

The Honey Bee Colony



The Honey Bee Colony

- ◆ Nest
- ◆ Caste Development and Differentiation
- ◆ Seasonal Cycles
- ◆ Anatomy – pollen and nectar collection
- ◆ Modern Hives

The Honey Bee Colony – Introduction

- ◆ What we call honey bees are represented by eight to 10 species in the genus *Apis*.
- ◆ “Api”-s is the foundation for beekeeping (apiculture) and the word for a bee yard (apiary).
- ◆ The species of honey bee commonly found today in Europe, Africa, the Middle East and the Americas is *Apis mellifera*, which means honey carrier.
 - This name is not technically correct as the bees carry nectar from flowers which they then use to produce honey back in the hive. Only when the bees are moving to a new nest (swarming) do they carry honey.

The Honey Bee Colony –

Apis races

- ◆ There are 24 races of *Apis mellifera*. The races have different physical and behavioral characteristics such as body color, wing length, and susceptibility to disease. The races can mate with each other.



Caucasian bees (*A. mellifera caucasic*) extremely docile. The black or Germa (*A. mellifera mellifera*) are known to overwinter well in severe climates.

The African group of bees includes the largest number of geographic races (1 which includes the notorious *A. mellifera scutellata*. A few queens of this high defensive race were brought into Brazil in 1957 and started the bees we now know as "Africanized honey bees."

The Honey Bee Colony –

Apis races

- ◆ The true honey bee was not native to the Americas. Prior to Columbus, people in Central and South America collected honey from bees known as "stingless bees."



- ◆ Although stingless bees do actually lack a stinger, they are not completely defenseless. They can inflict painful bites with their mandibles. They also do not produce honey in the same quantity as *A. mellifera*.

The Honey Bee Colony – History

◆ In the early part of the 16th century, the Spanish brought over the first honey bee colonies. English colonists did the same and soon honey bees had escaped into the wild and were buzzing all over North America.



◆ In some cases, the honey bees traveled in advance of the European settlers and came in contact with Native American tribes, who dubbed them "white man's flies." By the time the frontier had been settled, late in the 19th century, honey bees were regarded as a natural part of the insect world in North America.

The Honey Bee Colony – Nest



- ◆ A populous colony may contain 40,000 to 60,000 or more bees during the late spring or early summer.



The Honey Bee Colony – Caste Development and Differentiation



- ◆ The eusocial, or truly social, bees live in large colonies consisting of females of two overlapping generations: mothers (queens) and daughters (workers). Males play no part in the colony's organization and only mate with the queens.



The Honey Bee Colony – Caste Development and Differentiation

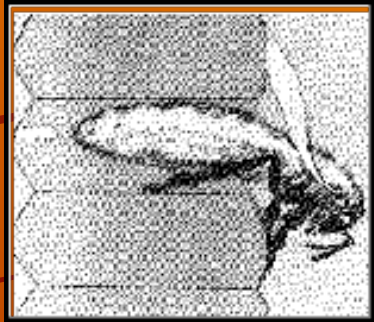


Figure 2. Queen lays an egg.

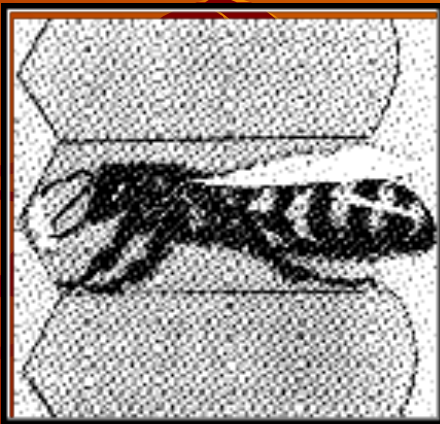


Figure 3. Young larva.

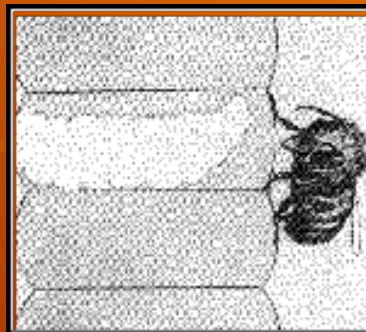


Figure 4. Mature larva.

