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DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System | Cooperative Extension Service

About Honey Bees

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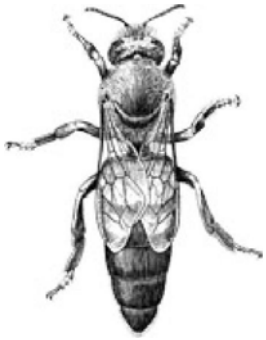
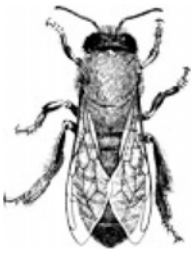
The Three Bees

There are different types of bees in a honey bee hive: Worker, Drone and Queen. Each has its own important roles and performs specific duties in a bee colony.



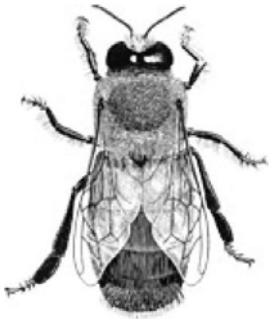
The queen bee can be recognized by her abdomen, which is usually smooth and elongated, extending well beyond her folded wings. Her function in the hive is one of production. She is normally the only reproductive female in the colony. Egg-laying begins in early spring, initiated when the first fresh pollen is brought home by the workers. Egg production will continue until fall, or as long as pollen is available. At the height of her productivity, the queen could lay as many as 2000 eggs each day. A queen bee can live for up to five years, but her period of usefulness rarely exceeds two or three years. Younger queens produce many more eggs, and older ones may produce excessive drones. Many beekeepers re-queen their colonies every year or two. Older queens are often superseded (replaced) by the workers without any assistance, or even knowledge, of the beekeeper. Good quality queens can be reared by an experienced beekeeper, but a beginner will usually do better to buy good queens from a reputable producer.

Queen bees also produce a pheromone known as **queen substance** . This mixture of chemicals is passed individually from bee to bee throughout the entire hive as they share food. If a queen bee is removed from a colony, the workers will notice her absence within several hours because of the drop in the level of this pheromone. This queenless state quickly initiates the urge to rear a new "emergency" queen from the youngest available larvae (1-3 days old). The presence of this pheromone also inhibits the development of the workers' ovaries. After a period of queenlessness, some may become laying workers. Workers also evaluate their queen based on the quantity of the pheromones she produces. If workers begin to receive an insufficient dose each day, they may perceive her as poor quality, and begin making preparations to supersede her. Beekeepers often mark the queen's thorax with a dot of paint to make her easy to find, and to determine if she has been replaced.



Workers are the smallest of the bee castes, but are by far the most numerous. All workers are female, and normally incapable of reproduction. They are unable to mate, but in a hopelessly queenless colony, workers may begin to lay unfertilized eggs, which develop into drones. Workers do all of the necessary tasks within a colony. They secrete the wax used in the hive, and form it into honeycombs. They forage for all of the nectar and pollen brought into the hive, and transform the nectar into honey. They produce royal jelly to feed to the queen and young larvae. They also tend to the needs of the larvae and queens. They cap the cells of mature larvae for pupation and remove debris and dead bees from the hive. Worker bees defend the hive against intruders and maintain optimal conditions by heating, cooling and ventilating the hive. Workers have well-developed compound eyes on the sides of their heads, and three simple eyes (ocelli) at the vertex. Their tongue is well developed and elongated for taking up nectar from flowers.

Workers reared in the spring and early summer tend to live for five to six weeks. The first two weeks of their lives is spent as house bees, doing tasks in the hive. The remainder of their time is spent as field bees, foraging for food outside the hive. Workers that reach maturity in the late fall may live well into the following spring. They must maintain a cluster of bodies around the queen bee, keeping her warm through the winter months. Later, when egg-laying resumes, they must raise the first generation of young bees the next year.



Drones are the male honey bees. They are visibly larger and stouter than workers. They possess large distinctive eyes that meet on the top of their heads, and have antennae slightly longer than the workers or queen. Their mouth parts are generally reduced. Drones develop from unfertilized eggs, and drone cells are visibly larger than those of workers. Drones do not tend the brood, produce wax, or collect pollen or nectar. They will feed themselves directly from honey cells in the hive, or beg food from worker bees.

The only function of a drone is to fertilize a young queen bee. They are reared chiefly in the spring and summer, beginning about four weeks before new queens are produced, thus ensuring that ample drones will be available to mate with emerging queens. Their day is typically divided between periods of eating and resting, and patrolling mating sites known as **drone congregation areas** . Drone production will cease in the late summer, as the quantity of available food declines. Before winter, the drones are usually driven out of the hive by workers, who guard against their return. A colony that has lost its queen may develop laying workers, who can produce only drones. When this occurs, the colony is effectively doomed. The production of many drones, therefore, will be their final effort to pass on the colony's genetic line by mating with a virgin queen from another colony.

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Races of Honey Bees

Around 20,000 species of bees have been described in the superfamily Apoidea. These all share a number of common traits that are unique to bees, and separate them from the rest of the Hymenoptera. While ants and wasps are carnivorous in at least some stage of their life cycle, bees are completely herbivorous, deriving all of their nutrition from the pollen and nectar of flowers (an exception to this is when, under nutritional stress, worker bees may kill and consume bee larvae, thus conserving the protein). The anatomy of the bee is superbly adapted for the collection of their food from flowers.

Multiple species of bees are kept around the world. In some tropical regions of Africa, Australia, and the Americas, native stingless bees are kept for honey production. In Asia several species of *Apis* are utilized by people. But the western honey Bee, *Apis mellifera*, is the most common bee kept for honey and pollination around the world. Originating in Africa, the western honey bee spread across the entire continent and into Europe and the Middle East, occupying environmental niches. Over centuries in isolation, distinct races, or sub-species, of *Apis mellifera* adapted to specific regions and climates, and acquired recognizable differences in behavior, appearance, and disposition.

Numerous races of the honey bee are recognized, and have been kept by people in many cultures throughout history. Each of the races of has genetic traits that are potentially desirable for beekeeping, such as honey production or disease resistance, and they may possess other traits that are less desirable, such as susceptibility to disease, or a highly defensive temperament. All of these races of honey bee are sub-types of a single species, and are capable of successfully interbreeding, resulting in hybrid bees types.

