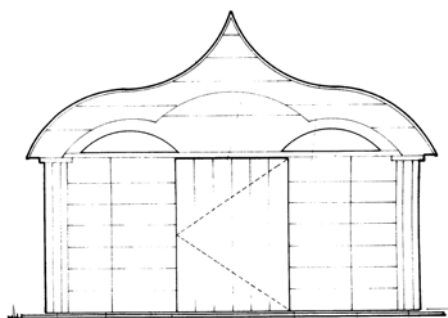


THE ROTCH-JONES-DUFF HOUSE & GARDEN MUSEUM



Teacher Resource Materials for 5th Apiary Program GROWING IDEAS: CULTIVATING CONNECTIONS

This program utilizes the property's unique urban garden setting to introduce students to the important role of the honey bee, conservation practices, beekeeping operations and the interaction and interdependency of the environment in plant and food production.

TABLE OF CONTENTS

| | |
|---|--------------|
| Honeybees at a Glance | |
| Short Descriptions of Bee Terminology & Vocabulary... | page 1, 2, 3 |
| Fun Facts About Honeybees... | page 4 |
| Worker Honey Bee Diagram with Labels... | page 5 |
| The Amazing Honeybee... | page 6 |
| Bee Basics - An Overview... | page 7, 8, 9 |
| History of Bees | |
| Types of Bees | |
| Swarming | |
| Honey | |
| Beeswax | |
| Beekeeping Equipment | |

HONEYBEES AT A GLANCE

The most common honeybee in America is Apis mellifera

QUEEN:

- Larger than drone and worker bee.
- One queen for each hive/colony.
- Lays all the eggs in the hive (1200-3000 each day) Starts laying in February.
- Lives longer than the other honeybees (11/2 – 5 years).
- Is fed royal jelly by workers.
- Eggs laid for production of Queen are in a larger cell.
- Produced from a fertilized egg.
- Has a sting that is used only to battle other queens.
- Releases different scents (pheromones) to control other colony members.
- Will fly only on her mating flights and if she should swarm.

WORKER:

- Is female.
- Smallest honeybee in the colony (1/2" long).
- Colony made up mostly of Worker bees (40,000-80,000 less the 600-1000 drones).
- Lives approximately 6 weeks in the summer, & as long as 6 months in the winter.
- Spends its 1st 3 weeks as a house bee, working inside the hive, last 3 weeks as a food gatherer.
- Is first fed royal jelly but after 3 days is fed bee bread (mixture of nectar /honey & pollen).
- Has honey stomach for storage of nectar and 1st step of its conversion to honey.
- Has pollen baskets or sacs on her hind legs.
- Has 4 pairs of wax glands which produce and secrete wax.
- Cleans & feeds Queen, feeds immature drones, cleans hive, protects hive, repairs hive, gathers pollen, nectar, & water.
- Makes honey, wax and propolis.
- Feeds the brood, builds the comb, stores the food.
- Has barbed stinger for defense of self & protection of hive.

DRONE:

- Male bee.
- Slightly larger than worker, has enormous eyes.
- Hatches from unfertilized egg.
- Has no sting.
- Young drones fed by worker (nurse) bees, older drones eat from cells.
- Usually number 600-1000 in a colony.
- Job is to mate with queen.
- Dies after mating.
- Driven from colony before winter or when food is scarce.

COLONY/ HIVE:

- The bees of a hive or nest are called the "colony".
- Colony is bound together by the Queen's scent (pheromones).
- Individuals have specific jobs, but cannot live independently.
- Bees build their own home or nest. They use existing structures (trees, hives, skeps, etc.) for exterior protection and construct their wax combs inside.
- The hive/ nest is made of wax "cells", which compose hanging structures/combs.
- Combs are spaced 3/8 " apart (bee space).

