



Anatomy Resource Listing

Books

Honey Bee Biology and Beekeeping - Dewey M. Caron, Available from Wicwas Press, www.wicwas.com
Honey Bee Biology and Beekeeping explains bee biology, what bees do, and provides the tools which make it possible for an individual to successfully manage bee colonies. The author has concentrated on the "why" aspects of bee biology so that the reader understands "when" and "how" certain things must be done to colonies. Bees and beekeeping are explained in a manner meaningful to a person who lacks an extensive background or knowledge of biology. Yet the author has not oversimplified bee biology to the point where it is meaningless to the serious beekeeper or informed biologist.

The Biology of the Honey Bee - Mark L. Winston, ISBN: 0674074092

The Biology of the Honey Bee not only reviews the basic aspects of social behavior, ecology, anatomy, physiology, and genetics, it also summarizes major controversies in contemporary honey bee research, such as the importance of kin recognition in the evolution of social behavior and the role of the well-known dance language in honey bee communication. Thorough, well-illustrated, and lucidly written, this book will for many years be a valuable resource for scholars, students, and beekeepers alike.

Bee - Rose-Lynn Fisher, ISBN: 1616890762

Of the ten million or so different species of insects on our planet, none is more fascinating than the honeybee. Magnified hundreds to thousands of times with a high resolution scanning electron microscope, honeybees become architectural masterpieces an elegant fusion of form and function. Now available in paperback, *Bee* presents sixty astonishing photographs of honeybee anatomy in magnifications ranging from 10x to 5000x. Rendered in stunning detail, these photographs uncover the strange beauty of the honeybee's pattern, form, and structure. Comprising 6,900 hexagonal lenses, their eyes resemble the structure of a honeycomb. The bee's six-legged exoskeleton is fuzzy with hairs that build up a static charge as it flies in order to electrically attract pollen. Wings clasp together with tiny hooks, and a double-edged stinger resembles a serrated hypodermic needle. These visual discoveries, made otherworldly through photographer Rose-Lynn Fisher's lens, expand the boundaries of our thinking about the natural world and stimulate our imaginations.

Online Resources

Anatomy and Morphology Photos
http://cyberbee.net/gallery/index.php/anatomy_0

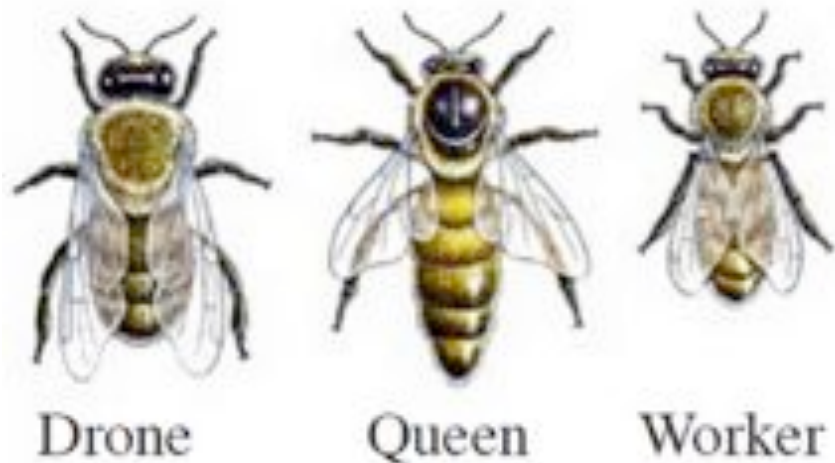


**Orange
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Bee School

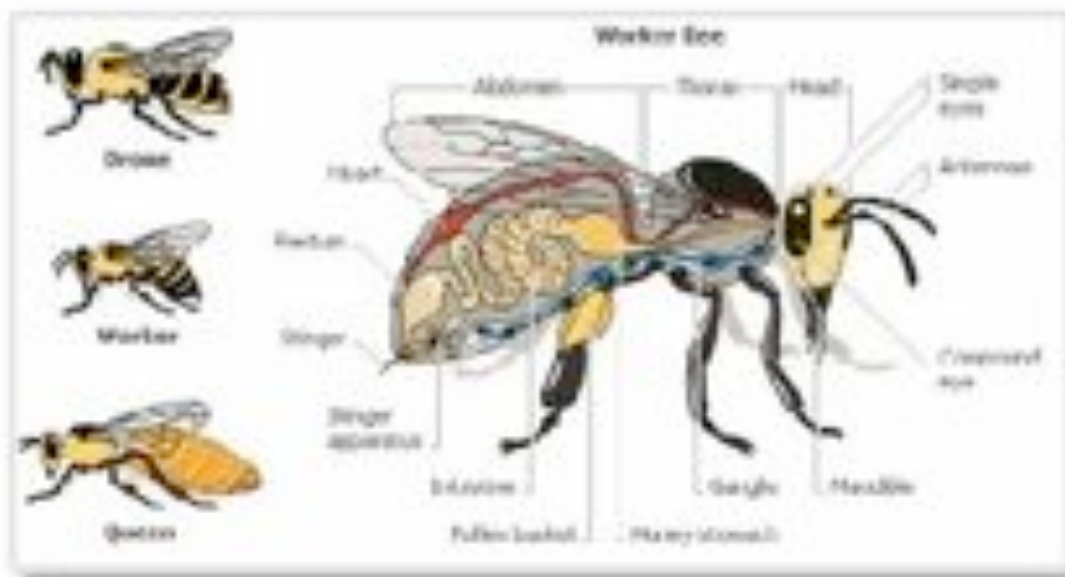
Honey Bees: Anatomy and Life Cycle

Who's Who in the Beehive



The Drone is male and the Queen and Workers are female

Honey Bee Anatomy





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Life-cycle of the Bees





Bee Castes



Worker (left), drone (middle) and mature queen (right). Photo by Zach Huang.