While honey hunting for wild bees' nests was probably common throughout the ancient world, the Egyptians were among the first to attempt keeping bees in artificial hives. Barges loaded with colonies of *Apis mellifera* lamarkii would travel up and down the Nile River, following the seasonal abundance of flora. As beekeeping methods spread, most ancient cultures are known to have kept the bees that were endemic to their regions. As Europeans explored and colonized other parts of the globe, they have transported and established the western honey bee on every continent except Antarctica. These bees adapted and thrived in many places while in others, they succumbed to parasites and diseases originally adapted to other bee host species. In the early 1600s, English colonists brought hives of *Apis mellifera* mellifera to the Jamestown settlement. These bees thrived in the old growth forests of the New World, and spread west in advance of the pioneers. These bees were said to be easily excitable, "runny" on the combs, and susceptible to some diseases, however they overwintered well in cold climates. In the mid-19th century, the Italian race of bees, *Apis mellifera* lingustica, was imported to the U.S. and became the most popular race of domestic honey bee due to a gentle disposition and high honey production.

Bees adapted to conditions in Europe faced fewer predators than those in Africa. The cold winters of northern Europe encouraged bees to gather excess honey for winter food, and forced the bees to develop their overwintering strategy of clustering for warmth. These traits helped the honey bees to thrive in North America, but when they were imported to South America, they did not fare as well in the tropical environment. In an attempt to breed a productive honey bee that was adapted to a tropical climate, Brazilian scientists in 1956 imported colonies of *Apis mellifera scutellata* from Tanzania. In 1957, some of the bees escaped and bred with populations of European honey bees in Brazil. These hybrids became known as **Africanized honey bees** (AHB) and thrived in the tropical environment. They quickly spread and have since moved through Central America and Mexico, effectively replacing most of the European bee stock in these regions. In 1990 the first AHBs were detected in Texas. In 2005 they had entered Arkansas. Re-queening colonies with bees of known gentle European stock will be essential in maintaining beekeeping in Arkansas with the arrival of the AHB.

Many races and hybrids of European honey bees are available for purchase in the U.S. There is no "perfect" honey bee for all locations, but the mixtures of traits that each type possesses can help the beekeeper choose a variety that may do well in a particular climate. Because honey bee stocks are constantly transported around the U.S. for sale and for pollination of crops, and because the mating behavior of honey bees takes place far outside of the hive, maintaining pure strains of any line of bees is practically impossible without instrumental insemination techniques or extremely isolated bee yards. The table at right compares some of the general characteristics associated with some of the common races of honey bees.

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Anatomy of a Worker Honey Bee

The honey bee is an elegant creature, and a blend of aesthetics and functionality. Nearly every aspect of a honey bee's body and many of its behaviors are perfectly adapted for its role as a pollinator. (Photo by Jon Sullivan, pdphoto.org)

Wings

The ability to fly far and fast has greatly contributed to the success of bees. They can forage up to three miles from their hives, and reach speeds of 15 miles per hour. Bees have four wings, but a row of small hooks, called hamuli, on the leading edge of the hindwing fits securely into a groove on the trailing edge of the forewing, allowing the bee to couple the wings together into a single flight surface. When at rest, the bee can unhook its wings and fold them back. (Photo by Jon Sullivan, pdphoto.org)

Compound eyes

Each of a honey bee's compound eyes contain over 6500 separate facets, allowing it to see in front, to the side, above and below itself. In addition, bees can perceive all the colors visible to humans except for red, which appears black to them. Honey bees, like many other insects, can see UV light as a separate color, which we cannot. Bees can also detect the polarization of UV light, which aids their navigation on cloudy days, when the sun is not visible in the sky. Bees also have three simple eyes, called ocelli, that are grouped together near the top of the head. These are sensitive to light, but cannot focus an image, and are likely used to orient to light. (Photo by Scott Bauer, USDA)

Antennae

A bee's antennae are covered with thousands of sensory cells for touch and smell. A bee's sense of smell is much more acute than any mammal's and is very important locating food and in communication between hive members. These sensitive organs also relay information about air speed and orientation during flight.

Branched setae

The bee's body is covered with branched setae, or feathery hairs. Pollen grains stick to these hairs as the bees forage on flowers. Some of the pollen is transferred to new plants, resulting in fertilization of the flowers. The rest is later combed into the pollen basket, and carried back to the hive. Most insects have some setae on their bodies, which aid in their sense of touch, but these finely branched hairs are unique to the bees. (Photo by Petr Kratochvil, www.publicdomainpictures.net)

Legs

The bee's six strong legs provide a very stable base for walking or standing, ensuring that at least three feet can contact the surface at all times when moving. Each foot is equipped with claws for grabbing uneven surfaces, as well as a sticky pad for gripping smooth surfaces. Each pair of legs is also equipped with special structures and arrangements of setae for grooming the body or pollen and debris.
(Photo by Scott Bauer, USDA).

Pollen basket

The pollen basket, or corbicula, is made of long stiff hairs that curve around a wide flattened section of the honey bee's back leg. Stiff hairs on the other legs are used to comb pollen grains from the bee's body, which is compacted and stored in the pollen basket for transport back to the hive. (Photo by Scott Bauer, bugwood.org)

Proboscis

The honey bee has a long tongue, or proboscis, which it uses to lap up nectar from deep inside of flowers. (Photo by Rose-Lynn Fisher)

Wax glands

Wax glands on the underside of the bee's abdomen secrete flakes of beeswax, which is used to build the honeycombs. Many bees work together to produce and form the wax that becomes their home. Bees must consume at least eight pounds of honey in order to metabolize one pound of wax. (Photo by Zack Huang, cyberbees.net)

Mandibles

These mouthparts, or mandibles, are strong and very useful. The jaws are attached to powerful muscles, and can be used to pick up and remove debris from the hive, to attack intruders, and to delicately manipulate the wax into perfectly formed honeycombs. (photo by Charles Krebs)

