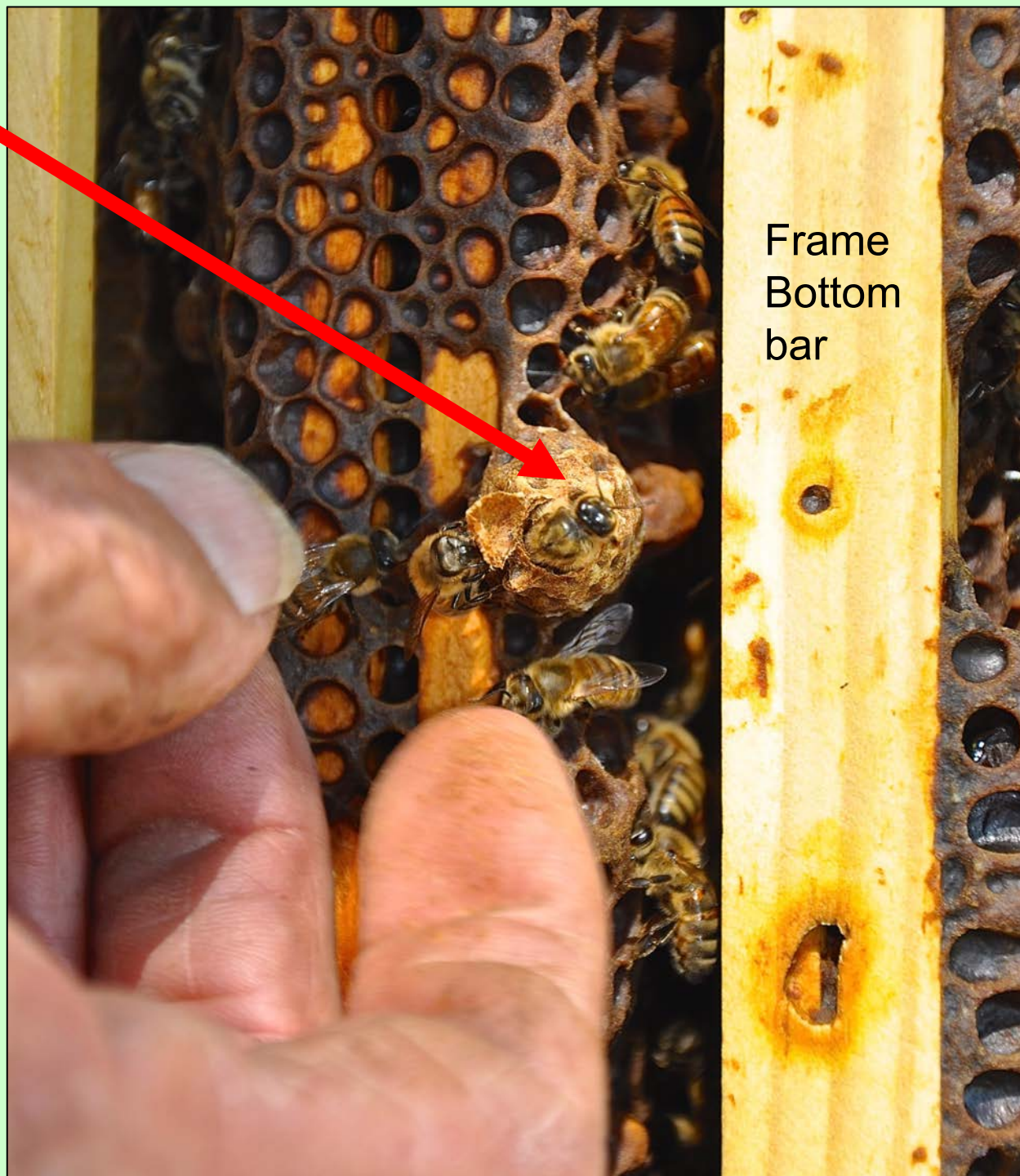
# Queen Succession

- ✓ First emerging daughter queen personally kills each of her rival sisters in their cells
- ✓ Once her rivals are eliminated, the queen takes her mating flight 3-5 days
- ✓ Queen will then begin laying eggs, and the colony starts to rebuild its winter food supply



# Emerging Virgin Queen from a Swarm cell

Brood box is  
turned up 90°  
so the frame  
bottoms are  
visible.