COLONY/ HIVE: (continued)

- Cells in combs are components for different chambers, specific to laying eggs, raising young and storing food.
- Hive is most active & production greatest when nectar & pollen sources are plentiful.
- Bees returning from gathering nectar often share it with other workers as part of the dance directing them to the source of the nectar.
- Pollen and honey (or nectar which is slowly converting to honey) are stored in cells.
- New food sources are communicated by a dance. The Circle Dance directs foragers to sources closer than 100 yards. The Wagtail Dance (which is the shape of figure 8), is used for more than 100 yards.
- Honey & pollen are the foods the colony requires to sustain themselves through the winter months.
- In winter, workers create a pulsating ball which protects the queen at its center. Workers rotate from outside to inside for food and warmth.

PRODUCTION OF HONEY;

Worker bees gather nectar from flowers to produce honey. The worker bee has a tube-like proboscis, which allows her to reach the nectar in the blossom. When she drinks it in, the nectar goes into a honey stomach (also called a crop or honey sac). Here, the nectar is stored while being transported back to the hive. The honey stomach also begins the development of nectar into honey, by the release of enzymes.

Once back at the hive, the gatherer has choices for the immediate use of the honey stomach contents. She may offer some to workers that have never gathered before. This is one part of the communication involved in the instruction of new foragers. She may bring it into the hive to younger workers, place small amounts on their mouth-parts, where they will alternately suck and blow air across the nectar, beginning the evaporation process. Later, workers will pack storage cells with this fluid, where continued fanning will thicken it to the desired consistency, before capping the storage cell with wax. (Honey Comb)

HONEYBEE ENEMIES:

- Bears – destroy hives to eat honey. Generally unaffected by bee-stings.
- Ants - enter hive and eat the bees..
- Skunks – scratch hive to alert workers, eats them as they exit hive.
- Ants – will enter hive and eat the bees.
- Yellow-jackets - will overtake laden foragers on the wing, kill and eat them.
- Mites – infest the bees and hive.
- Small Hive Beetles – eat through honeycomb causing leaks.

BEE VOCABULARY:

- Abdomen: the posterior body section, behind the thorax.
- Antennae: feelers on the bee's head used for touch, smell, and probably hearing.
- Beebread: a mixture of honey (or nectar) and pollen, used to feed drones and workerbees.
- Beechain: arrangement of workerbees, as they attach themselves one to another, each bee clinging to the one above, using it's front legs to hold the others' back legs. This is the formation they make when harvesting the wax scales from the underside of their abdomens.
- Beeline: the direct flight, in a straight line, which a bee takes to a food source.
- Beeswax: produced by the workerbees' wax glands. Wax is secreted in scales from the glands on the underside of the abdomen, then gathered and manipulated for use.
- Borrdchamber/nest: the section of the comb in the hive where eggs are laid and the young are raised. It is separate and distinct form honeycomb.
- Cell: the individual six-sided structure composed of beeswax, which has common walls with many other cells, making up the comb.
- Colony: the whole group of bees that live in a particular hive. A colony can live for 20 years or more.

VOCABULARY (continued):

- Comb: the network of cells constructed by the colony, which makes up the interior living and storage space of the hive.
- Dance: performed by a returning forager or scout bee, in combination with other acts, the dance relates the direction of the food source. The bee wags and moves its body, producing sounds. Other bees touch the dancer and through this, seem to learn the direction and distance of the food source.
- Drone: the male bee; hatches from an unfertilized egg (one set of chromosomes). Only purpose is to fertilize the Queen.
- Egg: honeybee egg is about the size of a comma. Eggs are laid by the Queen in the bottom of a broodcell.
- Extractor: machine used by the beekeeper to spin the honey out of the comb.
- Forage: the act of traveling to seek and obtain food.
- Hive: home of the bee.
- Hive tool: composed of a handle and blunt steel blade this tool is used to separate the frames of the modern hive for examination.
- Honey: food produced by bees from nectar.
- Larva(e): newly hatched, wingless stage of development.
- Nectar: liquid secreted by plants and flowers which workerbees drink, transport to the hive and make into honey.
- Orientation flights: The initial flight of a younger bee when it first goes out of hive to forage.
- Pollen: grains of protein produced by the flower
- Pollen baskets: technical name “corbicular”, a trough-like area on the back leg that is edged by rows of long rigid hairs. The worker combs the pollen from it’s body and compacts the grains specifically in these locations
- Propolis: resinous mixture collected from tree buds and sap and combined with bee saliva which bees use as cement or sealant in the hive. Valued as an antimicrobial for hive health
- Pupa(e): stage of development before adulthood when the adult structures of the body are formed, while larval structures are broken down. Pupae are immobile.
- Queen: the only fertile, egg-laying female in the colony of bees
- Royal jelly: secretion produced by workers to feed all larvae. Drones and worker larvae are also fed nectar and pollen. Queen larvae receive only royal jelly.
- Screen veil: The protective hat and covering worn by the beekeeper.
- Smoker: small covered can with attached bellows that, when filled with a smoky fire, can exude smoke which the beekeeper applies to the hive to force the workers to engorge on honey, rendering them quiet for handling.
- Swarm: queen-led exodus from an existing colony to a new location, generally accompanied by half to all of the colony.
- Wax glands: located on the sides of the workers’ bodies. These secrete the wax, which is gathered and used to construct cells in the hive.