- ◆ Honey is a sweet, thick, supersaturated sugar solution manufactured by bees to feed their larvae and for subsistence in winter. The nectar of flowers is ingested by worker bees and converted to honey in special sacs in their esophagi. It is stored and aged in combs in their hives.

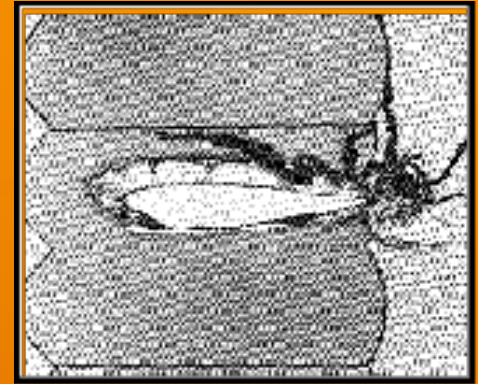


Figure 6. Adult emerges.

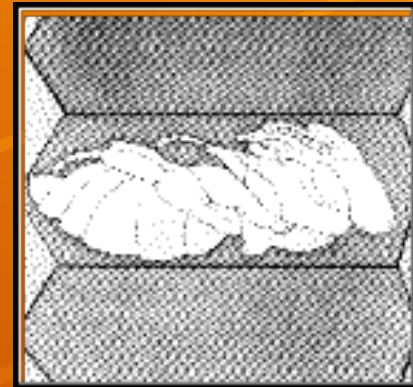
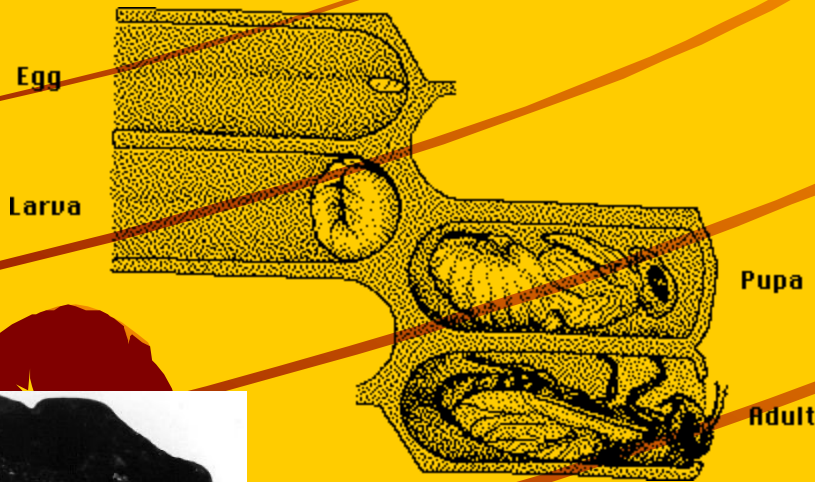


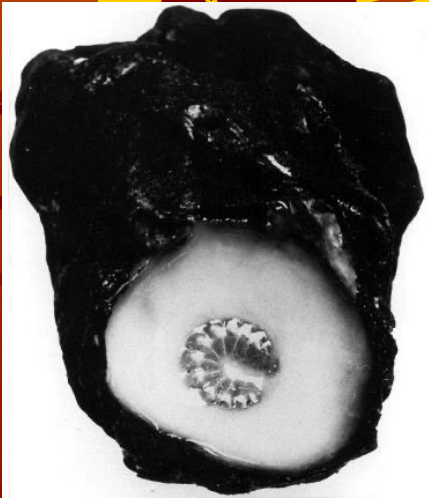
Figure 5. Pupal stage.



The Honey Bee Colony – Caste Development and Differentiation



◆ Larvae are fed pollen and royal jelly progressively—that is, cells are opened as necessary or are left open so that workers can tend the larvae.