Warning colors

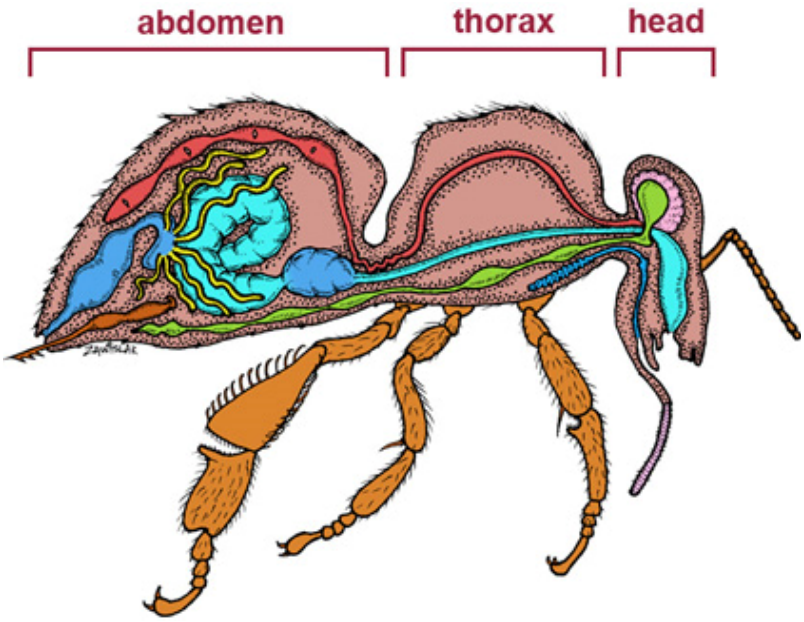
Yellow and black stripes are nature's warning colors. Like many wasps and bees, these highly visible markings warn other animals that the insect can be dangerous. Many harmless flies have adopted these colors as well, to fool predators into thinking they may be able to sting. (Photo by Jon Sullivan, pdphoto.org).

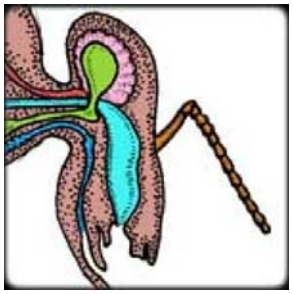
Stinger

The stinger is used by the bee only for defense. The end is barbed, like a fish hook, so it can penetrate skin, but not easily come out. When a bee stings, its stinger and attached venom sac is torn from her abdomen, and she will die shortly afterward. Honey bees are not naturally aggressive, and are reluctant to sting unless they feel that they, or their nest, are threatened. The shaft of the stinger is a modified ovipositor (egg-laying structure), and is therefore only found in worker bees. The queen bee's ovipositor is not barbed, and is used for egg-laying, but she can sting rival queens and occasionally will sting a careless beekeeper if she is mishandled. (Photo by Scott Bauer, USDA)

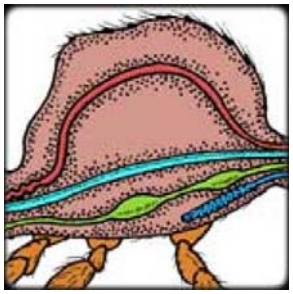
Internal Anatomy of a Honey Bee

Like all insects, a honey bee's body is divided into 3 segments: the head, thorax, and abdomen (illustration by Jon Zawislak).

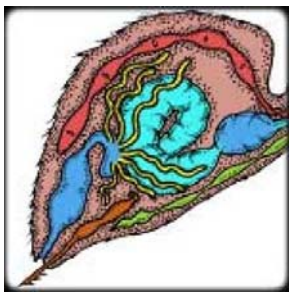




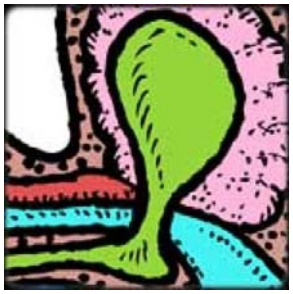
The **head** is dominated by large compound eyes, sensitive antennae and a complex arrangement of mouthparts. The bee's head also houses the brain and contains several important glands.



The **thorax** is primarily used in locomotion, as the attachment site for six legs and four wings. The ventral nerve cord, heart and esophagus pass through, but most of the space inside the thorax is taken up by sets of powerful flight muscles. Salivary glands are located ventrally, near the front of the thorax, connecting by a duct to the oral cavity in the head.



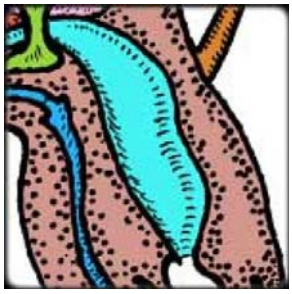
The **abdomen** protects the organs for the digestive system. Also present are the heart, venom sac, and several glands. The reproductive organs are also located in the abdomen. In a laying queen bee, the ovaries take up much of the space here, and account for the larger size of the abdomen. Among the sterile worker caste, however, these remain undeveloped.



The **brain** appears dominated by the optic lobes, which process the visual input from the large compound eyes. Honey bees also have excellent memory processing and learning abilities, necessary for long foraging flights away from their hives. The brain coordinates and regulates the functions of all the bodily systems. While only about 1 cubic millimeter in size, the honey bee's brain contains some of the most densely-packed neuropil tissue known in any animal brain.

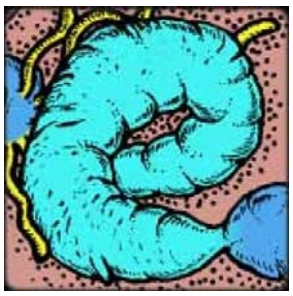
The **ventral nerve cord** runs the length of the bee's body, connecting the brain with all the other organs and systems. Numerous ganglia along the way assist in coordinating local neural processing.

Worker bees possess a **hypopharyngeal gland** that produces royal jelly, or bee milk. This rich blend of proteins and vitamins is fed to all bee larvae for the first three days of their lives, after which workers and drones are fed a mixture of pollen and honey. When a female larva is fed continuously on royal jelly, she will rapidly develop into a queen bee. This nutritious diet will remain the only food that a queen will ever consume, allowing her to maintain a high level of continuous egg production.