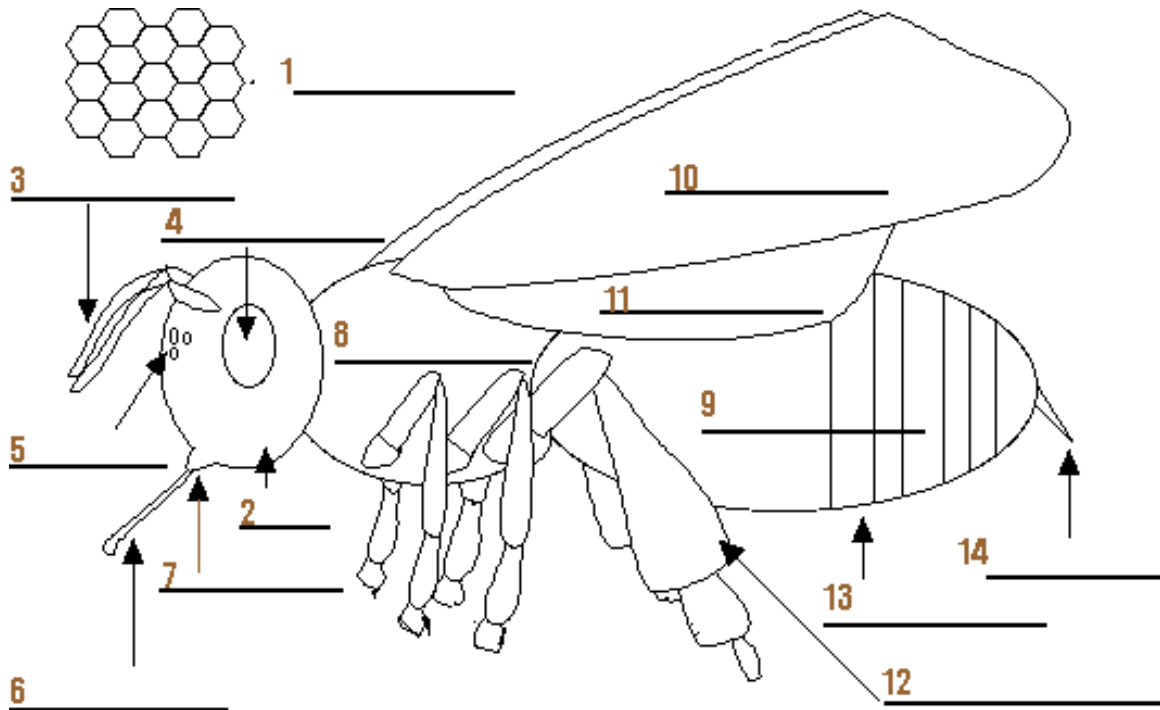
FUN FACT ABOUT HONEYBEES



1. How many flowers do honeybees have to visit to make a pound of honey?
2. How many eyes does a honeybee have?
3. How many sides to the cell in the honeybees' hive?
4. How many wings does a honeybee have?
5. How many flowers are visited by a honeybee in one trip?
6. What is the average amount of honey consumed per person each year in the United States?
7. Which state is the "Beehive State"?