# Queen Piping, Tooting & Quacking

- ✓ Queen piping are acoustic signals emitted by young queens during the process of swarming is called “tooting”
- ✓ Following the issuance of the primary swarm, a surplus of queens are raised by the workers, the queen that first emerges from her cell announces her presence by tooting and also by release of pheromones.
- ✓ Mature queens still confined within their queen cells answer the tooting with a distinct piping sound, the so-called “quacking”

**A Closer Look: Piping, Tooting, Quacking**

# Queen Supersedure

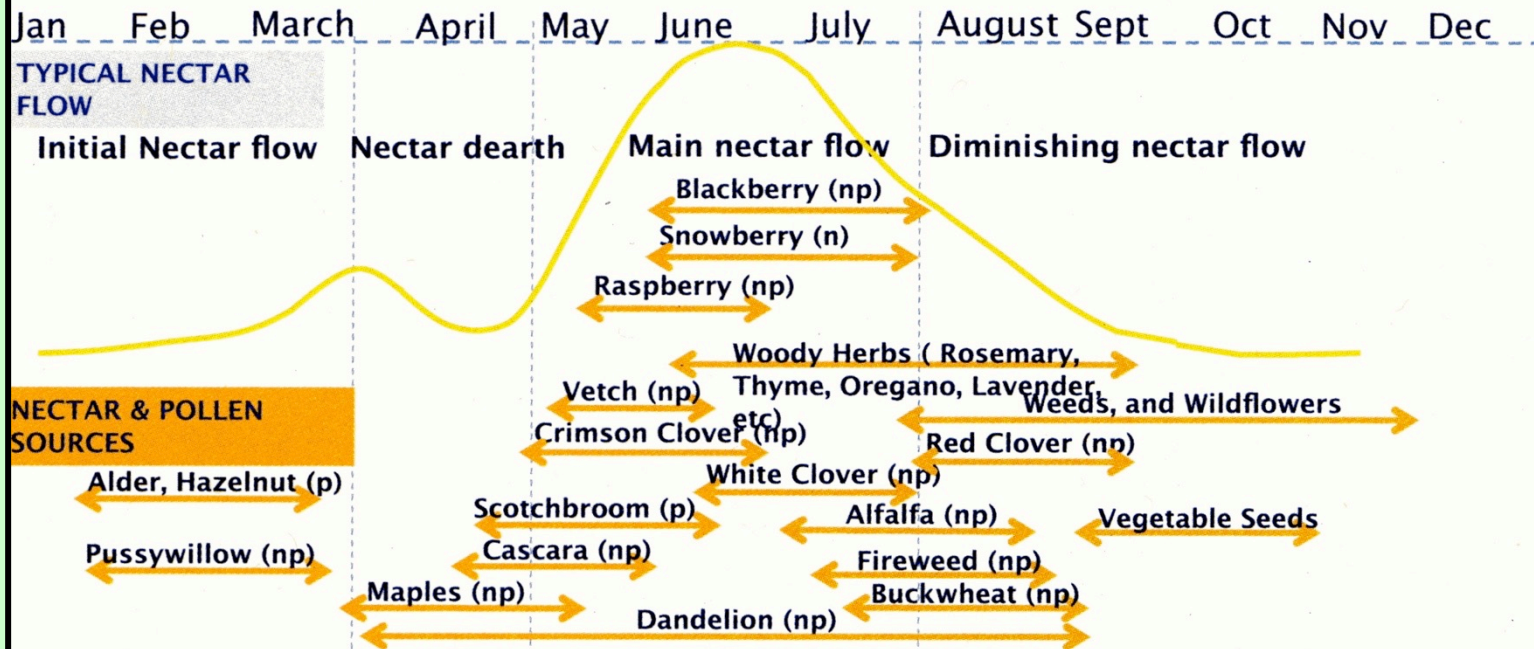
- ✓ This is not a swarm impulse
- ✓ Supersedure is done to replace a failing or lost queen
- ✓ Supersedure queen cells are usually located on the comb face or surface and not on the comb at frame bottom bar edges.



