



BEE WISE

GETTING TO KNOW THE OBSERVATION HIVE

A HANDBOOK FOR TEACHERS AND NEW HIVE OWNERS

OFFERED BY

THE BEE CAUSE

TABLE OF CONTENTS



PHOTOGRAPHY CREDIT

James, Olivia Rae. Bee Cause Photography: Throughout Book | Gallice, Geoff. Buttonbush: P. 29. | Gorman, Peter. Blazing Star: P. 29. | Mayfield, Frank. Hubam Sweet Clover: Page 29.

CONTENT	Page No.
Welcome Letter	5
Part One: Hive Orientation	6
Basic Hive Structure and Function	8
Safety Rules	10
How to Care for the Hive	11
Part Two: Meet the Honeybee	12
Fun Facts about the Honeybee	12
Beehive Members	13
Bee Biology in Brief	15
Observations of the Bee	17
Part Three: Inside the Hive	18
The Social Organism	18
A Closer Look at the Observation Hive	19
Bee Behavior within the Hive	20
In Depth Observation	21
Part Four: On the Path to Honey	22
Ogden Nash Poem	22
Pollen and Nectar	23
Fun Facts/Pollination	24
How Sweet It Is	25
Part Five: Beyond the Hive	26
Philosophical Quotes	26
Stresses on the Honeybee	26
Colony Collapse Disorder	27
Help the Honeybees in Everyday Life	28
Glossary	30





WELCOME LETTER FROM THE BEE CAUSE

The goal of this document is to serve as a handbook for teachers and new Observation Hive owners in order that they may effectively learn more about the characteristics of the hive and about honeybees in general. It is written to be user friendly both for teachers to share with students of all ages and for the layperson to become more knowledgeable.

We hope that this information engages the reader and creates an awareness so as to embrace the honeybee and not fear it. We also hope that this information will be shared with friends and family and the greater community.

Our belief is that the honeybee will thrive if we encourage more local hives, buy local honey, practice a pesticide free diet, and refrain from using chemical based products when landscaping. It is easy to get discouraged or overwhelmed when trying to make a difference as one person. Our hope is that each of our supporters will try to make one small change in their own yard, neighborhood, or community. That's how we can collectively make a difference to our world and to the noble honeybee.



BEE CAUSE CONTACT

The Bee Cause Contact for the Observation Hive is **Tami Enright**. If there is a situation that the Bee Advocates and Mentor cannot resolve, please call or email Tami.

CONTACT INFORMATION

Tami Enright

Executive Director + Bee keeper

Phone: 703.400.4473

Email: tami.enright@gmail.com



HIVE ORIENTATION



ASK THE AUDIENCE

- Has anyone seen a colony of bees?
- Has anyone ever seen a beehive that looks like a white box?
- Has anyone ever seen an observation hive?
- Has anyone ever been stung by a bee?

Although I've been a beekeeper for a long time, I will never forget my very taste of fresh honey straight out of the beehive. Almost ten years ago a neighbor, Mr. B, invited me to his apiary to meet his honeybees. I was apprehensive about the offer. I thought to myself, "Sure, I like honey, but I'm not so sure I like honeybees." Suddenly I imagined myself surrounded by a swarm of hundreds of buzzing bees. The idea scared me, as I think it would most people. But I was ready for a new adventure, so I accepted Mr. B's invitation.

It was a perfect early spring day when I showed up at Mr. B's home to meet his honeybees. In his backyard stood three tall boxes that looked like painted white file cabinets; these were his beehives. As Mr. B greeted me, he handed me a beekeeper's veil to put over my head for protection. Then he donned his own veil and walked toward the hives. As I followed him, heart pounding in my ears, he explained that honeybees, although quite docile, were also curious creatures. They liked to crawl into nooks and crannies and into our clothing. The veils should stop them from stinging our faces. "Stinging our faces?" I wondered what I was getting myself into. By the time we arrived at the hives, I was trembling. Mr. B lit his bee smoker, a small tin container that looked a little like a coffee can, and blew a few puffs of smoke into the front entrance of the first beehive. Then he lifted the cover to direct the smoke at the bees inside. He explained that the smoke calmed the bees and distracted them from our presence.

He then gently removed the cover completely from the hive and placed it on the grass. I craned my neck to peer inside, still trying not to get too close. Hundreds, maybe thousands, of honeybees crawled across the top of the ten perfectly positioned wooden frames that sat vertically inside the box. I was utterly surprised and relieved to see that the bees were indeed quite calm. With his bare hands, Mr. B, slowly removed a single wooden frame covered with bees. I watched with amazement as the bees walked across his fingers, then his hands, and onto his sleeve. But Mr. B took no notice. "These are Italian honeybees," he said. I had to smile. Since I am of Italian ancestry, I liked the idea of Italian honeybees. Out of nowhere came thoughts of telling my friends, "I raise Italian honeybees."

Mr. B inspected the frame and pointed out the different kinds of bees: the female worker bees that gathered the nectar and made the honey, and the male drone bees whose primary job was to mate with the queen. He told me that there was one queen bee in every hive and that all hive activities revolved around her egg-laying schedule. The female ruled the hive—I liked the way that sounded.

When Mr. B announced that it was my turn to hold the frame, I shrank back. But his gentle handling of the bees and his calm demeanor somehow gave me the courage to accept the frame from him with my own bare hands. Bees were everywhere—dozens of them crawling on my fingers and making their way onto my sleeves. I took a deep breath and held the frame firmly so as not to make any sudden movements and upset them. “I can do this bee thing,” I said to myself. “I am fearless.”

As I held the frame, Mr. B pointed out the perfectly formed honeycomb, made of beeswax, that filled the center of the frame. The honeycomb was where the queen laid her eggs and the worker bees stored their pollen and honey. When I held the frame up to the sunlight, the honeycomb looked like a beautiful stained-glass window. Mr. B poked his finger into the hexagon-shaped cells. Sparkling amber liquid oozed out of the cells and drizzled down the frame. Mr. B stuck his fingers under his veil and carefully licked off the precious honey. He invited me to do the same. Careful not to disturb a single bee, I poked my finger into a new cell to expose more of the pristine honey. As I excitedly drew my finger up to my mouth, I forgot about my protective veil and smeared it with the honey. Mr. B chuckled. I captured another dollop of honey, this time managing to bring my finger underneath my veil. It tasted glorious and exquisite, heavenly and perfect. It was like nothing I had ever savored. At that moment, I knew I wanted to keep Italian honeybees that made this divine treasure called honey.