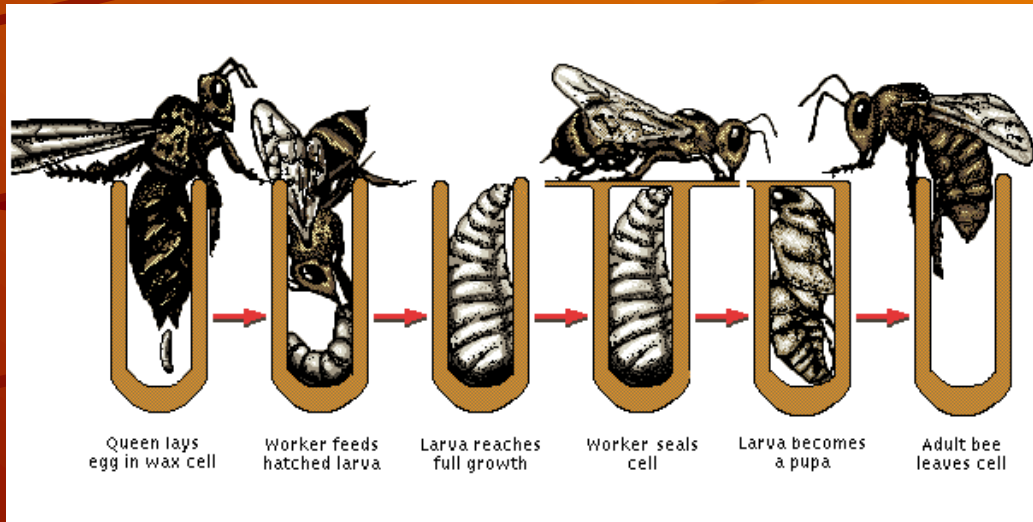
◆ Royal jelly, which is secreted from the salivary glands of worker bees, serves as food for all young larvae and as the only food for larvae that will develop into queen bees.



The Honey Bee Colony – Caste Development and Differentiation

- ◆ Bee honey is composed of fructose, glucose, and water, in varying proportions. It also contains several enzymes and oils. The color and flavor depend on the age of the honey and on the source of the nectar.

- ◆ We know that bees have been producing honey as they do today for at least 150 million years. Bees produce honey as food stores for the hive during the long months of winter when flowers aren't blooming and therefore little or no nectar is available to them.



- ◆ Honey bees are herbivores; they eat nectar and hone



The Honey Bee Colony – Caste Development and Differentiation

- ◆ At the individual level, honey bees have not one but three types of colony members: queens, drones and workers, each with their own specializations and place in honey bee society.



The queen reigns over the nest, surrounded by attendants and fed the rich food she requires to perform her few but crucial tasks in the colony. The queen produces powerful pheromones, chemical signals to recipient workers which control many of their behaviors and provide part of the 'social glue' which holds honey bee life together.



The Honey Bee Colony – Caste Development and Differentiation

- ◆ **Honey bee eggs hatch regardless of whether they are fertilized.**
- ◆ **Female bees--queens and workers--develop from fertilized eggs that contain 32 chromosomes. These 32 chromosomes consist of two sets of 16, one set from each parent. Hence female bees are said to be diploid in origin.**
- ◆ **The males (drones) develop from unfertilized eggs which contain only one set of 16 chromosomes from their mother. Drones are thus haploid in origin. This reproduction by the development of unfertilized eggs is called parthenogenesis.**





The Honey Bee Colony –

Caste Development and Differentiation



Queen



Drone



Worker

- ◆ The queen is the only sexually developed female in the hive. She is the largest bee in the colony.



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During this mating, she receives several million sperm cells, which last her entire life span of nearly two years.

- ◆ The queen starts to lay eggs about 10 days after mating. A productive queen can lay 3,000 eggs in a single day.



The Honey Bee Colony –

Caste Development and Differentiation

- ◆ Drones are stout male bees that have no stingers. Drones do not collect food or pollen from flowers. Their sole purpose is to mate with the queen. If the colony is short on food, drones are often kicked out of the hive



- ◆ Drones are tolerated in the hive only when there is a possibility that they may mate with a queen. Thus a few are tolerated in spring and fall, more in the summer, but none in the winter. The workers keep the drones out of the hive to starve to death in the autumn.
- ◆ Drones, like queens, lack the body parts to effectively harvest nectar or pollen to feed themselves. Drones also lack a stinger of any kind. They are designed for mating only.



The Honey Bee Colony – Caste Development and Differentiation



- ◆ Workers, the smallest bees in the colony, are sexually undeveloped females. A colony can have 50,000 to 60,000 or more workers.