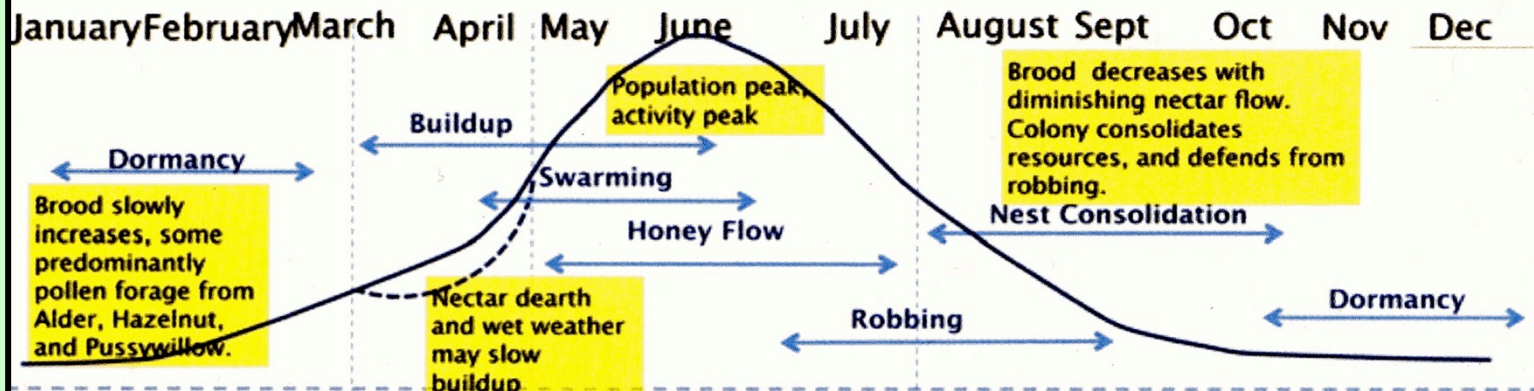


# The Big Seasonal Picture in WA

## Honeybee Forage and Feeding Cycles in Willamette Valley



## Typical Beekeeping Seasonal Cycle



# Climate Prediction Center 3-Month Outlook

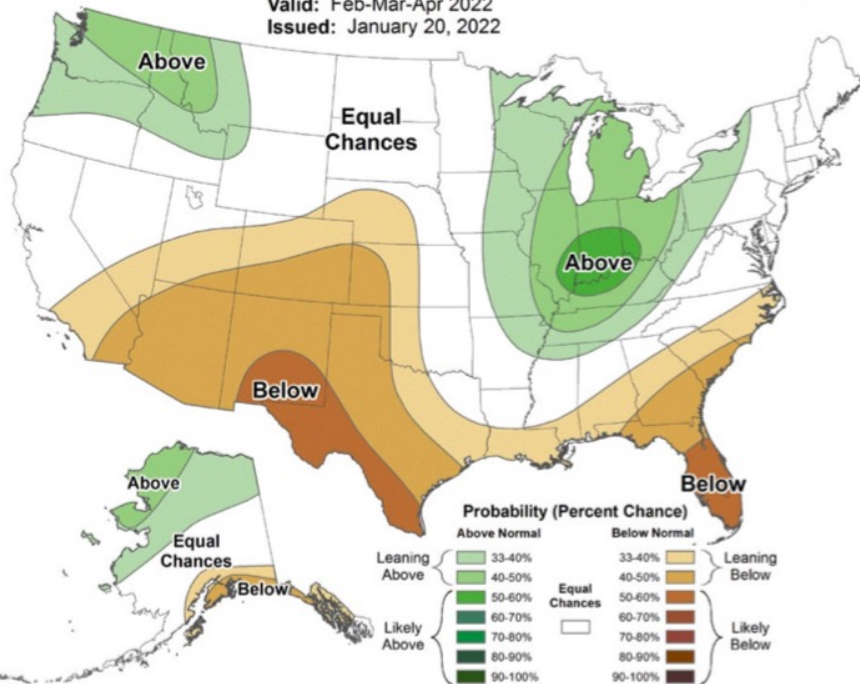