Answers:
1. 2 million
2. 5 (2 compound eyes on each side of her head and one eye on the top)
3. 6 (hexagon – the strongest shape in nature)
4. 8 (4 pairs)
5. 50-100
6. Slightly more than one pound
7. Utah

Worker Honey Bee



1. hexagonal comb
2. head
3. antennae
4. compound eye
5. ocellus (simple eye)
6. proboscis (tongue)
7. mandibles (jaws)
8. thorax
9. abdomen
10. forewing
11. hindwing
12. pollen basket
13. wax lands
14. sting

THE AMAZING HONEYBEE

- ✿ 3500 Species of Bees in the U.S.
- ✿ Honeybees are of the order: Hymenoptera; species: Apis (there are 8-10 of this genus)
- ✿ Apis mellifera is most common in America
- ✿ There are 24 races of A mellifera
- ✿ Honeybees from one race can mate with bees from another
- ✿ Honeybees first came to North America from Spain in 1500's
- ✿ Honeybees first came to Massachusetts from England in 1600's
- ✿ Bee Products include: honey, beeswax, pollen, royal jelly, propolis, and bee venom
- ✿ Honeybees in Massachusetts produce more than \$252,000 of honey annually (from 15,000 hives)
- ✿ Honeybees in U.S. produce 4 million lbs. Of beeswax each year
- ✿ In U.S. honeybees produce 250 million lbs. Of honey annually
- ✿ Bees produce wax in tiny flakes from glands on their abdomen
- ✿ Bees use their wax to build comb and seal cells containing larvae, honey & other foods
- ✿ Bees collect nectar from flowers to make honey
- ✿ Fructose makes the honey sweet (1.5 times sweeter than cane sugar)
- ✿ A worker bee will collect enough nectar in her lifetime to produce ½ teaspoon of honey
- ✿ Bees use the honey for energy food (carbohydrate)
- ✿ Bees store finished honey in sealed cells to use when flowers are not blooming
- ✿ Honey comes in different flavors & colors depending on the flowers where the bee drinks
- ✿ Honeybees pollinate our food crops

✿ Crops that rely solely on insect pollinators:

| | | | | | |
|---------------|--------------------|------------------|-------------------|------------------|-----------------|
| Almond | Apple | Apricot | Avocado | Blueberry | Cherry |
| Citrus | Cranberry | Grapes | Kiwi | Melon | Olives |
| Peach | Pear | Raspberry | Strawberry | Asparagus | Broccoli |
| Carrot | Cauliflower | Cucumber | Onion | Pumpkin | Squash |
| Peanut | Soybean | Cotton | Sunflower | | |

(foods in bold are grown in our area)

BEE BASICS AN OVERVIEW

Bees may not have a good reputation because of their ability to sting, but many are important and beneficial. We see them as industrious (“Busy as a bee”) and we appreciate their main product, honey, as setting the standard for all that is wonderful and sweet.

Over 25,000 species of bees have been identified in the world, with perhaps as many as 40,000 species yet to be identified. In the continental United States scientists have found approximately 3,500 species of bees.

What we call honey bees are represented by eight to ten species in the genus *Apis*, a name from which comes the word for beekeeping (apiculture) and the word for a bee yard (apiary). The species of honey bee commonly found in America is *Apis mellifera*. 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. But, since they are from the same species, bees from one race can mate with bees from another race, creating even more variation within the honey bee universe.

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.” Honey bees were first brought to Massachusetts in the 1600’s. Honey was used to sweeten food and the bees were needed to pollinate apples. The bees were carried in beeskep baskets. As an industry, beekeeping grew dramatically during the first half of the 20th century. During World War II, when sugar was strictly rationed, managing bees for honey production gave Americans an alternative way to still have sweets and sweeteners. Beeswax was also an essential component of machine lubricants used by the military.

More than 211,000 beekeepers maintain about 3.2 million honey bee colonies in the United States. In Massachusetts more than 15,000 honey bee colonies produce \$252,000 worth of honey each year. Honey bees are also essential for pollinating the apple, pear, cranberry, blueberry, squash, pumpkin, and vegetable crops. The northeastern United States lost 70 to 90 percent of honey bee colonies in 2001. The cause of death was two different mites that have been widespread throughout the U.S. Medication helps beekeepers to maintain bee hives, but it does not cure the problem. With research and the dedication of the beekeeper, these important and hard working agricultural resources will be protected.