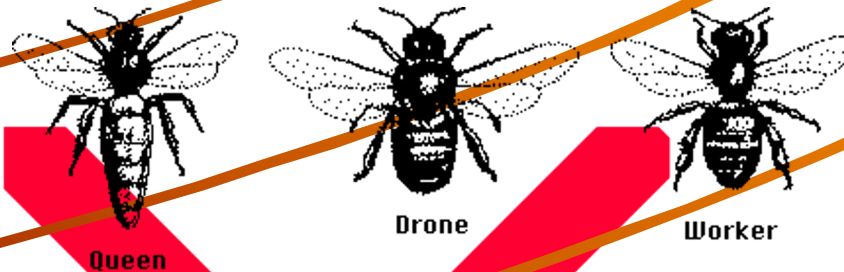
- ◆ Worker and drone larvae are also fed royal jelly for their first four days. For the remainder of their larval stage, they are fed bee bread.

- Bee bread is made from pollen collected in the field. Two pollen pellets are dropped into a cell, which are then manipulated and mixed with honey and secretions from worker bees. This mixture, called bee bread, is then pushed into the cell until it is two-thirds full.



The Honey Bee Colony – Caste Development and Differentiation

- ◆ The life span of a worker bee varies according to the time of year. Her life expectancy is approximately 28 to 35 days. Workers that are reared in September and October, however, can live through the winter.



- ◆ Workers feed the queen and larvae, guard the hive entrance and help to keep the hive cool by fanning their wings. Worker bees also collect nectar to make honey. In addition, honey bees produce wax comb. The comb is composed of hexagonal cells which have walls that are only $\frac{2}{1000}$ inch thick, but support 25 times their own weight.



The Honey Bee Colony – Caste Development and Differentiation

	Queen	Drone	Worker
Relative size	large	medium	small
#/hive	1	~200 or 0	20K-200K
Lifespan	2 years depending on #sperm	21-32 days spring 90 days summer or until mating 0 winter	20-40 days summer (worked to death) 140 days winter
Sex	female	male	sterile female



Queen



Drone



Worker

The Honey Bee Colony –

Caste Development and Differentiation

Functions

Queen

- kill sisters and mother
- mate with males
- lay 1500 eggs/day
= 200K eggs/year
- secrete pheromone =

Drone

- mate with young queen

Worker

- make comb
- tend larvae
- tend young drones
- tend queen
- clean hive
- gather nectar
- gather pollen
- gather propolis
- evaporate nectar
- cap cells
- defend hive
- starve drones
- move larvae for making new queens



The Honey Bee Colony –

Caste Development and Differentiation

- ◆ Newly emerged workers begin working almost immediately. As they age, workers do the following tasks in this sequence: clean cells, circulate air with their wings, feed larvae, practice flying, receive pollen and nectar from foragers, guard hive entrance and forage.



- ◆ Unlike colonies of social wasps and bumble bees, honey bee colonies live year after year. Therefore, most activity in a bee colony is aimed at surviving the next winter.

- ◆ Workers, as their name implies, do most of the "work" around the hive. They secrete wax from glands on the abdomen and fashion the honeycomb and broodcomb from it. This comb contains hexagonal cells large enough to hold a developing worker or drone, a small quantity of honey, or pollen. When the cells are filled with honey, pollen, or a pupa, a worker caps the cell thereby sealing the contents inside.



The Honey Bee Colony – Caste Development and Differentiation

- ◆ During winter, bees cluster in a tight ball. In January, the queen starts laying eggs in the center of the nest. Because stored honey and pollen are used to feed these larvae, colony stores may fall dangerously low in late winter when brood production has started but plants are not yet producing nectar or pollen.



- ◆ When spring "nectar flows" begin, bee populations grow rapidly. By April and May, many colonies are crowded with bees, and these congested colonies may split and form new colonies by a process called "swarming."

◆ A crowded colony rears several daughter queens, then the original mother queen flies away from the colony, accompanied by up to 60 percent of the workers. These bees cluster on some object such as a tree branch while scout bees search for a more permanent nest site - usually a hollow tree or wall void. Within 24 hours the swarm relocates to the new nest. One of the daughter queens that was left behind inherits the original colony.

The Honey Bee Colony – Caste Development and Differentiation

Table 1. Development time of honey bee castes.

Stage	Days after Laying Egg		
	Worker	Queen	Drone
Hatching	3	3	3
Cell capped	8	8	10
Becomes a pupa	11	10	14
Becomes an adult	20	15	22.5
Emerges from cell	21	16	24



The Honey Bee Colony – Caste Development and Differentiation

- ◆ The queen keeps the workers uninterested in reproduction on their own by secreting a pheromone. This chemical is spread from body to body among the workers starting with those tending the queen.