Source: National Weather Service

## Precipitation



### Seasonal Precipitation Outlook

Valid: Feb-Mar-Apr 2022  
Issued: January 20, 2022

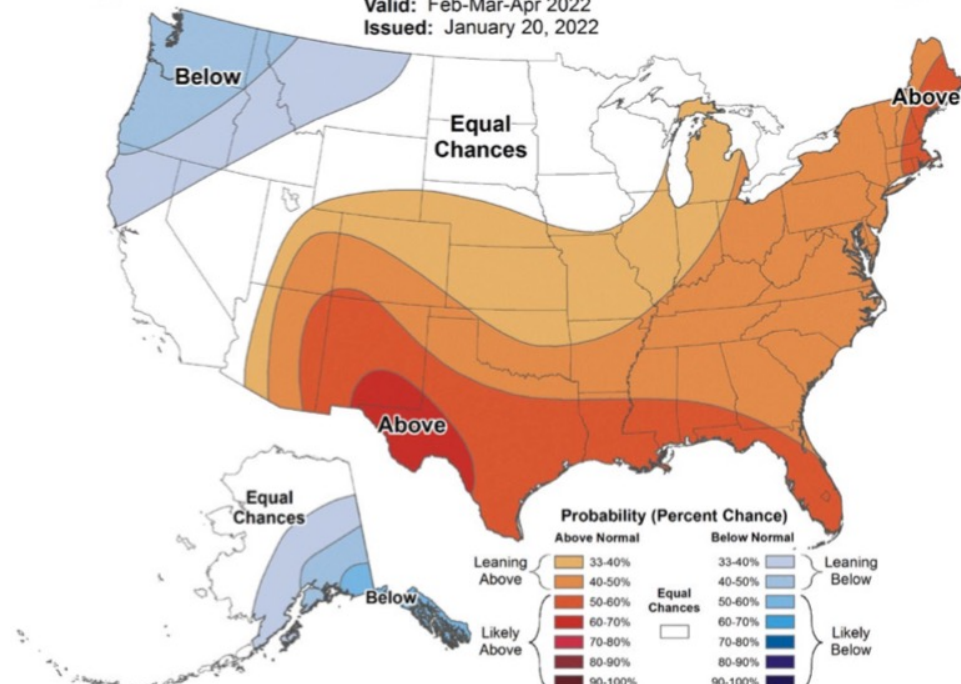


## Temperature



### Seasonal Temperature Outlook

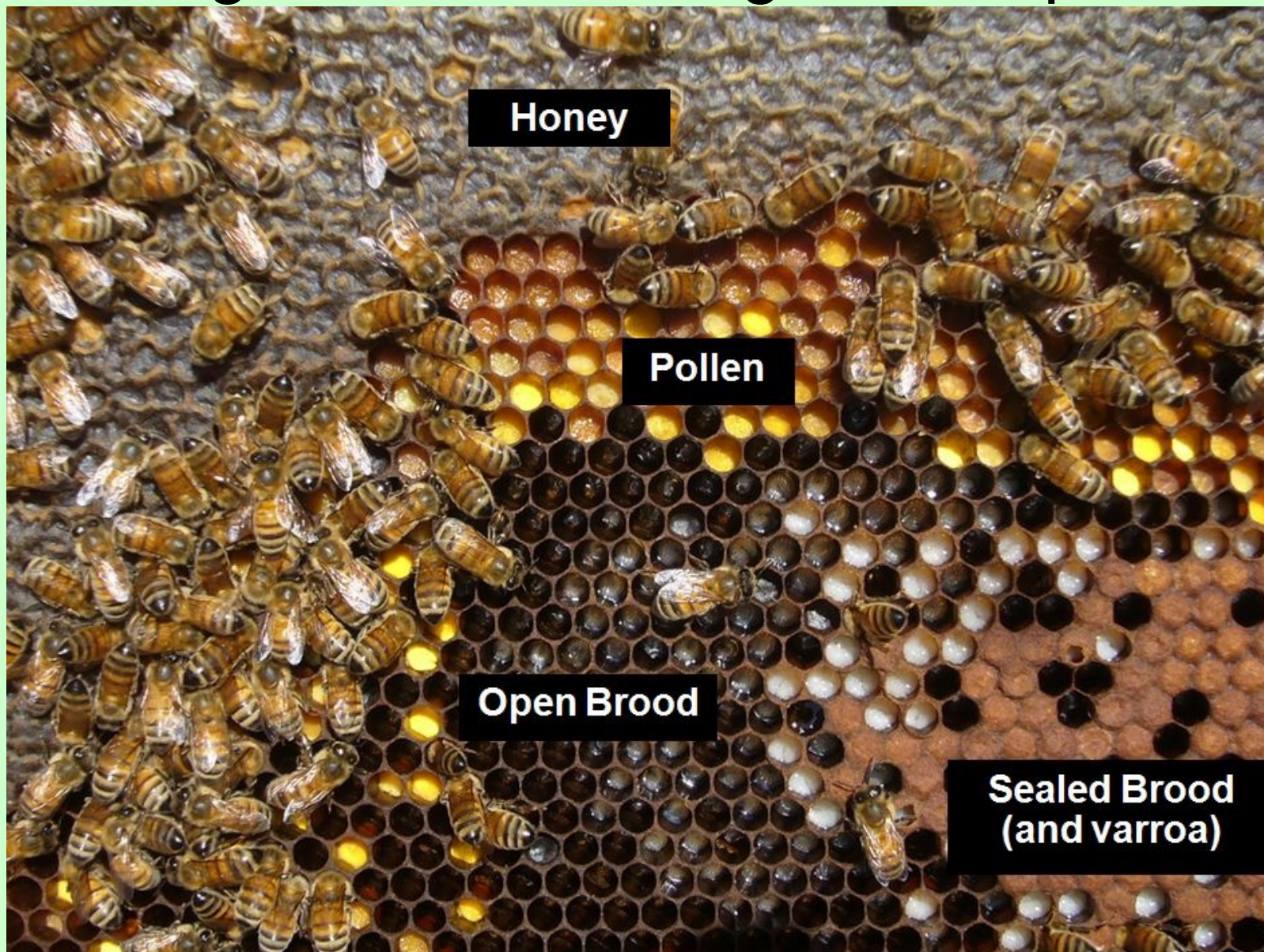