HONEY BEES

Honey bees belong to the order Hymenoptera and to one of the *Apis* species. Honeybees are kept in large cities and villages, on farms and range lands, in forests and deserts, from the Arctic and Antarctic to the Equator. Honey bees are not domesticated. Those living in a man-made domicile called a beehive or hive are no different from those living in a colony in a tree.

Pollen, nectar, water, and salt are the natural food materials for bees. The pollen supplies the bee with the protein essential to the growth of the developing bees; nectar provides the sugars for energy. But pollen and nectar provide minerals and other substances important to the bee’s diet.

BEE COLONIES

A colony of honeybees is a highly complex cluster of individuals that functions virtually as a single organism. It usually consists of the queen bee, a fertilized female capable of laying a thousand or more eggs per day; from a few to 60,000 sexually undeveloped females, the worker bees; and from none to 1,000 male bees, or drones. The female of most species of bees is equipped with a venomous sting.

THE QUEEN BEE

The queen bee’s chief function is to lay eggs, and she rules the hive with chemical messages called pheromones. The number of eggs laid by a normal queen depends largely on the amount of food she receives and

on a favorable temperature in the hive. A good queen lays her eggs in a compact arrangement, leaving very few empty cells. She attaches an egg to the bottom of each cell.

The first queen to emerge after the mother queen departs with the swarm immediately attempts to destroy the others. If two or more emerge at the same time, they fight to the death. When the surviving virgin is about a week old, she soars off on her mating flight; she frequently mates with more than one drone while in the air. She may repeat the mating flights for two or three successive days, after which she begins egg laying. She rarely leaves the hive again except with a swarm. The queen can live up to five years, although many beekeepers replace the queen every year or two.

Normally, the queen is much longer than either the workers or the drones. Because she has a longer abdomen, her wings appear shorter and her thorax slightly larger than the workers' but smaller than the drones'. She does not have pollen baskets or wax glands. Her sting is shorter than the workers', has fewer and shorter barbs, and is curved. She rarely uses her sting, except when she emerges from her cell and encounters other queens in the colony. The young queens battle until only one is left.

THE WORKER BEES

The worker bee, a sterile female, does all the work the hive requires. The workers, although female, lack the fully developed reproductive organs of the queen. Immediately after emerging, they groom themselves, and eat honey and pollen to gain strength. As they become acquainted with the hive and grow older, they do the jobs in the colony. They may clean out cells and the hive, feed the older larvae, take orientation flights, evaporate nectar, build comb, and act as sentinels and ventilators. During the latter half of their lives, they engage in field duties of carrying water, pollen, nectar, and propolis. Worker bees gather food, primarily pollen and nectar, from flowers. As they forage from flower to flower, pollen sticks to their hairy bodies. Often, when the bees brush against petals and branches, pollen will fall into unfertilized flowers. Honeybees unintentionally pollinate more than 90 cultivated crops, with a combined annual value of \$20 billion.

Worker bees live about six weeks during the active season but may live for several months if they emerge as adults in the fall and spend the winter in the cluster. Usually, enough workers survive the winter to carry on in the spring until others are reared to take their place. As the name implies, worker bees do all the work of the hive, except the egg laying.

DRONES

Drones are reared only when the colony is populous and there are plentiful sources of nectar and pollen. They usually live a few weeks, but are driven from the hive to perish when fall or an extended period of adversity comes upon the colony. The only duty of the drone is to mate with the queen. The drones die in the act of mating.

The drones are larger and heavier than the workers, but not as long as the queen. It is easy to identify a drone by its compound eyes that come together at the top of the head. The eyes of the queen and workers are on the sides of the head. The drones have no sting. The young drones are fed by the workers; the older drones feed themselves. At the approach of winter, the drones are driven from the colony to starve.