Excerpt from Honeybee by C. Marina Marchese

LESSONS ON THE HIVE

Remember that the Observation Hive has pairs of frames. This means that the space sandwiched between the frames, or bee space, is not visible to the observer. Since the bees like to work in a darker environment, they may be more concentrated in these spaces. But, don't worry; there will be plenty of exciting activity to observe!

THE OBSERVATION HIVE

The Observation Hive is unique in that bees can be observed and studied without disrupting the colony. The hive case is made of solid wood and Plexiglas, a shatterproof material, and is secure.

The hive consists of eight frames arranged in stacking pairs. Each removable, wooden frame offers a base structure, a foundation made of thin sheets of beeswax imprinted with a pattern of honeycomb. The bees use this form to build their own combs out of beeswax. The combs are created for raising new bees, storing pollen and nectar and storing honey.

The entrance to the hive is at the bottom of the hive near the mounting wall. The bees find their way from the outside through a tube to the entrance. There are ventilation holes on the sides, screened for your protection. It is important that the hive has good ventilation to keep it healthy. A feeding station is located on the top surface of the Observation Hive. Your beekeeper will instruct you if the bees need supplemental food before winter.

Finally, the Observation Hive moves! It is mounted to rotate so that both sides of the hive can be observed. This feature allows for better viewing and study.

THE BEES INSIDE

Right away, you should notice that the bees are busy. Every bee has a mission and is actively working to get the job done... which is never done! Some frames will have more bees on them than others. This is dependent on the purpose of that frame...the brood combs on the bottom half of the hive are usually more active than the others.

When you are near the hive, both a noise and an odor may be apparent. There will be a noticeable, gentle hum in the space shared with the hive, especially during the busy spring and summer foraging season. There may also be a slight fragrance from the hive, dependent on the type of bloom on which the bees are foraging. You may notice that the hive glass is warm to the touch, especially during brood season, which is late spring and early summer.

MAINTENANCE

Generally speaking bees will take care of themselves, and bees know best what is good for bees. Once your bees are installed in your hive case, the colony of bees will forage food and will create the perfect habitat needed for its well-being. A colony will instinctively self-adjust its work flow and life cycles to the seasons; creating brood, reproducing itself by swarming; collecting pollen and nectar, storing honey, and clustering for winter. In the low country, the colony will need minimal attention. Your beekeeper mentor will want to check for colony strength and honey/brood balance in both the fall and the spring.



COVERING THE HIVE WHEN IT IS NOT BEING OBSERVED IS HIGHLY RECOMMENDED

As honeybees prefer a dark environment, they will be more productive if covered. In addition, the hive can more easily maintain an ideal temperature if it has slight insulation. This can be accomplished with poster board cover panels or a draped tapestry or blanket.

In the winter, if there is not enough honey stored to sustain the bees through the season, the beekeeper may recommend feeding the bees a supplement of simple syrup or honey. A hive top feeding station that houses a glass mason jar makes easy work of this task without removing the Observation Hive to the outdoors.

A great advantage of the Observation Hive is that you can see inside and keep an eye on the health of the hive without having to open the hive and disrupt the bees.

See “Interactive with Hive” on the Page 11 for more detail on your hive’s health.

I hadn't been out to the hives before, so to start off she gave me a lesson in what she called 'bee yard etiquette'. She reminded me that the world was really one bee yard, and the same rules work fine in both places. Don't be afraid, as no life-loving bee wants to sting you. Still, don't be an idiot; wear long sleeves and pants. Don't swat. Don't even think about swatting. If you feel angry, whistle. Anger agitates while whistling melts a bee's temper. Act like you know what you're doing, even if you don't. Above all, send the bees love. Every little thing wants to be loved.

Sue Monk Kidd
The Secret Life of Bees

IF YOU ARE ALLERGIC TO BEES USE YOUR RECOMMENDED TREATMENT IMMEDIATELY

In the year 2000, the World Health Organization reported 54 deaths from bee stings in the USA. This means that you are more likely to be killed by lightning, which causes 90 deaths per year, than by bee stings!

BuzzAboutBees.net

SAFETY RULES

SIGNAGE: All Observation Hives come with a sign to be posted near the beehive entrance on the exterior of the building. This helps alert visitors to the fact that there are bees in the area. Also, it helps to remind people about not using harmful chemicals, especially near the Observation Hive.

BEE ENTRANCE: For the Observation Hive, the bees enter and exit on the outside of the building. If you are outside, please stay clear of the entrance. Bees need about 4 to 5 feet of clearance before they fly up towards the sky! It is a good idea to give them a safe, 10-foot perimeter so that their flight is uninterrupted.

SWING ARM: This feature is integral in the purpose of the Observation Hive. When moving the hive, be sure to do so with care. Slowly rotating the hive for better observation is welcomed. Avoid swinging the hive quickly or with a jerky motion, and never hang on the hive.

BEES INSIDE THE CLASSROOM OR OFFICE:

Frankly there's not much to be concerned about. The hive case is a sturdy and secure container. Bees cannot fly out, climb out, or chew out. In the rare incident where a bee may have found its way into the building without using the bee entrance, you may gently place a cup over the bee and slide a piece of paper between the cup and surface on which the bee landed. The bee may then be transferred outside.

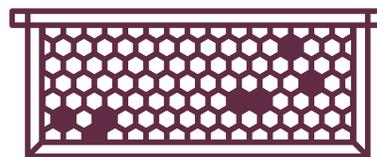
BEE ETIQUETTE: The honeybees are very busy, and for the most part, will not notice you near the Observation Hive. Please keep it that way. Strong vibrations or very loud noises may agitate the bees, and in order to protect the hive, they may sting someone outside. Help the bees feel at home by providing an environment void of extremes in temperature and noise.

A BEE STING: If you do get a bee sting, make sure the stinger is removed as quickly as possible. A fingernail or credit card can be used to effectively remove the stinger. Bentonite Clay or Baking Soda will help soothe and reduce swelling. A cold compress will also relieve some of the pain. Do not rub or scratch the site, as this will produce more histamine, which causes itchiness and swelling. Evidence of the sting will disappear in a few days.

HOW TO CARE FOR THE HIVE

- 1** Log the temperature in the room and the temperature outside...note the difference from the temperature inside the hive, 93.5 degrees. If there is a large temperature difference, hive panels or case covers may be needed to improve colony health.
- 2** Look at each frame and note any changes in population. Report a significant decrease to the beekeeper.
- 3** Look for insects other than bees in the hive. You may see mites or hive beetles. Report any sightings to the beekeeper.
- 4** Are any of the combs broken or sagging? This may indicate a temperature regulation problem or trauma to the hive. Let your beekeeper know.
- 5** If needed, your beekeeper may teach you how to feed the bees a mixture of sugar water and special tea blend.
- 6** Keep the hive covered when not used for observation.