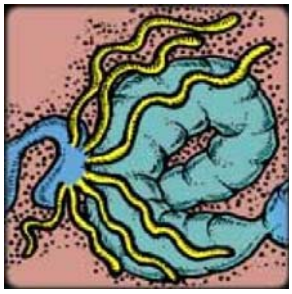
The **pharynx** is the first section of the alimentary canal. Strong muscles here provide suction to draw in nectar from flowers. This is also the site for taste reception in insects.

The **honey crop** (also called the honey stomach) is where the worker bee stores collected nectar for the trip back to the hive without digesting it. A muscular valve called the proventriculus can be closed, keeping the nectar from passing into the stomach. The crop is expandable, allowing the bee to carry a larger load. Back in the hive, the contents of the crop can be ejected back through the mouth for storage in a honey cell or to feed other bees by trophallaxis.

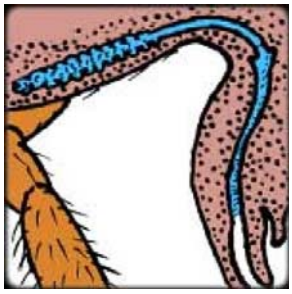


The true **stomach** (or ventriculus) is the site of primary digestion for pollen and nectar. Coiled around in the abdomen, it is actually about twice the length of the bee's body. The epithelial cells that line the stomach wall are the site of attack by the microsporidia Nosema.

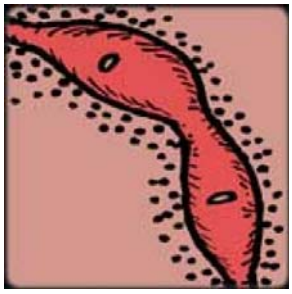
The **hind gut** is composed of the intestine and rectum, where reusable metabolic products are reclaimed and excess water is reabsorbed into the body. The rectum is also distensible, and can hold a large volume of waste matter. Bees keep meticulously clean nests, and will hold their wastes until they can make a "cleansing flight" outside of the hive. In climates with long, cold winters, bees can actually wait for weeks or months to perform this task.



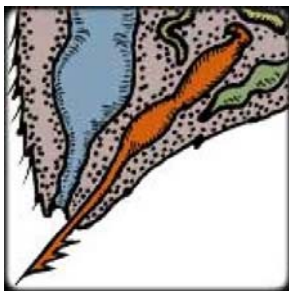
Numerous **Malpighian tubules** connect to the basal end of the hid gut and float freely in the abdominal cavity. They function much like the kidneys of vertebrates, removing excess salts and metabolic wastes from the blood and concentrating it into the intestine, where it can be removed.



Salivary glands are located in the front of the thorax, and connected to the mouth by a duct. This gland produces enzymes which aid in the breakdown of food. In particular, an enzyme called invertase is released, which functions to break down the sugars in nectar, and is essential to the process of converting it into honey.



An insect's **heart** is simply a series of musculated chambers connected the aorta, a tube that runs forward to the head. When relaxed, blood from the abdominal cavity enters the heart chambers through openings called ostioles. When it contracts, the ostioles close, and blood is forced forward through the aorta to the brain, and then circulates back through the thorax, bathing all the organs and muscle tissues along the way. This type of open circulatory system is well well-suited for a small insect.



Connected to the stinger is a **venom sac**, which holds a mixture of protein chemicals (the venom) and alarm chemicals. These proteins can quickly cause a painful localized reaction in vertebrates, which can be severe to life-threatening in highly sensitive individuals. When a bee stings, the barbed shaft of the stinger is left behind, along with the venom sac. An attached muscle continues to pump venom through the stinger, even after it has been disconnected from the bee. For this reason, a bee stinger should be removed immediately by scraping it with a credit card or pocket knife blade, and not by pinching it, which can forcibly inject the venom into the skin.

The antennae are important sensory organs for the bee, which must remain clean in order to function effectively. Each of bee's front legs is equipped with an **antenna cleaner**. This specialized notch is lined with numerous fine, stiff setae. As the shaft of the antenna is drawn through, debris is removed. The tibial spur on the front legs helps to hold the antenna against the notch.

The **tibial spur** of the middle legs can be used to stab the fresh wax flakes secreted by glands on the lower abdomen. The wax can then be transferred to the mandibles where it is be shaped and positioned on the comb.

The **pollen press** is located just below the pollen basket on the hind legs. As pollen is combed from the rest of its body, the bee uses this leg joint to compress the grains into a dense mass, which can be more efficiently stored in the corbicula.

For further reading, **The Anatomy Of The Honey Bee** by **R.E. Snodgrass** is now available online in the Google Book archive.

For detailed video lessons on honey bee structure visit the **Understanding Bee Anatomy website** .