- ◆ The mating flight follows a pattern. The virgin queen flies to a congregation area where hundreds or thousands of drones await. The drones pursue the queen and several mate with her in flight.

- ◆ The other job of the queen is to lay eggs and this task consumes all her conscious effort. A group of five to ten workers feed her a small bit after she lays about 20 eggs.

- A newly hatched queen destroys any other unhatched queens, fights to the death any hatched queens, may destroy her mother, and then takes her mating flight.

The Honey Bee Colony – Caste Development and Differentiation

Bee Nutrition:

Pollen is stored in broodcomb cells and is the main supply of protein and vitamins for the hive. Pollen is 6 to 28% protein by weight and usually contains the 10 amino acids essential for bees.

Nectar is from 5 to 80% sugar, so nectar is the carbohydrate supply for the hive.



Nectar is placed in honeycomb cells and the bees tending the honeycomb evaporate the water from the nectar by rapid wing movement to create ventilation.

When the amount of water remaining in the nectar is less than 18%, the mixture is called honey and the bees cap off the cells.

The Honey Bee Colony – Caste Development and Differentiation

- ◆ A mixture of honey and pollen is called "bee bread" and is the food for most larvae and bees.
- ◆ When a worker egg has been selected to become a queen, it is moved to a much larger queen cell and is fed large quantities of "royal jelly" which is similar to bee bread but contains more mandibular gland secretions and more honey (34% vs. 12%).
- ◆ The larger cell for growth, larger food supply, additional carbohydrate, and more worker secretions results in the development of a queen.

The Honey Bee Colony – Pheromones

- ◆ Bees use pheromones for a number of different communication and behavior-control purposes. One pheromone may cause many different responses, depending on environmental conditions and pheromone concentration.

Behavioral Pheromones



- ◆ The pheromone produced by the Nasonoff gland, which opens onto the side of the abdomen, attracts workers and queens.
- ◆ Another pheromone produced by virgin queens (and released with feces) repels when a new queen feels threatened by the workers.

The Honey Bee Colony – Pheromones

- ◆ The main alarm pheromone is released with the sting, and is a mix of many compounds. They induce flight behavior, others cause only recruitment of more bees from within the hive.



- ◆ Marker Pheromones: honeybees use Nasonoff gland pheromones for marking food sources, in marking the hive, in scenting prospective hive locations by scouts, and in gathering swarms in flight.
- ◆ The odor of each colony is different, and probably results from a combination of endogenous (pheromone or pheromone-like) materials and exogenous (food) materials in each hive.

The Honey Bee Colony – Pheromones

- ◆ The queen bee exerts her influence over the hive by means of the Queen Mandibular Pheromone (QMP):
 - mating attractant for the drones
 - suppresses the reproductive systems of the workers, ensuring that the queen is the only reproductive female in the hive.



- ◆ QMP is distributed around the hive by food sharing. As long as the queen substance circulates by this method, the workers know that the queen is present.
- ◆ If the queen is removed, QMP no longer circulates in the hive, and the workers begin to feed royal jelly to larvae to produce a new queen.

The Honey Bee Colony – Seasonal Cycles

The honey bee exhibits a combination individual traits and social co-operation which is unparalleled in the animal kingdom. Although a hive only needs 20-30 lb. of honey to survive an average winter, the bees are capable, if given space of collecting much more. This is what the beekeeper wants them to do