INTERACTIVE WITH THE HIVE





MEET THE HONEYBEE



ASK THE AUDIENCE

- Who has seen a honeybee outside of the hive?
- Has anyone heard stories or seen movies about bees?
- Has anyone ever seen a queen bee?

FUN FACTS ABOUT HONEYBEES

The honeybee has been around for about 30 million years.

Honeybees are one of the few bees with hairy compound eyes.

The honeybee's wings stroke over 200 times a second! This fast motion is what creates the distinctive honeybee buzz.

During honey production periods, spring and summer, a worker bee's life span is about 6 weeks.

The average honeybee will actually make only one twelfth of a teaspoon of honey in its lifetime...

About the size of your pinky fingernail.

Bees die after they sting! The stinger has a barb that is attached to the abdomen; so, when they sting they lose part of their abdomen and die.

Honeybees can perceive movements that are separated by 1/300th of a second. Humans can only sense movements separated by 1/50th of a second. Were a bee to enter a cinema, it would be able to differentiate each individual movie frame being projected.

Queens will lay almost 2000 eggs a day at a rate of 5 or 6 a minute. Between 75,000-200,000 eggs are laid per year.

BEEHIVE MEMBERS

QUEEN: She is just that, the queen of the hive. There is only one queen in a **colony** of bees, and she serves as the central focus of the colony. She is a completely developed female and is the only honeybee that lays eggs. The queen is also the only honeybee without a barb on her stinger. This means that she can sting repeatedly without dying. This feature allows her to kill other queens who may venture into the hive.

While she starts out the same as all the other worker bees as a simple egg, the queen is cared for differently. When her egg is selected to become the queen, the **larva** is fed a rich diet of **royal jelly** (a milky, rich bee secretion) for the entire time that she is developing into a mature bee... a total of 16 days. This is the reason that her abdomen is 2-3 times larger than all of the other bees, for they only receive royal jelly for 3 days. Usually, the colony produces several queens for security of survival. If so, when the queens hatch, they fight to the death so that one queen lives to reign over the hive.

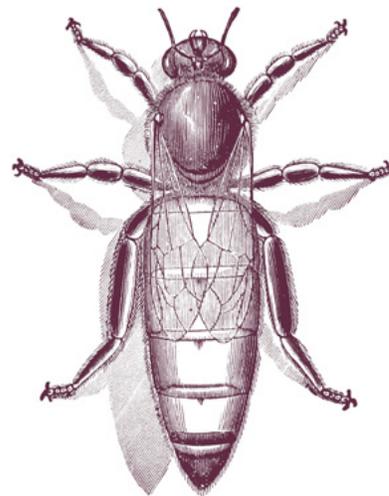
A queen's productive life span can be 3-5 years. She is usually born in the spring and will stay with her hive for an entire year; however, after a full year, she will leave her hive and start a new hive. The queen will **swarm** by taking about half of the colony with her, leaving the remaining bees with a newborn queen. This is the honeybees' way of expanding their population.

WORKER BEES: Worker bees are all female bees! They do have developed ovaries but do not normally lay eggs. Nearly all of the bees in a hive are worker bees. A hive consists of 20,000 - 30,000 bees in the winter, and 60,000 - 80,000 bees in the summer.

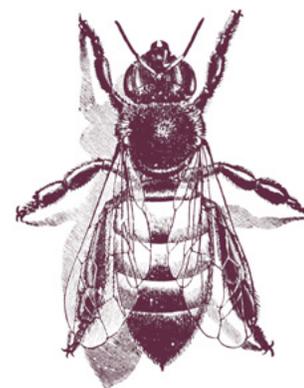
The worker bee has many different tasks within the hive. When a worker bee is born, her first job is to clean out the cell in which she was born. After that, her job and duties in the hive depend on her age.

The **nurse** duties are to care for the **brood**, the developing bees in various life stages. They protect the eggs, feed in the larvae, and cover the cells for the pupae to develop. If the young are

LESSONS ON THE HONEYBEE



Queen Bee



Worker Bee

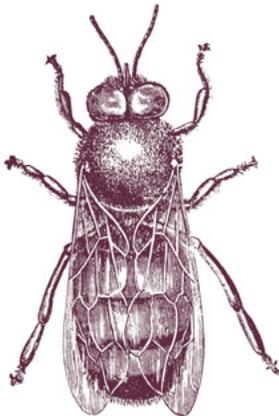
Days Old	Job Title
1-2	Cleans cells and keeps the brood warm.
3-5	Feeds older larvae, immature bees.
6-11	Feeds youngest larvae
12-17	Produces wax, builds comb, carries food, removes debris and dead bees from the hive.
18-21	Guards the hive entrance.
22+	Leaving the hive begins: pollinates plants, collects pollen, nectar.

not healthy, they will not feed them. Housekeeping is a very important duty.

The workers will remove dead bees and anything that is not a part of the hive colony in order to prevent disease. They will also spend time building new combs cell-by-cell, organizing food stores, producing wax, producing royal jelly, secreting **propolis**, and making honey.

The **guard** duties are to protect the hive. With its stores of honey and brood, the hive is attractive to many other insects and bees from other hives, so the bees guard the entrance of the hive checking to see that an arriving bee is a member of the hive and not a robber. They also will sting anything that threatens the hive (like bears or people or other animals) and release a pheromone (a smell like bananas) that will alert other workers of the threat.

Finally, the worker bee will spend most of her lifetime gathering pollen and nectar from nearby flowering plants. A worker's life expectancy during the active summer months when they are producing honey is only 6 weeks (they literally work themselves to death); however, they can live for 4-9 months during the relatively inactive winter period.



Drone Bee

DRONES: Drones are male bees that are made from unfertilized eggs. They are slightly larger and usually darker than the worker bees. They have bigger eyes and a thicker body. They actually do not serve a purpose within the hive itself. Drones are produced for the benefit of the greater honeybee population. They cannot mate with their own queen, their mother, but they do leave the hive and mate with queens who are on their voyage to create new colonies. After mating, the drone dies.

Drones make up a very small percentage of the total colony. There are only 300-3000 drones in a hive. These male bees are fed by the workers and allowed to stay in the hive during the summer, fruitful months. However, they are of no use once mating season is over; so, the drones are expelled from the hive in the autumn by the female worker bees.

Finally, drones do not have a stinger! You can safely handle a drone bee with no fear of getting stung.

BEE BIOLOGY IN BRIEF

Honeybee Anatomy (scientific name, *Apis mellifera*)- Honeybees have two antennae, two compound eyes, two pairs of wings (4), three pairs of legs (6), a nectar pouch or honey sac, and a segmented abdomen. At the end of the abdomen is the stinger with a barb, which anchors the stinger in the victim's body. The bee leaves its stinger and venom pouch behind and soon dies from abdominal rupture.