Valid: Feb-Mar-Apr 2022  
Issued: January 20, 2022



## Burlington 15-Day Forecast



# Reading the comb during hive inspections



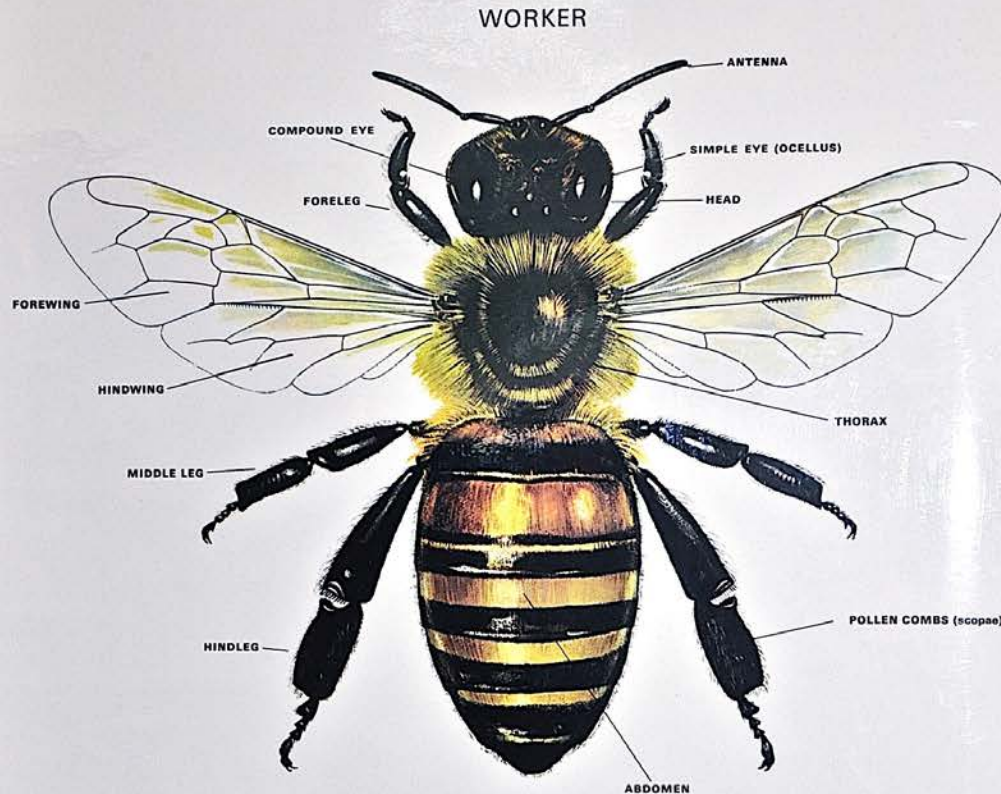
<http://scientificbeekeeping.com/first-year-care-for-your-nuc/>