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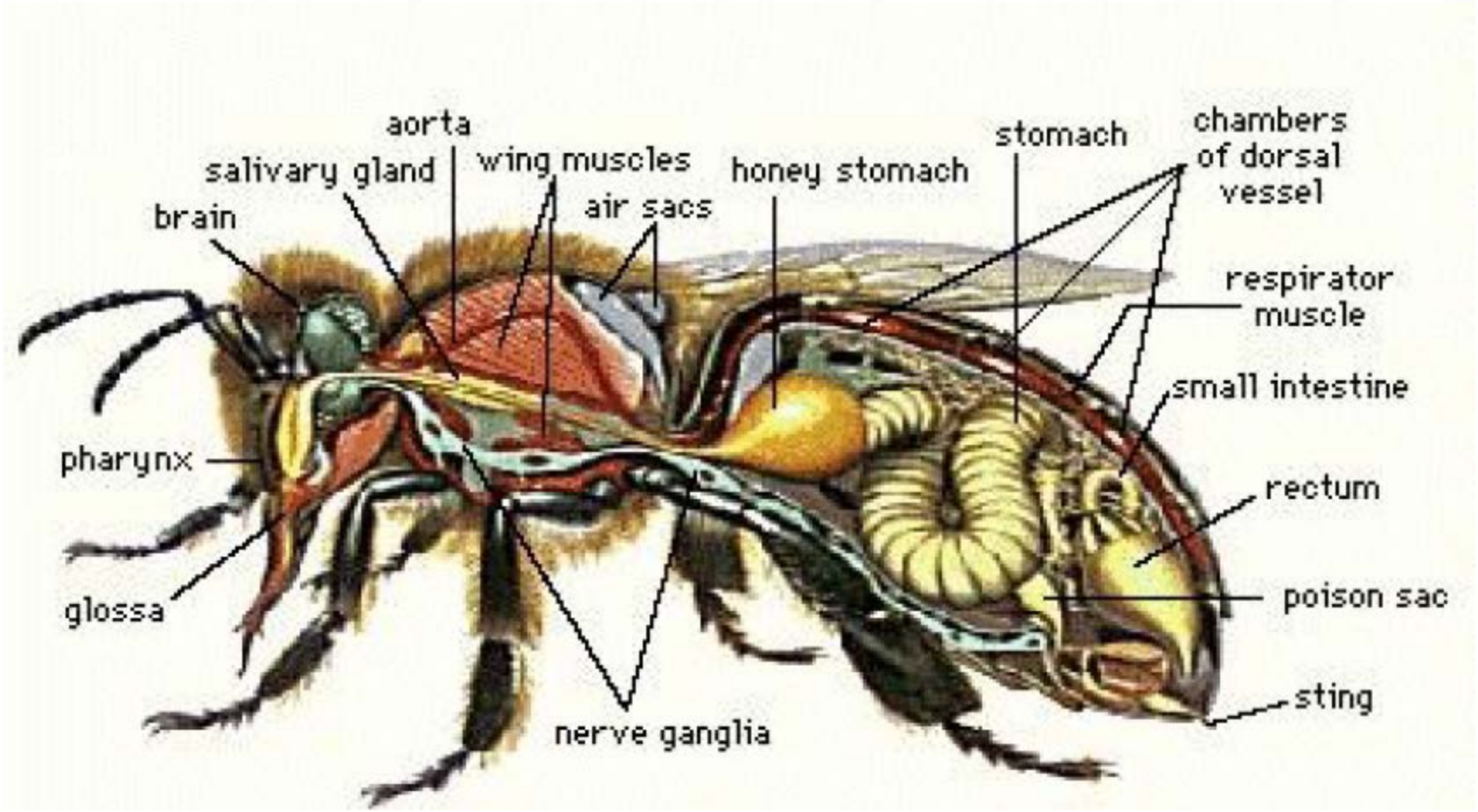
Anatomy Of A Honey Bee



INFORMATION SHEET 1

Bee Basics

Bees may not have a good reputation because of their ability to sting, but many are important and beneficial. Honey bees are the bees with the best public image. 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. Here we will discuss some basic facts and history about bees.

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. The desert regions of northern Mexico and southern Arizona have the richest diversity of bees found anywhere in the world. Although there is no exact count, a bee scientist at the USDA Carl Hayden Bee Research Center says there are between 1,000 and 1,200 species of bees within 100 miles of Tucson!

You may wonder how this can be true. It turns out that not all bees are social bees that live in large families like bumble bees and honey bees. Most are less well-known bees called solitary bees, for example carpenter bees, leafcutter bees, alkali bees, digger bees or sweat bees. Female solitary bees build their own nests and provide food for only their own offspring. All bees collect pollen and nectar, and many of the solitary species are essential because they pollinate plants ignored by honey bees.

What we call honey bees are represented by eight to 10 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 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.

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 all of the same species, bees from one race can mate with bees from another race, creating even more variation within the honey bee universe. Caucasian bees (*A. mellifera caucasica*) are known to be extremely docile, whereas the black or German bees (*A. mellifera mellifera*) are known to overwinter well in severe climates. The African group of bees includes not only the largest number of geographic races (12), but also some of the best known, such as the notorious *A. mellifera scutellata.* It was a few queens of this highly defensive race that were brought into Brazil in 1957 and started the bees we now know as "Africanized honey bees."

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*.

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 travelled 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.

In Brazil and other tropical areas, the introduced honey bees did not survive as well as they did in temperate climates. In an effort to improve honey production in the tropics, a scientist began some breeding experiments using some of the common European honey bees and crossing them with the *A. mellifera scutellata* bees. This Africanized mixture proved to have the highly defensive behavior of the African race. In 1957 some of the bees escaped, and they have been slowly spreading northwards ever since. Africanized honey bees reached Arizona in 1993.

More than 211,000 beekeepers maintain about 3.2 million honey bee colonies in the United States. Beekeepers often use their bees for pollination of crops rather than for honey production. In fact, one third of our food production is the direct result of pollination by insects. So, although we will have to be more cautious of honey bees in the future, they will remain an important part of our environment.

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INFORMATION SHEET 2

The Honey Bee Body

Honey bees have many characteristics common to all insects. Insects have a hard outer covering called an exoskeleton, rather than an internal skeleton like vertebrates. The exoskeleton, which is made of a material called chitin, helps to protect the internal organs of the insect and helps prevent desiccation (drying out). In order to grow, the insect must shed the exoskeleton.

Insects have three body regions: the head, thorax and abdomen. The head contains the sensory organs, and appendages for ingestion. The thorax contains the appendages for locomotion, the legs and wings. The abdomen contains the organs for digestion and reproduction.

Honey Bee Anatomical Characteristics

Abdomen. The honey bee abdomen is composed of nine segments. The wax and some scent glands are located here in the adult. The sting is contained in a pocket at the end of the tapering abdomen in adult females.

Antenna(e). The form of the antenna in insects varies according to its precise function. The antennae are feathery in male moths, elongated in the cockroach, short and bristle-like in the dragonfly, and bead-like in the termite. In honey bees, the segmented antennae are important sensory organs. The antennae can move freely since their bases are set in small socket-like areas on the head. Each of the antennae are connected to the brain by a large double nerve that is necessary to accommodate all of the crucial sensory input. The tiny sensory hairs on each antenna are responsive to stimuli of touch and odor.

Eye(s). Honey bees and people do not see eye to eye. Although honey bees perceive a fairly broad color range, they can only differentiate between six major categories of color, including yellow, blue-green, blue, violet, ultraviolet, and also a color known as "bee's purple," a mixture of yellow and ultraviolet. Bees can not see red. Differentiation is not equally good throughout the range and is best in the blue-green, violet, and bee's purple colors.