HEAD

The head of the bee contains the brain, the eyes, the proboscis, & the mandibles - the 2 antennae are attached to the head.

COMPOUND EYE

One of two large eyes that are made up of many hexagonal lenses.

ANTENNAE

UPPER LIP
JAW
LOWER LIP

MANDIBLES

A pair of plier-like jaws - located on the lower sides of the head. They are used to carry things, construct and clean the hive, hold enemies, and release pollen from flowers.

THORAX

Body section between the head and abdomen - the legs and wings attach to the thorax.

FORE WING

ABDOMEN

Segmented tail area of a bee, that contains the heart, reproductive organs, wax glands, & most of the bee's digestive system.

STINGER

A sharp shaft located at the end of the abdomen and used for defense - only present on females.

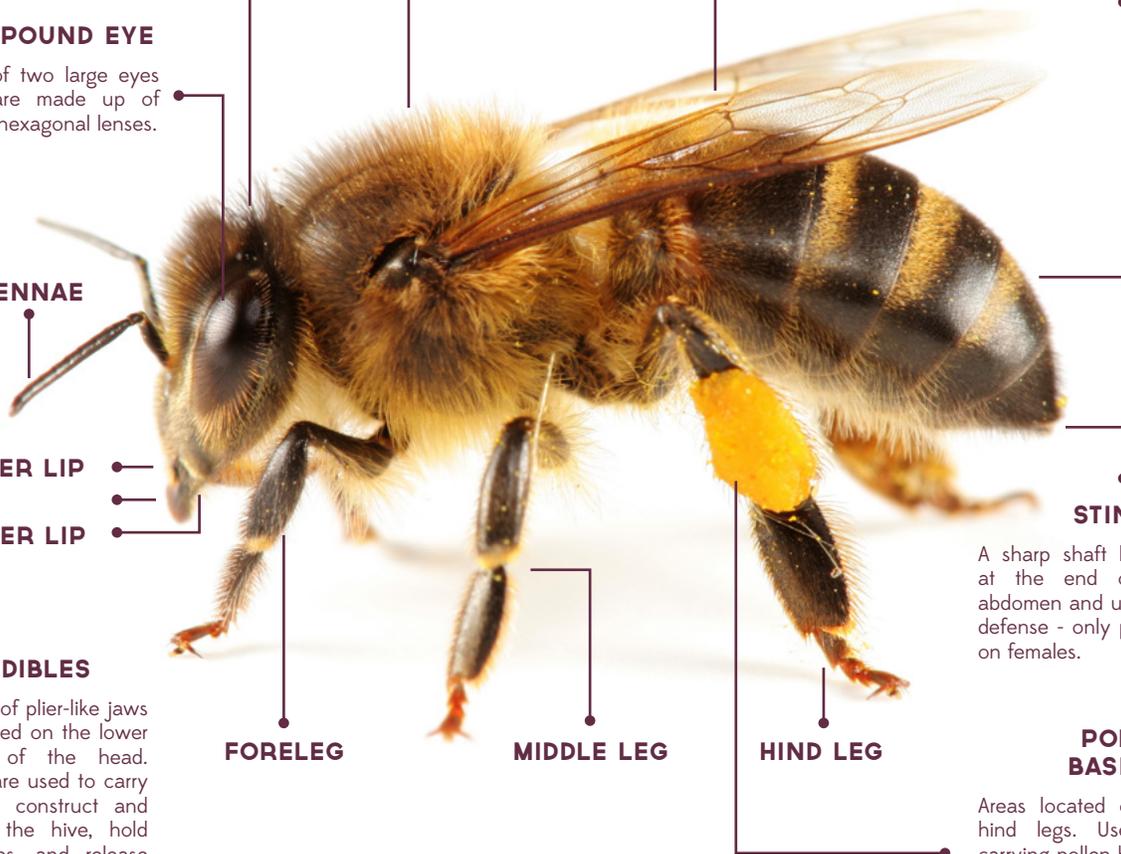
POLLEN BASKETS

Areas located on the hind legs. Used for carrying pollen back to the hive.

FORELEG

MIDDLE LEG

HIND LEG



LIFE STAGES

The four life stages are egg, larva, pupa and adult. The queen produces all of the eggs. Before she starts egg production, she mates only once with up to 15 different male, drone bees from several other hives, which makes her fertile for life. The variety of mates for the queen assures a healthy diversity of the bee population in the colony.

Back in the hive, she lays up to 2000 eggs per day! The eggs are deposited one per cell in the brood comb. After 4 days, the larva (a small, white, grub-like form) hatches. The worker nurse bees feed the larva royal jelly (a milky, rich bee secretion) for 3 days. They then feed the larva beebread, a combination of pollen, nectar, and enzymes for the remaining 3 days. The cell is then capped, and the pupa (developing bee) forms and grows within the cell. It takes a total of 23 days from the time the egg was deposited for the honeybee to become fully developed and ready to exit the cell.

Fertilized eggs become female, worker bees, and unfertilized eggs become male, drone bees. When the queen dies or becomes unproductive, the other bees will “make” a new queen by selecting a young larva and feeding it a diet of royal jelly for its entire larva stage. For queen bees, it takes 16 days from egg to emergence.

LIFE STAGES TABLE

	Queen	Worker	Drone
Gender	Female	Female	Male
Fertilized Egg	Yes	Yes	No
Egg	3 Days	3 Days	3 Days
Larva	5.5 Days	6 Days	6.5 Days
Pupa (Capped Cell)	7 Days	12 Days	14.5 Days
Total	16 Days	21 Days	24 Days

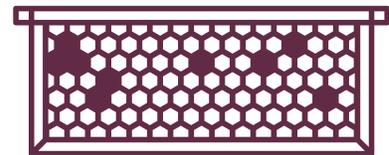
NAVIGATION AND DANCE

Bees use the sun as a compass. Even when clouds obscure the sun, bees can detect its position from the light in brighter patches of the sky. Scientists have also studied bee behavior and have learned that the worker bees dance for each other as a way to communicate the direction and distance to the source of nectar and pollen. See “Part Three” for more detail.

OBSERVATIONS OF THE BEES

- 1** Using the Observation Hive, identify the different hive members; try to find the queen (she may be marked with a colored dot) and the drones; notice all the workers and how they may differ slightly in color.
- 2** Look for the different life stages of the eggs, larvae and pupae in the brood comb. You may need a magnifying glass to see an egg. A larva would be the easiest to spot, as it is larger and white and uncapped in the comb. A pupa should be capped with a darker shade of beeswax.
- 3** Put your ear to the hive wall and see if you can hear the buzz of the colony. How fast can you move your arms in a second?
- 4** Find the ventilation holes and smell the hive. Do you sense floral tones or sweetness?