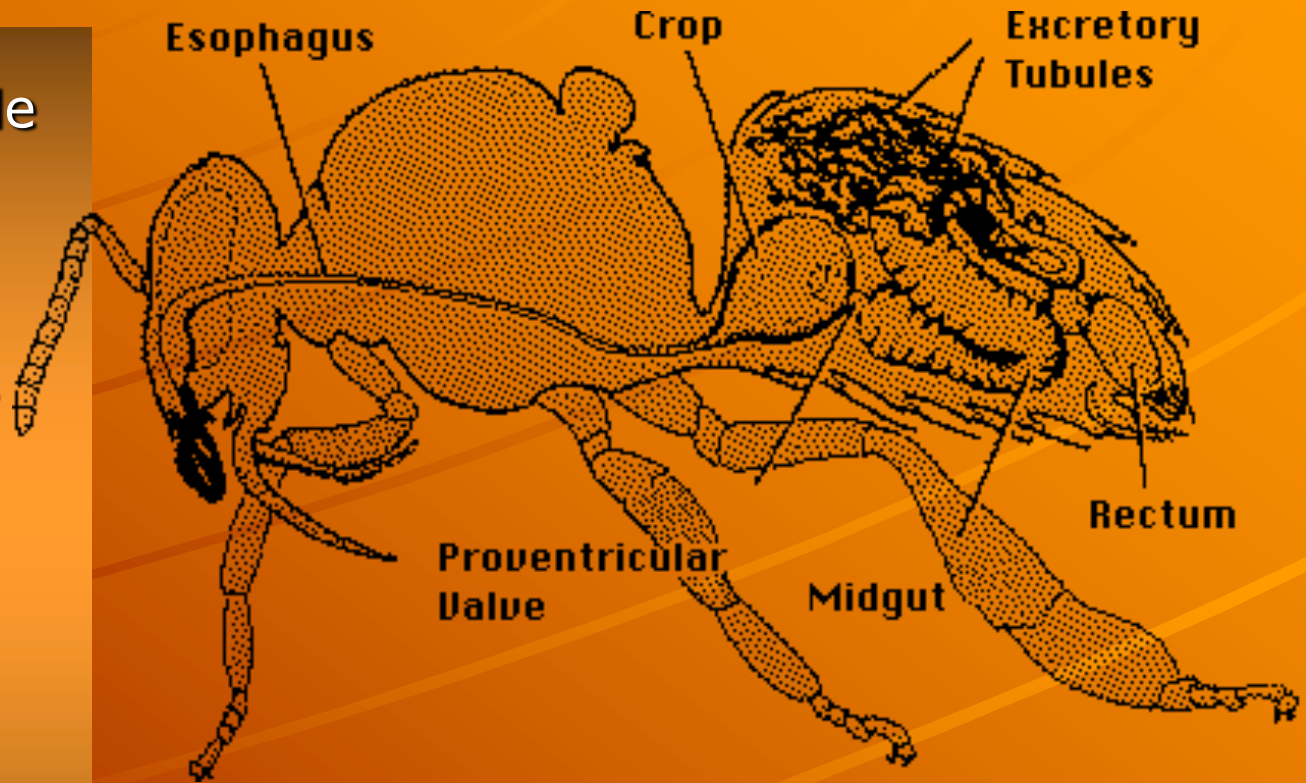
The Honey Bee Colony – Anatomy for Pollen and Nectar Collection



- ◆ Most bees have specialized branched or feathery body hairs that help in the collection of pollen.

The Honey Bee Colony – Anatomy for Pollen and Nectar Collection

- ◆ The rewards plants provide bees include nectar and pollen. The nectar is a sweet liquid composed of mostly sucrose. The bees collect this liquid in their crop