Like most insects, honey bees have compound eyes that are made up of thousands of tiny lenses called facets. Scientists think that each facet in a compound eye takes in one small part of the insect's vision. The brain then takes the image from each tiny lens and creates one large mosaic-like picture. This image is somewhat analogous to the image produced on a television screen, in which the "picture" is essentially a grid composed of dots of light. The advantage of the compound eye is its ability to detect movement. Honey bees can easily differentiate between solid and broken patterns, but show a preference for broken figures. Related to this, bees respond more readily to moving flowers than to stationary ones. Therefore, their eye is better adapted for movement perception than for form percep tion.

Honey bees also have three smaller eyes in addition to the compound eyes. These simple eyes or "ocelli" are located above the compound eyes and are sensitive to light, but can't resolve images.

Head. The honey bee head is triangular when seen from the front. The two antennae arise close together near the center of the face. The bee has two compound eyes and three simple eyes, also located on the head. The honey bee uses its proboscis, or long hairy tongue, to feed on liquids and its mandibles to eat pollen and work wax in comb building.

Leg(s). The honey bee has three pairs of segmented legs. The legs of the bee are prima rily used for walking. However, honey bee legs have specialized areas such as the anten nae cleaners on the forelegs, and the pollen baskets on the hind legs.

Mandible(s). T he honey bees have a pair of mandibles located on either the side of the head that act like a pair of pliers. The mandibles are used for any chores about the hive that require grasping or cutting, such as working wax to construct the comb, biting into flower parts (anthers) to release pollen, carrying detritus out of the hive, or gripping enemies during nest defense.

Proboscis. The proboscis of the honey bee is simply a long, slender, hairy tongue that acts as a straw to bring the liquid food (nectar, honey and water) to the mouth. When in use, the tongue moves rapidly back and forth while the flexible tip performs a lapping mo tion. After feeding, the proboscis is drawn up and folded behind the head. Bees can eat fine particles like pollen, which is used as a source of protein, but cannot handle big particles.

Pollen Basket(s). A smooth, somewhat concave surface of the outer hind leg that is fringed with long, curved hairs that hold the pollen in place. This enclosed space is used to transport pollen and propolis to the hive. Also called a corbicula.

Pollen Press. Once the bees have gathered the pollen, they move it to the pollen press located between the two largest segments of the hind leg. It is used to press the pollen into pellets.

Rakes and Combs. Structures on the legs used to collect and remove pollen that sticks to the hairy bodies of honey bees.

Stinger. The stinger is similar in structure and mechanism to an egg-laying organ, known as the ovipositor, possessed by other insects. In other words, the sting is a modified ovipositor that ejects venom instead of eggs. Thus, only female bees can have a stinger.

The sting is found in a chamber at the end of the abdomen, from which only the sharp -pointed shaft protrudes. It is about 1/8-inch long. When the stinger is not in use, it is re tracted within the sting chamber of the abdomen. The shaft is turned up so that is base is concealed. The shaft is a hollow tube, like a hypodermic needle. The tip is barbed so that it sticks in the skin of the victim. The hollow needle actually has three sections. The top section is called the stylet and has ridges. The bottom two pieces are called lancets. When the stinger penetrates the skin, the two lancets move back and forth on the ridges of the

stylet so that the whole apparatus is driven deeper into the skin. The poison canal is en closed within the lancets.

In front of the shaft is the bulb. The ends of the lancets within the bulb are enlarged and as they move they force the venom into the poison canal, like miniature plungers. The venom comes from two acid glands that secrete into the poison sac. During stinging, the contents of the alkaline gland are dumped directly into the poison canal where they mix with the acidic portion.

When a honey bee stings a mammal, the stinger becomes embedded. In its struggle to free itself, a portion of the stinger is left behind. This damages the honey bee enough to kill her. The stinger continues to contract by reflex action, continuously pumping venom into the wound for several seconds.

Thorax. The thorax is the middle part of the bee and is the anchor point for six legs (three pair), as well as two sets of membranous wings in the adult. Pollen baskets for carrying pollen back to the hive are located on the hind legs.

Wax Gland(s). Four pairs of glands that are specialized parts of the body wall, which during the wax forming period in the life of a worker, become greatly thickened and take on a glandular structure. The wax is discharged as a liquid and hardens to small flakes or scales and sits in wax pockets. The worker bee draws the wax scales out with the comb on the inside hind leg. The wax scale is then transferred to the mandibles where it is chewed into a compact, pliant mass. The beeswax is then added to the comb. After the worker bee outgrows the wax forming period, the glands degenerate and become a flat layer of cells.

Wing(s). The honey bee has two sets of flat, thin, membranous wings, strengthened by various veins. The fore wings are much larger than the hind wings, but the two wings of each side work together in flight. Just flapping the wings does not result in flight. The driv ing force results from a propeller-like twist given to each wing during the upstroke and the downstroke.

INFORMATION SHEET 3

Honey Bee Biology

The following is a discussion of the members of a honey bee colony, their development and their duties within the colony.

The vast majority of adult honey bees in any colony are female **worker** bees. The jobs of the worker bees are: tending and feeding young bees (larvae), making honey, making royal jelly and beebread to feed larvae, producing wax, cooling the hive by fanning wings, gathering and storing pollen, nectar and water, guarding the hive, building, cleaning and repairing the comb, and feeding and taking care of the queen and drones. In part, the job the worker honey bee performs on any given day depends on its age.

As insects, honey bees pass through four distinct life stages: the **egg**, **larva**, **pupa** and **adult**. The process is called complete metamorphosis, which means that the form of the bee changes drastically from the larva to the adult. Passing through the immature stages takes 21 days for worker bees. On the first day, the queen bee lays a single egg in each cell of the comb. The egg generally hatches into a larva on the fourth day. The larva is a legless grub that resembles a tiny white sausage. The larva is fed a mixture of pollen and nectar called **beebread**. On the ninth day the cell is capped with wax and the larva transfor ms into the pupa. The pupa is a physical transition stage between the amorphous larva and the hairy, winged adult. The pupa doesn't eat. On day 21, the new adult worker bee emerges.