INTERACTIVE WITH THE HIVE



OTHER ACTIVITIES

- Coloring Worksheet
- Q & A Worksheet
- Crafting with wool (felted bee) or paper (origami bee) or recycled materials (bottle bee) to make beehive members



INSIDE THE HIVE



ASK THE AUDIENCE

- What are some different ways that we communicate with each other?
- What shapes do we use to build our homes?
- Have you ever seen a honeycomb?
- What are different ways to navigate and find your way?

THE SOCIAL ORGANISM

A single bee is alive, that is true, but bees are not like you and I. Though a single bee can fly and move, gather and perform many tasks, no bee lives for itself. It is not quite a cell either. It is a member of a society that forms the larger organism, the colony. It is the colony of honeybees, which inhabits the box in the yard. Single bees do not make decisions. Single bees do not determine if the colony leaves or stays. No single bee raises another bee. The only bee capable of performing her function alone, the queen, is in fact the product of the collaboration of many bees together. Honeybees exist in colonies, and it is the colony that lives or dies. The colony grows strong and the colony weakens. They will live together in the warm summer. If they starve in the winter, they do so as one. The story of each bee is really the story of all. Together they form the story of the colony, and it is the voice of the colony we choose to listen to.

Excerpt from voiceofthehive.com

ON DEMOCRACY IN THE HIVE

Honeybees make decisions collectively--and democratically. Every year, faced with the life-or-death problem of choosing and traveling to a new home, honeybees stake everything on a process that includes collective fact-finding, vigorous debate, and consensus building.

Excerpt from Thomas D. Seeley, *Honeybee Democracy*

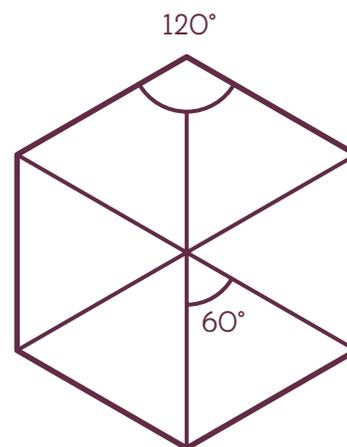
A CLOSER LOOK AT THE OBSERVATION HIVE

COMBS: Combs are made from beeswax. Honeybees produce beeswax from eight paired glands on the underside of their abdomen. The brood combs are found in the bottom half of the hive, and are darker in color. This is where the majority of the activity is happening in the hive, feeding the growing larvae and caring for the pupae. You may observe bees feeding larvae, sealing the cells to allow the pupa to grow, or helping a newborn get out of the cell.

The nectar and honey stores are in the combs on the top half of the observation hive and will be tended to by bees that are making honey or collecting honey to feed to others. Honey and pollen storage also occurs on the edges of the brood comb so as to have easy access when feeding the brood.

CELLS: With beeswax, the bees build precise hexagon cells, which are the building blocks to the comb. These hexagons are the strongest and most efficient shape for the hive to store its honey and pollen and to house the nursery cells for new baby bees. The cells may differ slightly in size depending on their use, but they are always hexagonal in shape.

LESSONS ON THE HIVE



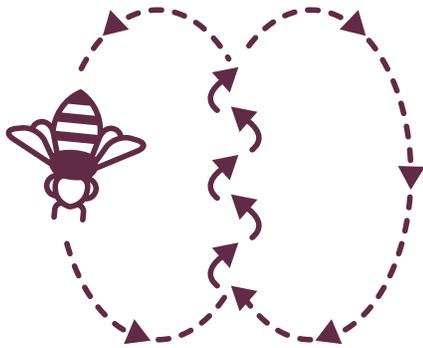
A HEXAGONAL CELL

Perfect hexagonal tubes in a packed array. Bees are hard-wired to lay them down, but how does an insect know enough geometry to lay down a precise hexagon? It doesn't. It's programmed to chew up wax and spit it out while turning on its axis, and that generates a circle. Put a bunch of bees on the same surface, chewing side-by-side, and the circles abut against each other - deform each other into hexagons, which just happen to be more efficient for close packing anyway.

Peter Watts
Blindsight



The Round Dance



The Waggle Dance

ALARM PHEROMONE

In addition, because the familiar scent of home is on all the worker bees in the hive, the guard bees can smell when there is an invader bee approaching the hive. Because bees' sight is not reliable, this pheromone is very important for the survival of the hive. Unlike the queen pheromone in which only the queen emits, any worker bee can set off the alarm pheromone. When a bee stings a predator it emits the alarm pheromone and alerts the other bees. Interestingly, the alarm pheromone smells like bananas!

BEE BEHAVIOR WITHIN THE HIVE

COMMUNICATION: One way bees can communicate is through dancing. The dances indicate the location of flower sources around the hive. The other bees follow the pattern of the dance to receive the directions to the food sources. There are two distinct dances you may be able to see in the hive.

The **Round Dance** is a simpler dance that indicates the flower source is near the hive. The bees dance in a circular pattern as displayed in the diagram.

The **Waggle Dance** is more complicated. This dance resembles a figure eight and represents that the flower source is farther away. In the middle of the figure eight, the bee “waggles” for different amounts of time to correlate to a specific distance of the source. The angle that the honeybee waggles correlates to the direction of the source.

Another way bees communicate is through **pheromones**, a chemical substance produced and released into the environment affecting the behavior or physiology of the other bees. There are several important pheromones including the **queen pheromone** and the **alarm pheromone** with which the bees use to communicate.

The queen emits a pheromone that lets the hive know of her presence. If the queen dies or has left, the hive notices that the queen pheromone is no longer present and will start a new queen.

REGULATING TEMPERATURE: Bees must maintain the hive temperature at a balmy 93.5 degrees! This means that in the summer they need to cool the hive. They use water and fanning their wings to help keep the temperature from getting too hot. In the winter, they will compact themselves more towards the center and use propolis, a resinous mixture collected from tree buds and sap flows, to seal any drafty gaps.

DAILY AND SEASONAL ACTIVITY: The hive is always busy, but the journey out of the hive only occurs during daylight hours. So from sunrise to sunset you may see activity near the entrance. However, the bees generally do not venture out if the temperatures are below 57°F or above 100°F.

WINTER: You may see little or no activity near the entrance. The bees will cluster near the brood to help keep the colony warm.