SWARMING

When the colony becomes crowded with adult bees and there are insufficient cells in which the queen can lay large number of eggs, the mother queen departs from the beehive with the swarm. Swarming usually occurs during the middle of a warm day, when the queen and a portion of the worker bees (usually from 5,000 to 25,000) suddenly swirl out of the hive and into the air. After a few minutes flight, the queen alights, preferably on a branch of a tree but sometimes on a roof, a parked automobile, or even a fire hydrant. All the bees settle into a tight cluster around her while a handful of scouts reconnoiter a new homesite. When the scout bees have located a new domicile, the cluster breaks, the swarm takes to the air and in a swirling mass proceeds to the new home. Swarming is the bees' natural method of propagation or increase.

HONEY

Honey has been delighting humans for more than 40 centuries. In ancient Egypt, taxes were paid with it.

Each year, honeybees in the United States produce about 250 million pounds of honey, a by product valued at \$200 million. Honey bees also manufacture 4 million pounds of beeswax each year and several lesser known substances like bee pollen, bee venom, and royal jelly, which are important ingredients in a variety of products.

The average honeybee flies at a speed of 15 miles per hour. A hive of bees must fly 55,000 miles to produce a pound of honey. It would take approximately one ounce of honey to fuel a bee's flight around the world.

Bees fly to millions of flowers, gathering tiny droplets of nectar which the flowers offer to the bees in trade for pollination services. The bees convert the nectar by enzyme processes into honey. To make honey, bees drop the collected nectar into the honeycomb and then evaporate it by fanning their wings. Honeybees "dance" to communicate the direction and distance of nectar sources. The bees need the honey as their only source of carbohydrates, or energy food. The honey is stored in wax combs which the bees also make for themselves. The bees store the honey for use during times when flowers aren't blooming.

The fructose in honey makes it sweeter than sugar. At 21 calories a teaspoon, honey is one and a half times as sweet as sugar, which is about 15 calories per teaspoon. Honey acts quickly to produce energy for it is described as "predigested" and when taken into the body, goes right to work. Ordinary (refined) sugar has to be digested or converted by the body before it can produce energy. Some vitamins are found in honey, including vitamin C and most of the vitamin B complex. Honeys containing a lot of pollen are rich in vitamin C, and this is not lost as quickly from honey as it is from fruits and vegetables. However, honey that has been strained, filtered or overheated in order to remove the pollen (which makes the honey look cloudy) is almost totally lacking in vitamin C.

Honey is marketed in several different forms: liquid honey, comb honey, and creamed honey. Liquid honey is extracted honey which has been removed from the honey combs by the use of centrifuge equipment. These machines are called extractors. Comb honey is honey which is still in the original wax combs made by the bees. This honey is less adaptable to cooking or mixing in tea, but is relished by connoisseurs who prefer its natural flavors. Honey comes in lots of different colors and flavors. The nectar given off by different types of flowers will smell and taste different. Soil chemistry and honey-comb quality are also factors influencing how honey tastes and looks. Honey may vary from white and clear (usually alfalfa honey from drier, alkali soils) to very dark (buckwheat from acidic soils). Colors between these extremes range through pleasing golden, red, and even green hues. converted by the body before it can produce energy.

BEESWAX

Bees secrete beeswax in tiny flakes on the underside of the abdomen and mold it into honeycomb, thin-walled, back-to-back, six-sided cells. When beekeepers uncap or break honeycombs, they try to salvage the beeswax. First, they recover as much honey from the combs as possible by drainage or extraction. They then place the material in water heated to slightly over 145 degrees F. This melts the wax, which rises to the surface. After it cools and hardens, the cake of wax is removed and refined for reuse in comb foundation. Beeswax has many other uses: in quality candles, cosmetics, agriculture, art, and industry. Wax is a highly stable commodity that can be transported long distances under unfavorable conditions without damage.

BEEKEEPING EQUIPMENT

By the 17th century they had learned the value of smoke in controlling them and had developed the screen veil as protection against stings. Standard tools of the modern beekeeper are: the smoker to quell the bees; a veil to protect the face; gloves for the novice or the person sensitive to stings; a blunt steel blade called a hive tool, for separating the frames and other hive parts for examination; the uncapping knife, for opening the cells of honey; and the extractor, for centrifuging the honey from the cells.