# Review

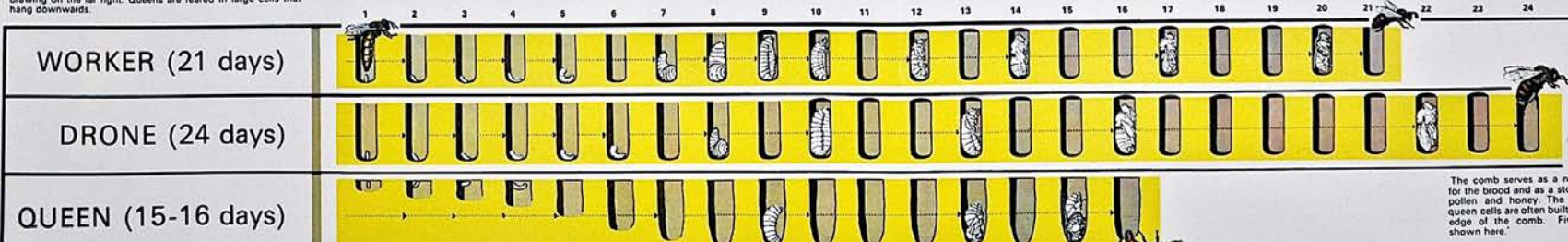
## THE HONEYBEE

(APIS MELLIFERA)



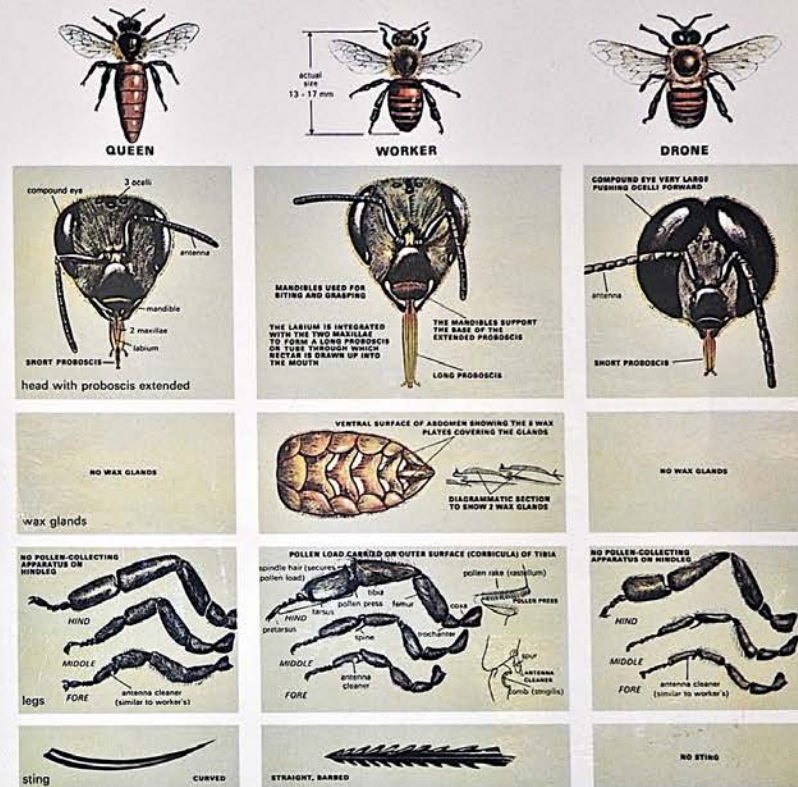
### Development of brood from egg to adult