SPRING: They start out again. With the very first flowering of trees and plants each year, the bees recognize the arrival of spring and energize the colony to produce many new worker bees to capture the new pollen and nectar for their hive while it is available. This is the time when most swarms take place.

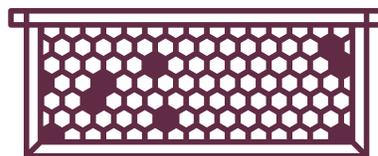
SUMMER: Nectar flow and honey production slows down, but the workers are still collecting pollen. This is the time where the population stabilizes.

FALL: The population dramatically reduces as the bees are preparing for winter. In addition, the remaining drones are kicked out of the hive so that they may not be a burden to feed during the winter. It is not good to remove a large amount of honey during this time, for the bees need it to survive the winter months.

OBSERVATIONS OF THE BEES

- 1 Looking at the hive, identify the different comb types, find cells of different sizes, and notice the hexagonal shapes.
- 2 Look in the hive for bees doing the “waggle dance” or “round dance”.
- 3 Use beeswax for molding and to create shapes. Warm it in your hands for easy molding. Imagine what its like for the bee to form the hexagonal shapes for the cells in the comb.
- 4 Try some beeswax or honey comb to chew. What is its texture and flavor?
- 5 Note the weather and how it may be affecting bee activity.

INTERACTIVE WITH THE HIVE



OTHER ACTIVITIES

- Play challenge games with a group. Work together like honeybees. Hold hands and tangle yourselves, then try to untangle by using good communication.



ON THE PATH TO HONEY



ASK THE AUDIENCE

- Have you ever seen a bee on a flower?
- Do you eat honey?
- What are some of your favorite products made from honey?
- What are some of your favorite fruits and vegetables?

I EAT MY PEAS WITH HONEY

I eat my peas with honey
I've done it all my life
It makes the peas taste funny
But it keeps them on the knife!

Ogden Nash

THE POLLEN NECTAR HONEY CYCLE

The honeybees collect pollen and nectar; they store pollen and make honey from the nectar; they use the pollen and honey as nourishment to help make more bees and as energy to collect more pollen and nectar...and the cycle continues. It is because of this cycle that we are able to benefit from the honey produced by the colony!

POLLEN AND NECTAR

COLLECTING POLLEN & NECTAR: Using the sun as navigation and information from the round dance or waggle dance, the worker bees will forage for pollen and nectar all day. They fly from flower to flower collecting pollen and sweet nectar. The pollen is trapped in pollen baskets on the legs and abdomen, and the nectar is extracted through the bee's proboscis, or tongue, which functions like a straw. The nectar is stored in her honey sac, which is like a second stomach.

POLLEN IN THE HIVE: When the bees return to the hive, the pollen is removed from the bee's legs by worker bees that will pack it into the comb cells using their heads. The pollen is usually mixed with honey or nectar and enzymes to make a hard pack beebread. This is their main food source and a great source of protein for all hive members. It is also used to nourish the developing larvae.

MAKING HONEY: Once the bee returns to the hive, the nectar load is sucked from her nectar pouch, honey sac, by other worker bees through their proboscises. The workers then "chew" the nectar, which adds enzymes from the bee. Basically, honey is nectar that the bees have spit up and eaten over and over many times.

The bee then deposits the honey from her mouth into one of the cells in the honeycomb. The worker bees get as much water out as possible by fanning the honey with their wings. The honeybee is not born knowing how to make honey; the younger bees are taught by the more experienced ones. The reason the bees make honey is so that they can have food in the future and during the winter when there are no flowers blooming.

LESSONS ON POLLEN AND NECTAR

THE FOLLOWING FORMULA BEST DESCRIBES HONEY

Sucrose (nectar) + invertase
(bee enzyme) = fructose +
glucose = Honey!

BuzzAboutBees.net

HONEY FACTS

Honey is the only food on the planet that will not spoil or rot.

Honey has been used for millennia as a topical dressing for wounds since microbes cannot live in it. It also produces hydrogen peroxide. Honey has even been used to embalm bodies such as that of Alexander the Great.

When left in a cool dark place for a long time, honey may start to “crystallize”. When this happens, loosen the lid, boil some water, place the honey container in the hot water, turn off the heat and let it re-liquefy. It is then as good as it ever was. Never bring the honey to a boil or put it in a microwave, doing so will kill the beneficial enzymes.

Fermented honey, known as Mead, is the most ancient fermented beverage. The term “honey moon” originated with the Norse practice of consuming large quantities of Mead during the first month of a marriage.

To make one pound of honey, workers in a hive fly 55,000 miles and tap two million flowers.

It takes one ounce of honey to fuel a bee’s flight around the world.

Honey is nectar that bees have repeatedly regurgitated and dehydrated.

POLLINATION

Once a honeybee discovers a good source of nectar, she will continually return to that same type of flower. Because she prefers to collect nectar from one kind of flower, she spreads pollen from one plant to another individual of the same variety. The pollen sticks to the bee’s legs and gets dusted onto the next plant that the bee visits. This is called pollination. A flowering plant must get pollen from a flower other its own in order to have fertilization and produce fruit and nuts. This makes us very dependent on bees and other pollinators for our food!

In North America alone, honeybees pollinate nearly 95 kinds of fruits, including almonds, apples, avocados, blueberries, cranberries, cherries, kiwi fruit, macadamia nuts, asparagus, broccoli, carrots, cauliflower, celery, cucumbers, onions, legume seeds, pumpkins, squash, and sunflowers. Farmers are dependent on the bees visiting their crops to maintain good production levels.

In Spain, hilly terrain and antiquated planting and harvest practices keep farmers from retrieving more than about 100 pounds [of almonds] per acre. Growers in the Central Valley, by contrast can expect up to 3000 pounds an acre. But for all their sophisticated strategies to increase yield and profitability, almond growers still have one major problem - pollination. Unless a bird or insect brings the pollen from flower to flower, even the most state-of-the-art orchard won’t grow enough nuts. An almond grower who depends on wind and a few volunteer pollinators in this desert of cultivation can expect only 40 pounds of almonds per acre. If he imports honeybees, the average yield is 2,400 pounds per acre, as much as 3,000 in more densely planted orchards. To build an almond, it takes a bee.

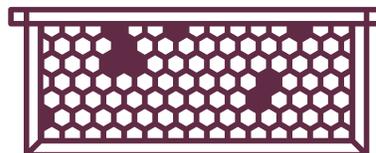
Hannah Nordhaus, *The Beekeeper’s Lament: How One Man and Half a Billion Honey Bees Help Feed America*



HOW SWEET IT IS

- 1 Look in the Observation Hive and find bees with pollen on their legs and abdomen. Notice how these bees are greeted by other worker bees that remove and transfer the pollen.
- 2 Look for cells with nectar (more clear) and how they differ from the honey cells (more dense and usually capped).
- 3 Look for the pollen stores, vibrant yellow-orange cells. Identify foods dependent on honeybees.
- 4 Research and share recipes that highlight the use of honey in cooking. It can often be substituted for sugar.
- 5 Write your own poem about bees.