The male members of the colony, the **drones**, are somewhat larger and make up only about five percent of the hive population. Drones are fed **royal jelly**, and develop in a slightly larger cell than worker bees from unfertilized eggs. Drones remain in the pupal stage for 15 days, so they don't emerge until day 24. Drones have huge compound eyes that meet at the top of their head and an extra segment in their antennae. In comparison to worker bees, drones have wider bodies and their abdomens are rounded rather than pointed. Drones, like all other male bees and wasps, do not have stingers.

There is only one **queen** in a honey bee colony. She is slightly larger than a worker bee, with a longer abdomen. She does not have pollen baskets on her legs. Eggs destined to become queens are laid in a larger cell, and the larvae are fed only royal jelly. The adult queen's sole duty is to lay eggs, up to 2,000 a day! She is fed by the workers and never leaves the hive except to mate.

Queen bees also have stingers and use them in battles with each other for dominance of the colony. If a new queen emerges from her incubation cell and is detected by the current queen, the "old lady" often goes over and kills her rival. In this way, the stability of the colony is maintained. When a queen gets old or weak and slows her production of queen substance, she is generally replaced by a new queen. New queens are also produced in colonies about to swarm.

Virgin queen bees take what is known as a "**nuptial flight**" sometime within the first week or two after emerging from the pupal chamber. The new queen flies out of the hive and begins to produce a perfume-like substance called a "**pheromone**." The drones in the area are attracted to the pheromone and the queen will mate with as many as 20 of them. After mating, the drones die.

Once the queen has mated, she heads back to the hive to start laying eggs in beeswax chambers that the workers have created especially for this purpose. A queen can lay her own weight in eggs every day and, since she can maintain the sperm she has collected for her lifetime in a special pouch in her body, she can continue laying eggs indefinitely. The fertilized eggs laid by a queen become female worker bees and new queens. The queen also lays some unfertilized eggs, which produce the drones. Since they come from unfertilized eggs, the drones carry only the chromosomes of the queen.

The drones could be called the couch potatoes of the insect world. While they wait for an opportunity to mate with a virgin queen, they are fed and cared for by workers, and only occasionally fly out of the hive to test their wings. If no opportunity to mate arises by fall, the drones are ejected from the nest by the workers and left to fend for themselves.

On average, queen bees live for about a year-and-a-half, although some have been known to survive for up to six years. While she is alive and active, the queens are constantly cared for by workers acting as attendants. In cases where a queen dies prematurely and the colony had no new queen to replace her, some worker bees develop the ability to lay eggs but, because they cannot mate, they produce only drones and the colony eventually perishes.

When the colony starts to become too crowded, some of the bees split off to form a new colony. This is called **swarming**. First the eggs for new queens are laid in their special larger cells. "Swarming" occurs when part of the colony breaks off with the old queen and flies off looking for another place to call home. The bees engorge themselves on their honey reserves before leaving so as to have sufficient energy to make it to a new location. There can be multiple swarms from one hive, since new queens can also emerge and fly off with part of the worker force.

A honey bee swarm in a tree.

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The Different Types of Honey Bees

Introduction

Honey bees, like all other living things, vary among themselves in traits such as temperament, disease resistance, and productivity. The environment has a large effect on differences among bee colonies (for example, plants in different areas yield different honey crops), but the genetic makeup of a colony can also impact the characteristics that define a particular group. Beekeepers have long known that different genetic stocks have distinctive characteristics, so they have utilized different strains to suit their particular purpose, whether it be pollination, a honey crop, or bee production.

What Is a Bee Stock?

The term “stock” is defined as a loose combination of traits that characterize a particular group of bees. Such groups can be divided by species, race, region, population, or breeding line in a commercial operation. Many of the current “stocks” in the United States can be grouped at one or more of these levels, so the term will be used interchangeably, depending on the particular strain of bees in question.

Wide variation exists within stocks as well as among them. Any generalities about a particular stock should be treated with caution, since there are always exceptions to the rule. Nonetheless, the long and vast experience of beekeepers allows some oversimpli- fications to be made in order to better understand the different types of bees available. The following is a brief overview of some of the more common commercially available honey bee stocks in the United States.

	Italian	***German***	***Carniolan***	***Buckfast***	***Caucasian***	***Russian***
Color	Light	Dark	Black	Medium	Dark	Gray
Disease resistance						
Varroa	-	-	-	-	-	+
Tracheal	-	-	-	+	0	+
*AFB**	0	-	+	0	0	0
*EFB***	0	0	0	0	0	0
Other	0	0	+	+	-	0
Gentleness	Moderate	Low	High	Low-Mod	High	Low-Mod
Spring buildup	Good	Low	Very good	Low	Very low	OK
Over-wintering ability	Good	Very good	Good	Good	OK	Very good
Excess swarming	OK	OK	High	Low	Low	OK
Honey processing	Very good	OK	Good	Good	Low	OK
Propolis	Low	OK	Low	Low	High	OK
Other traits	Heavy robbing	Short tongue, nice white cappings	Low robbing, good comb builders	Supersedure queens produce defensive colonies	Long tongue	Brood rearing affected by flow, queen cells always present

	Italian	*German*	*Carniolan*	*Buckfast*	*Caucasian*	*Russian*
* AFB = America foulbrood ** EFB = European foulbrood						

The Italian Bee

Italian honey bees, of the subspecies Apis mellifera ligustica, were brought to the United States in 1859. They quickly became the favored bee stock in this country and remain so to this day. Known for their extended periods of brood rearing, Italian bees can build colony populations in the spring and maintain them for the entire summer. They are less defensive and less prone to disease than their German counterparts, and they are excellent honey producers. They also are very lightly colored, ranging from a light leather hue to an almost lemon yellow, a trait that is highly coveted by many beekeepers for its aesthetic appeal.

Despite their popularity, Italian bees have some drawbacks. First, because of their prolonged brood rearing, they may consume surplus honey in the hive if supers (removable upper sections where honey is stored) are not removed immediately after the honey flow stops. Second, they are notorious kleptoparasites and frequently rob the honey stores of weaker or dead neighboring colonies. This behavior may pose problems for Italian beekeepers who work their colonies during times of nectar dearth, and it may cause the rapid spread of transmittable diseases among hives.