In the illustration below, daily development is shown diagrammatically from left to right. In fact, workers and drones are reared in cells that lie back-to-back across the comb, as in the drawing on the far right. Queens are reared in large cells that hang downwards.



LONGITUDINAL SECTION THROUGH A COMB TO SHOW THE CELLS

The comb serves as a nursery for the brood and as a store for pollen and honey. The large queen cells are often built at the edge of the comb. Five are shown here.



The queen and worker honeybees are female and the drone is male. There is normally only one queen in a colony, and she lays all the eggs. There are many workers (say 50,000 in summer), and they do almost all the work. In summer there may be a few hundred drones, but these die before winter. What each worker bee does depends on her age and on the varying needs of the colony. Young bees work in the hive, first cleaning out used brood cells, and later feeding the brood, the queen and the drones. Some secret wax for building or repairing the combs, process the nectar into honey, and pack pollen in the cells. Other bees guard the colony, using their stings if necessary.

The older worker bees go out of the hive, first on orientation flights and then to forage for what the colony requires: nectar, pollen, water or propolis (bee glue). Nectar is the carbohydrate food of bees, whereas pollen is a protein food, important for young workers, larvae, and the queen. Water may be needed by the bees feeding brood; also, in hot weather, bees collect and evaporate it to cool the hive. Water and nectar are carried in the honey sac, and so cannot be seen; pollen and propolis are brought home on the hindlegs. The legs, as well as the four wings, are attached to the thorax, which contains the muscles that enable the bee to walk and fly. The head contains several important glands, and the abdomen contains the honey sac as well as digestive and sting organs.



# Worker bees

- ✓ The most numerous in the colony
- ✓ Have many duties throughout their life span:
  - ✓ Take care of queen
  - ✓ Feed the brood
  - ✓ Clean and defend nest
  - ✓ Forage on nectar & pollen
  - ✓ Recruit sisters and  $\frac{1}{2}$  sister foragers
  - ✓ Regulate resource use
  - ✓ Regulate when to swarm

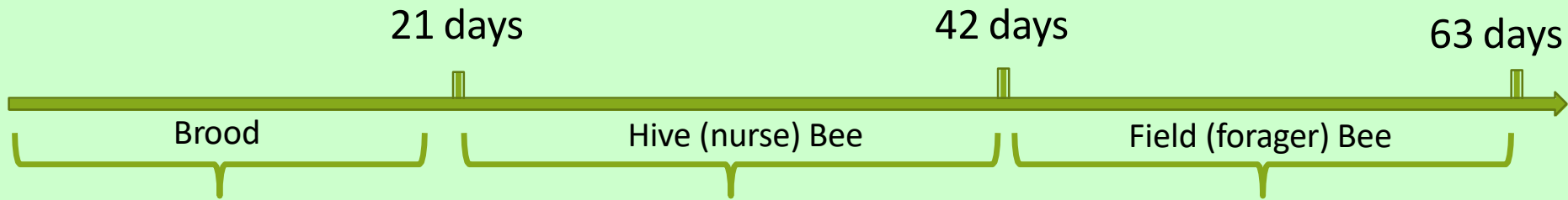


Nectar: Mountain Mint & Black-eyed Susan



Peach Pollination Flower

# Life of a worker bee



- Develop from:
  - Egg
  - Larvae
  - Pupae
  - Adult bee



- Clean cells
- Feed older larvae
- Feed young larvae
- Feed queen
- Build comb
- Clean hive
- Hive Ventilation