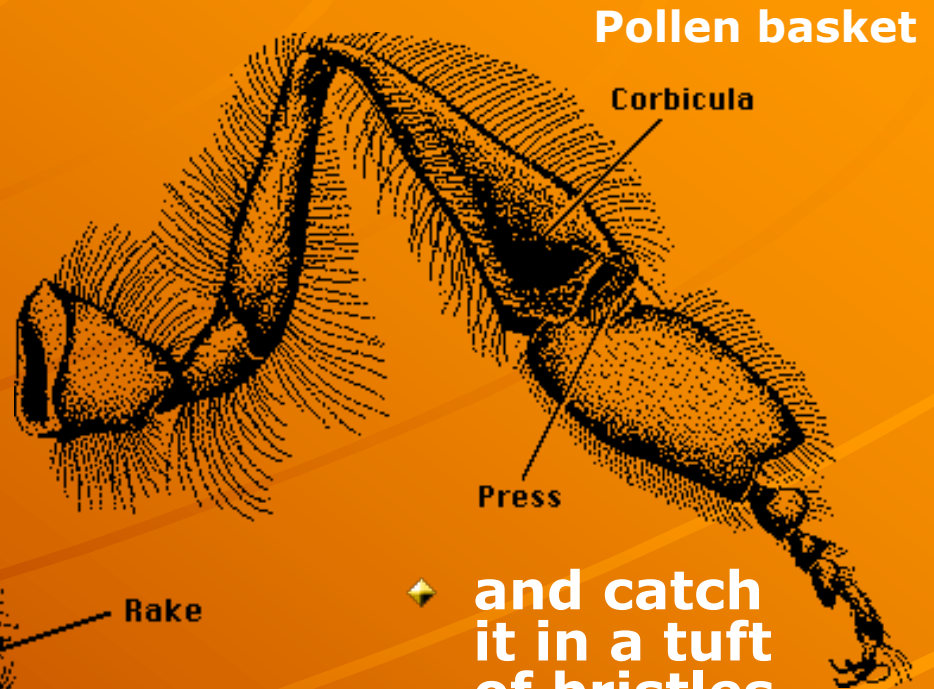
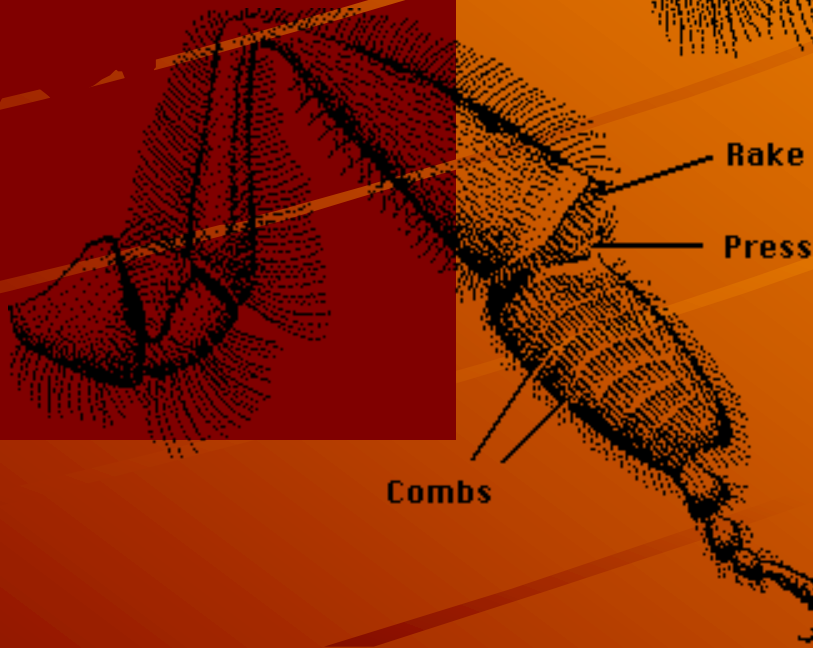
The Honey Bee Colony – Anatomy for Pollen and Nectar Collection

- ◆ Digestive enzymes, most importantly invertase, are added. By the time the bee returns to the hive, much of the sucrose is converted to glucose and fructose. In the hive the bee empties its crop into a cell or the nectar is transferred to another worker who takes it to the honeycomb for evaporation to make honey. The bee here has a full crop!



The Honey Bee Colony – Anatomy for Pollen and Nectar Collection

- ◆ Pollen is dusted all over the bee as she visits a flower. The bee's legs are designed to comb this pollen from her body



- ◆ and catch it in a tuft of bristles on her third pair of legs

The Honey Bee Colony – Modern Hives



The Honey Bee Colony – Modern Hives





The Honey Bee Colony – Modern Hives



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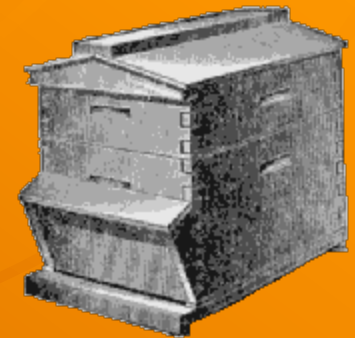
Prior to the middle of the 1800s, most bee hives in North America and Europe were simple shelters for the bees. Skews, log gums and box hives were common types of hives in this period. Bees attached their wax combs to the hive's roof and walls, just like they do in wild hives.



- ◆ Skews were made from grass straw, and often had sticks inside to provide support for the honey combs. Beekeepers inspected skew hives from the bottom.
- ◆ Box hives were simple shelters to house a swarm of bees.
- ◆ Log gums were made from hollow logs, fitted with a roof.
- ◆ It was also hard to get honey from these hives without damaging or destroying the bee colony and getting the bees upset.