INTERACTIVE WITH THE HIVE





BEYOND THE HIVE



ASK THE AUDIENCE

- Do you know what it feels like to be stressed?
- Do you have any pests in your life?
- Do you have a vegetable garden or any flowers in your yard?

Bees live as people should live: naturally, symbiotically, and in a manner that only contributes positively to the world around them.

Ted Dennard
Beekeeper

STRESSES ON THE HONEYBEE

Several factors may create stress in the hive, which can cause a decrease in population. Below are some of those possible contributors. All of these effects on the colony can be observed, some more easily than others, in the Observation Hive.

VARROA MITES: The **Varroa mite** is a **parasitic**, invasive species that was introduced to the United States in the 1980's . It originated in Asia and the western honeybee has no resistance. The mated adult female Varroa mites enter the brood cells right before the bees cap the pupae and feed on the growing bee. The bee will hatch with deformities such as misshapen wings that result in an inability to fly.

SMALL HIVE BEETLES: **Hive beetles** are pests to honeybees. They entered the United States in the late 90's. Most strong hives will not be severely affected by the beetle; however, if the hive beetle becomes too overbearing, the colony will desert the hive. The beetle tunnels in the comb and creates destruction in the storage of honey and pollen. Ways to identify a beetle problem is a smell of fermented honey, a slimy covering of the comb, and the presence of beetle maggots.

DISEASE: although bees keep their hive very clean and try to maintain sanitation as best as possible, there are many **pathogens**, disease causing microorganisms, which can infect the bees. These include: American foulbrood, European foulbrood, Sacbrood, Nosema, Chalkbrood. The resulting diseases are very serious, as they are highly contagious. In these particular cases, a state beekeeper should be notified, and the hive would need to be disposed of carefully and properly.

ROBBERS AND PREDATORS: A hive will have robbers that want to steal honey or eat the brood of the honeybee. These are animals or other insects that can smell the food sources. While other honeybees or wasps are after the honey and pollen, natural predators are usually after their brood, not their food. The natural predators of the honeybee brood include the skunks, bears, and mice. Birds, toads, lizards, dragonflies, and spiders will catch and eat the adult bees.

HARMFUL PESTICIDES: The use of pesticides and other chemicals for growing food and for landscaping can be a serious stress to the honeybee. If they do not directly kill the bee, they can compromise the bee's immune system, and hence compromise the entire colony.

COLONY COLLAPSE DISORDER

Colony Collapse Disorder (CCD) is a recent phenomenon where the adult worker bee population disappears from the hive, leaving behind only a few young bees and the queen with the remaining brood, pollen, and honey. The term was coined in 2006 after a drastic decline in the population of commercial honeybees. Scientists are still trying to determine the exact cause of this behavior; however, many speculate that certain insecticides containing **neonicotinoids** are a main cause. This insecticide affects the central nervous system of insects, including the honeybee.

While it is known that pesticides and insecticides can directly affect the honeybees, they may also affect the bees' immunity and prevent them from naturally resisting other stresses. Many countries have banned such chemicals harmful to the honeybee, but in the United States they are still widely used. It is important to practice chemical-free landscaping and gardening, especially in the area near the entrance to the Observation Hive.

Global warming may also be a contributing factor. With newly recorded warmer temperatures, plants may bloom earlier, shifting the cycle of foraging for the honeybee. Also, warmer weather seems to be advantageous to several parasites, allowing for large increases in such pest populations.

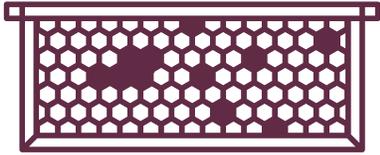
Finally, the beekeeper himself may be at fault. Very large, commercial beekeeping operations must move the bees from one **monoculture** crop to another. The changing environment and transportation that the bees endure may add to stress on the honeybee colony.

LESSONS ON BEES IN OUR ENVIRONMENT

A human being is a part of the whole...our task is to free ourselves by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.

Albert Einstein

INTERACTIVE WITH THE HIVE



Whether it is a natural area in which plants tangle and flowers scramble or a more formally designed landscape, a school garden can provide both a source of inspiration and a learning resource that can be integrated through the school. A garden offers a direct way for students to learn about the environment and is somewhere to find a quiet place. Many gardens become a focal point for community engagement, a project that brings families and local businesses together.

Pollinators are easy to incorporate into a school garden. All that is needed is careful choice of plants and provision of nesting or egg-laying sites. Pollinators can be the subject of many lessons. The resources listed on this page will help you plan and design a garden, introduce you to the diversity of insect pollinators, and provide lesson plans and other teaching materials.

Xerces.org

HELP THE HONEYBEES IN EVERYDAY LIFE

- 1 Check the Observation Hive for healthy population levels. There should be bees on almost every frame.
- 2 Identify flowers that bees visit.
- 3 Buy pesticide free foods and products.
- 4 Create **Integrated Pest Management** projects.
- 5 Plant a vegetable garden or Pollinator Garden.

BEE BENEFICIAL GARDENING

BELOW IS A LIST OF FLOWERING PLANTS WHEN CONSIDERING A POLLINATOR GARDEN

Ask your local nursery about the local species of flowering plants.

NATIVE SOUTHEAST FLOWERING PLANTS THAT ARE BENEFICIAL TO HONEYBEES

Aster, Beardtongue, Beebalm, Blanketflower, Blazing Star, Blueberry, Carolina Rose, Chaffhead, Crownbeard, Giant Ironweed, Goldenrod, Joe Pye Weed, Magnolia, Milkweed, Mountain Mint, Partridge Pea, Rattlesnake Master, Redbud, Rosinweed, Sourwood, Sunflower, Twinberry, Tuliptree, and Wild Plum.

GARDEN PLANTS TO SUPPLEMENT THE NATIVES

Basil, Catnip, Cosmos, Giant Hyssop, Lavender, Majoram, Mexican Sunflower, Oregano, Purple Coneflower, Pincushion Flower, and Rosemary.

BELOW ARE SOME OF THE TOP PICKS FOR POLLINATORS



BLAZING STAR

With its showy, electric pink or purple flower spikes, blazing star is a magnet for bees and butterflies. Its foliage is usually attractive, too, and the plant's tidy appearance makes it a great choice for gardens and landscaping. Over 30 species of blazing star are native to the United States, east of the Rockies only. All are perennial. Blazing star flowers in mid to late summer and sometimes into the fall.