- Collect water
- Collect pollen
- Collect nectar
- Collect resin



# Summary

- ✓ Bees are social insects that have cooperative brood care, division of labor, and overlapping generations
- ✓ This social system within a hive system has allowed humans to manage colonies
- ✓ Bees exhibit interesting communication behaviors



Leister's Apiary (January 25, 2012)

# Links to Detailed Honey Bee Anatomy

Adam Tofilski, Department of Pomology and Apiculture, Agricultural University, Krakow, Poland. **External & External Honey Bee Anatomy:**

<<http://honeybee.drawwing.org/>>

School of Life Sciences, Arizona State University. **Bee Anatomy:**

<<https://askabiologist.asu.edu/honey-bee-anatomy>>



# Honey Bee Book Links for New Beekeepers

[First Lessons in Beekeeping \(2007\)](#)

[Natural Beekeeping: Organic Approaches to Modern Apiculture, 2nd Edition \(2013\)](#)

[Wisdom for Beekeepers: 500 tips for successful beekeeping \(2013\)](#)

[BeeCabulary Essentials \(2018\)](#)

[Storey's Guide to Keeping Honey Bees, 2nd Edition: Honey Production, Pollination, Health \(2018\)](#)

# Honey Bee Book Links for New Beekeepers

[The Backyard Beekeeper, 4th Edition: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden \(2018\)](#)

[Keeping Bees Alive: Sustainable Beekeeping Essentials \(2019\)](#)

[Beekeeping For Dummies 5th Edition \(2020\)](#)

[Applied Beekeeping in the United States \(2020\)](#)

[The Beekeeper's Handbook Fifth Edition \(2021\)](#)



# Honey Bee Book Links for 2nd, 3rd, 4th, Year Beekeepers and UP

[The Buzz about Bees: Biology of a Superorganism \(2009\)](#)

[Honeybee Democracy \(2010\)](#)

[The Beekeeper's Bible: Bees, Honey, Recipes & Other Home Uses \(2011\)](#)

[The Beekeeper's Problem Solver \(100 common problems explored and explained\) \(2015\)](#)

[The Honey Factory: Inside the Ingenious World of Bees \(2017\)](#)

# Honey Bee Book Links for 2nd, 3rd, 4th, Year Beekeepers and UP

[Queen Spotting: Meet the Remarkable Queen Bee \(2019\)](#)

[The Lives Of Bees](#)

[The Untold Story of the Honey Bee in the Wild \(2019\)](#)

*Encyclopedia's*

[The Hive and the Honey Bee \(2015\)](#)

[The ABC & XYZ of Bee Culture \(2020\)](#)

*College Textbook*

Honey Bee Biology and Beekeeping 3<sup>rd</sup> Edition ( Available  
Spring 2022)



# Podcasts

## [Beekeeping Today Podcasts:](#)

The podcast for the latest beekeeping news, Hosts Jeff Ott and Kim Flottum bring you interviews and commentary. Bee Culture

## [Two Bees in a Podcast:](#)

The Honey Bee Research and Extension Laboratory

## [Honey Bee Obscura Podcast](#)

Short, in-depth review of all things honey bees with hosts, Kim Flottum and Jim Tew

## [Beekeeping At Five Apple Farm](#)

Sustainable beekeeping talk and techniques from a North Carolina mountain apiary.

## [Beekeepers Corner](#)

Beekeeper's Corner is a place where we'll share our exploits as 'backyard' beekeepers.

## [2 Million Blossoms](#)

The Podcast, bringing you science, arts and news on the environment and sustainability.

# Youtube Channels

[Bob Binnie](#)

[Kamon Reynolds - Tennessee's Bees](#)

[Frederick Dunn](#)

[David Burns](#)

[Joe May: Little Bits Honey Bees](#)

[Lewis Cauble, NC Bee Inspector](#)



# YouTube Channels

[University of Guelph Honey Bee Research Centre](#)

[Ohio State Beekeepers Association](#)

[Dyce Lab for Honey Bee Studies](#)

[NC State Apiculture](#)

[Cabarrus County Beekeepers](#)

[Betterbee](#)

# QUESTIONS?

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