The Honey Bee Colony – Modern Hives

- ◆ By the year 1900, most modern beekeepers were using variants of the Langstroth hive with Hoffman-style frame.
- ◆ These inventions helped make beekeeping a viable business.
- ◆ The modern bee hive has not changed very much during the 20th century. The most significant beekeeping advances of the 20th century involved the extracting process and bee management.



The original Langstroth hive.



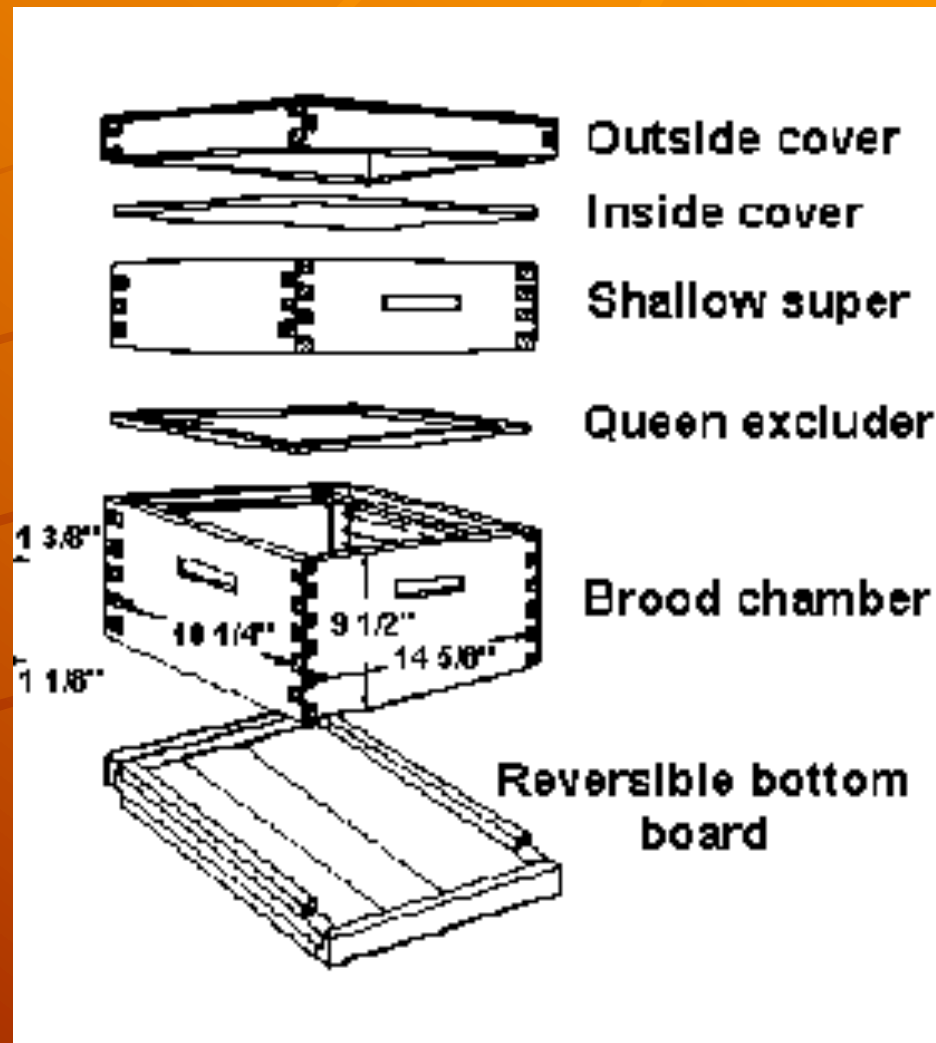
The Honey Bee Colony – Modern Hives



◆ Langstroth Hive



The Honey Bee Colony – Modern Hives



Honey Bee In-Service Training for UF/IFAS Extension Agents

Thank you for your time ...

- ✦ Information in this presentation came from a number of websites including, but not limited to:
http://koning.ecsu.ctstateu.edu/Plants_Human/bees/bees.html
- ✦ <http://www.beemaster.com/honeybee/caste.htm>
- ✦ <http://www.bees4kids.org.uk/whybees/facts.html>
- ✦ <http://www.apimondia2005.com/historyofirishbeekeeping/historyofirishbeekeeping.html>
- ✦ <http://maarec.cas.psu.edu/bkCD/HBBiology/beebiology.html>
- ✦ <http://outdoorplace.org/beekeeping/history1.htm>