The German Bee

Honey bees are not native to the New World, although North America has about 4,000 native species of bees. Honey bees were brought to America in the 17th century by the early European settlers. These bees were most likely of the subspecies *A. m. mellifera*, otherwise known as the German or “black” bee. This stock is very dark in color and tends to be very defensive, making bee management more difficult. One of the German bees’ more favorable characteristics is that they are a hardy strain, able to survive long, cold winters in northern climates. However, because of their defensive nature and their susceptibility to many brood diseases (such as American and European foulbrood), this stock lost favor with beekeepers well over a century ago. Although the feral bee population in the United States was once dominated by this strain, newly introduced diseases have nearly wiped out most wild honey bee colonies, making the German bee a rare stock at this time

The Carniolan Bee

The subspecies *A. m. carnica*, from middle Europe, also has been a favored bee stock in the United States for several reasons. First, their explosive spring buildup enables this race to grow rapidly in population and take advantage of blooms that occur much earlier in the spring, compared to other stocks. Second, they are extremely docile and can be worked with little smoke and protective clothing. Third, they are much less prone to robbing other colonies of honey, lowering disease transmission among colonies. Finally, they are very good builders of wax combs, which can be used for products ranging from candles, to soaps, to cosmetics.

Because of their rapid buildup, however, carniolan bees tend to have a high propensity to swarm (their effort to relieve overcrowding) and, therefore, may leave the beekeeper with a very poor honey crop. This stock requires continued vigilance to prevent the loss of swarms.

The Caucasian Bee

A. m. caucasica is a race of honey bees native to the foothills of the Ural mountains near the Caspian Sea in eastern Europe. This stock was once popular in the United States, but it has declined in regard over the last few decades. Its most notable characteristic is its very long tongue, which enables the bees to forage for nectar from flowers that other bee stocks may not have access to. They tend to be a moderately colored bee and, like the Carniolans, are extremely docile. However, their slow spring buildup keeps them from generating very large honey crops, and they tend to use an excessive amount of propolis—the sticky resin substance sometimes called “bee glue” that is used to seal cracks and joints of bee structures—making their hives diffi- cult to manipulate.

The Buckfast Bee

In the 1920s, honey bee colonies in the British Isles were devastated by acarine disease, which now is suspected to have been the endoparasitic tracheal mite Acarapis woodi. Brother Adams, a monk at Buckfast Abby in Devon, England, was charged with creating a bee stock that could withstand this deadly disease. He traveled the world interviewing beekeepers and learning about different bee strains, and he created a stock of bees, largely from the Italian race, that could thrive in the cold wet conditions of the British Isles, yet produce good honey crops and exhibit good housecleaning and grooming behavior to reduce the prevalence of disease. Bees of this stock are moderately defensive. However, if left unmanaged for one or two generations, they can be among the most fiercely defensive bees of any stock. They also are moderate in spring population buildup, preventing them from taking full advantage of early nectar flows.

The Russian Bee

One of the newer bee stocks in the United States was imported from far-eastern Russia by the US Department of Agriculture's Honey Bee Breeding, Genetics, and Physiology Laboratory in Baton Rouge, Louisiana. The researchers' logic was that these bees from the Primorski region on the Sea of Japan, have coexisted for the last 150 years with the devastating ectoparasite Varroa destructor, a mite that is responsible for severe colony losses around the globe, and they might thrive in the United States. The USDA tested whether this stock had evolved resistance to varroa and found that it had. Numerous studies have shown that bees of this strain have fewer than half the number of mites that are found in standard commercial stocks. The quarantine phase of this project has been complete since 2000, and bees of this strain are available commercially.

Russian bees tend to rear brood only during times of nectar and pollen flows, so brood rearing and colony populations tend to fluctuate with the environment. They also exhibit good housecleaning behavior, resulting in resistance not only to varroa but also to the tracheal mite.

Bees of this stock exhibit some unusual behaviors compared to other strains. For example, they tend to have queen cells present in their colonies almost all the time, whereas most other stocks rear queens only during times of swarming or queen replacement. Russian bees also perform better when not in the presence of other bee strains; research has shown that cross-contamination from susceptible stocks can lessen the varroa resistance of these bees.

Other Notable Stocks

Many other honey bee stocks are worth noting:

- The Minnesota Hygienic stock has been selected for its exceptional housecleaning ability, significantly reducing the negative effects of most brood diseases.
- The VSH, or the "Varroa Sensitive Hygiene" stock (used to be named the SMR stock, referring to "Suppression of Mite Reproduction"), also was developed by the USDA honey bee lab in Louisiana by artificially selecting commercial stocks for mite resistance. While not an independently viable stock on its own (because of inbreeding), the VSH trait has been incorporated into other genetic stocks so that these stocks may also express this highly desired characteristic.
- The Cordovan bee is a type of Italian bee that has a very light yellow color, which is more attractive to many beekeepers.

Numerous hybrid stocks are also available commercially:

- The Midnite bee was developed by crossing the Caucasian and Carniolan stocks, hoping to maintain the extreme gentleness of both strains while removing the excessive propolis of the Caucasians and minimizing the swarming propensity of the Carniolans.

- The Starline was developed from numerous strains of the Italian stock by Gladstone Cale of the Dadant Bee Company. It was once favored by commercial beekeepers because of its tremendous honey yields, particularly in clover, but the popularity of this stock has declined in recent decades.
- The Double Hybrid is a cross of the Midnite and the Starline.

Conclusion

While a tremendous amount of variation remains within and among the different bee stocks, some generalities still can be made. Bee differences can be used to advantage by beekeepers, depending on what traits interest them, so using different stocks can be a powerful tool at the beekeeper's disposal. There is no "best" strain of bee, as the traits favored by one beekeeper may differ significantly from another's choice. Thus, it is best for each beekeeper to experience the characteristics of the different bee strains first hand and then form an opinion about which stock best fits his or her situation.

For more information on beekeeping, visit the Beekeeping Notes website (http://entomology.ces.ncsu.edu/apiculture/beekeeping-notes/).

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