BUTTONBUSH

This plant blooms at a time when some gardens have little else to offer pollinators. In addition to its gorgeous, spherical flowers, it grows well in dry to wet conditions, establishes easily, is a pollinator magnet, and its seeds also benefit other wildlife. Because it is adapted to wetter soils, it also serves as fantastic protection for riparian buffers, helping to keep soils from eroding.



HUBAM SWEET CLOVER

Hubam is an annual species that produces flowers in the first year. It is a great option for warm season cover cropping, especially on dry, heavy clay, saline, and other marginal soils. It grows in full sun, and is a fantastic soil-building cover crop. As an introduced species, it should not be considered a replacement for actual native plant restoration in natural areas, but it's wonderful for use in gardens and farms.

GLOSSARY

A-C

ALARM PHEROMONE: A chemical secretion from the worker bee that warns others of a threat to the hive. It smells like bananas.

APIARY: A place where bees are kept; a collection of beehives.

APITHERAPY: The use of products derived from bees for medicine, including venom, honey, pollen, propolis, and royal jelly.

BEE SPACE: The crawl space needed by a bee to pass easily between two structures about 3/8 of an inch. If the space between any two surfaces in the hive is too small for a bee to pass through easily, the bees will seal it with propolis.

BEEBREAD: A hard-packed mixture of pollen, nectar, and enzymes from the bee.

BEEHIVE: A structure in which bees are kept, typically in the form of a dome or box. In nature, this may be a tree hollow.

BEESWAX: Waxy material produced by worker bees and used to build combs.

BROOD: The immature, developing bees. Includes all life stages of the bees before adult.

BROOD COMB: The comb dedicated to raising the brood.

CELL: A hexagonal shaped structure that holds brood and food. The cells are built wall-to-wall and make up the comb.

COLONY COLLAPSE DISORDER: A recent phenomenon where worker bees disappear from the hive. They abandon the honey and their queen.

COLONY: The term used to describe the group or “family” of bees within the hive that are socially organized around the queen bee. A colony can reach up to 80,000 bees.

COMB: The beeswax structure comprised of individual, hexagonal cells that are shaped within a frame or border.

GLOSSARY

D-M

DRONES: Male bees, whose main function is to fertilize the queens outside of their hive. Drones make up a very small percentage of the total colony. In the autumn drones are expelled from the hive by the female worker bees.

FOUNDATION: Thin sheets of beeswax imprinted with a pattern of honeycomb. The beekeeper installs these sheets into wooden frames as “starters” for the bees in making uniform combs.

FRAMES: The removable wooden structures, which are placed in the hive. The bees build their comb within them. The removable quality allows the beekeeper to easily inspect the colony.

GLOBAL WARMING: A gradual increase in the overall temperature of the earth’s atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, chlorofluorocarbons, and other pollutants.

GUARD: Describes the worker bee that protects the hive from invaders or predators.

HIVE BEETLE: A small dark beetle that is major threat to hive health, as they consume brood, pollen and honey. The beetle larvae can ruin the combs full of honey as they tunnel, defecate, and produce slime over them.

HONEY: The sweet, viscous product created by bees from nectar.

INTEGRATED PEST MANAGEMENT: An ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

LARVA: The grub-like, immature form of the bee, after it has developed from the egg and before it has gone into the pupa stage.

MONOCULTURE: Agriculture practice of growing one crop throughout a large area.

GLOSSARY

N-P

NATIVE BEES: Usually the best pollinators for plants that are native to the same region. Squash bees (*Peponapis*) and bumble bees (*Bombus*) are an excellent example of bees that pollinate plants native to the Americas.

NECTAR: Sweet fluid produced by flowers is 60% water and 40% solids. This is collected by the bees and converted into honey at 17%-18% moisture content.

NEONICOTINOIDS: A relatively new class of insecticides that share a common mode of action that affect the central nervous system of insects, resulting in paralysis and death.

NURSE: Describes the worker bee that cares for the brood.

PARASITE: An organism that lives in or on another organism (its host) and benefits by deriving nutrients at the host's expense.

PATHOGEN: A bacterium, virus, or other microorganism that can cause disease.

PHEROMONE: A chemical produced and secreted into the environment that prompts a social response within a species.

POLLEN: Very small dust-like grain produced by flowers. These are the male germ cells of the plant. This provides a protein source for the honeybees.

POLLINATION: The transfer of pollen from the anther (the male part) of one flower to the stigma (female) of another flower in the same species. This occurs by way of wind, honeybees, and other pollinated insects. This process ensures fertilization of the plant.

PROBOSCIS: An elongated sucking mouthpart that is typically tubular and flexible. Bees use their proboscis to extract nectar from flowers, like a using a straw.

PROPOLIS: Sticky, brownish gum gathered by bees from trees and buds, used to seal cracks and drafts in the hive. Also called "bee-glue." Propolis has anti-viral properties and is used medicinally.

PUPA: The immature form of the bee (following the larval stage) while changing into the adult form.

QUEEN PHEROMONE: Communicates the presence of the queen to the hive.

QUEEN: The only fertile female bee in a colony. She lays all of the eggs and serves as the central focus of the colony. There is only one queen in a colony of bees. A healthy queen's productive life span is 3-5 years.

ROUND DANCE: A circular dance that communicates a flower source is near the hive.

ROYAL JELLY: A jelly that is secreted from the glands in the heads of young nurse worker bees and is fed to all bee larvae. After three days, only the queen larvae will continue to be fed this special substance throughout her development.

SUPERORGANISM: A form of life composed of mutually interdependent parts that maintain various vital processes for the benefit of the whole. The well-being of the whole is more important than the individual.

SWARM: A queen and about half of her colony that have left the hive and are in the process of finding a new hive. The swarm is kept intact with the queen's pheromone.

SWARMING: The action of a colony finding a new home. This is how the honeybees expand their population.

VARROA MITE: A mite that attaches itself to the honeybee, usually on its back. If the bees are not mite resistant, this debilitating parasite can cause death in the hive.

WAGGLE DANCE: A complex dance that expresses the direction and distance of a flower source.

WORKER: A completely developed female bee that has developed ovaries but does not normally lay eggs. The workers do all of the work in the hive and forage for food. A worker's life expectancy is only several weeks during the active summer months; however, they can live for many months during the relatively inactive winter period.

GLOSSARY

Q-Z

Superorganism Example 1

Colony of honeybees that live to promote the health of the entire hive, as well as other hives.

Superorganism Example 2

Grove of Aspen trees whose roots are interconnected and shared.