During the summer, a Langstroth hive colony consists of 40 to 60 thousand adult bees. During the winter, a typical hive will have around 20 thousand bees including one queen and few to no drones. Like most living things, bees have two sexes, either female (queen and workers) or male (drones). Within the two sexes, there are 3 castes of bees within any colony: the queen, the drones, and the workers.

The approximate breakdown by caste is:

- * 1 queen.
- * 100 - 300 drones.
- * 26 - 40 thousand in-hive bees (young workers).
- * 13 - 40 thousand foragers (oldest workers).

The brood, comprising of eggs and young is typically:

- * 5 - 7 thousand eggs.
- * 7 - 11 thousand larvae.
- * 16 - 24 thousand pupae.

The queen can lay up to 2,000 eggs a day during the height of the laying season. She does not lay from November through January.



Hive Genealogy

The relationship in any one hive is quite complex with the queen being sister to some and mother to others. With the queen mating with many drones, there are three possible levels of relationship among female siblings: those with the same father are super sisters; those with fathers who are brothers are full sisters; and those with unrelated fathers are half sisters. The result is a hive with varied genetic origins.



Queens

The queen is the only sexually developed female in the hive and is the largest bee in the colony. While the queen decides the sex of her young, workers select which fertilized eggs become queens. In other words, queens and worker bees start out the same, the difference being the larger queen cell accommodates the larger size of the larva and pupa that result from the difference in diet queen larva is fed. While both worker and queen larva are fed royal jelly for the first three days, the queen receives royal jelly for her entire larval stage. Receiving royal jelly during her entire larval stage allows the queen's hormone/pheromone producing glands, and her reproductive organs to develop fully. She is one and a half times larger than a worker, with an elongated abdomen. The queen is fed only royal jelly for her entire life.

Queens are not treated as queens until her pheromone glands become fully functional after successful matings. While queen can mate with up to 40 drones, the average is about 12. The more matings a queen has, the more her pheromones change, and the more acceptable she is to the workers. Orientation flights near the hive,

beginning at about 1 week, allow her to learn the landmarks and strengthen her flight muscles. The stronger her muscles, the longer she can fly, allowing more matings. A queen flies further than drones thus limiting the possibility of inbreeding. If, for whatever reason--such as bad weather, a queen does not mate during her second week as an adult, she will be past the mating age, and the colony will replace her.

Workers push, cling to, and pull on the virgin queen's legs and wings in effort to get her to leave the hive for her maiden flights. The attacks subside when she returns to the hive, but begin again before the next flight. They continue until the queen starts laying eggs.

With only one queen available at a time for maiden flights and with the continued existence of the hive dependant upon her, the queen does not take her maiden flights alone, but is accompanied by a host of worker bees. She is too valuable accomodity to be out in the world on her own. She doesn't know the land marks, plus there is safety in numbers as far as predators are concerned. Almost 100% of virgin queens return safely to the hive.

During April and May, the queen lays day and night, each egg taking about 20 seconds. That's over 2000 eggs a day, more than the body weight of the queen. The queen inspects and measures the size of each cell with her front legs



before deciding to use it. Drone cells are deeper and wider than worker cells. It is the size of the cell that tells the queen whether or not to fertilize the egg she lays in it. While the queen fertilizes the eggs that become workers, it is the workers who guide the queen to the empty cells, and in essence are also responsible for the sex of the brood.

The pheromones produced by the queen have many effects within the colony. Most obvious is the retinue response to her in which the workers lick her and rub their antennae on the queen. It also encourages the workers to feed and groom her. Through this behavior, workers acquire and distribute the queen's pheromones throughout the colony regulating the activities of the hive such as inhibiting reproduction by workers, control swarming and regulate worker tasks critical to colony growth and survival.

Queens can live for 5 years, though they are generally replaced in managed hives every other year as their egg laying capability diminishes over time due to depletion of their sperm bank. Due to pesticide use, she may live as little as 6 months, necessitating vigilance on the beekeepers part.



Drones

Bees raise about 10-15% drone brood. Drone cells are normally found around the edge of the brood pattern as drone larvae is kept at temperature a degree or two cooler than worker larvae. Since drones develop from unfertilized eggs, they have only one set of chromosomes (16), with their genetic characteristics coming solely from their mother. Technically that means they have a grandfather, but no father. Since all sperm cells produced by any one drone are genetically identical, sisters (known as super sisters) are more closely related than full sisters of other animals where every sperm is genetically not identical. In other words, super sister bees would roughly compare to identical twins, and full sister bees to fraternal twins. The drones have two reproductive functions. First they convert and extend the single unfertilized egg from which they develop into about two million genetically identical male sperm cells; secondly they mate with a new queen to fertilize her eggs.

The drone's sole purpose in life is to mate with a queen insuring the survival of the species, and if successful, his reward is death. His sexual organ, which is barbed, is ripped out upon completion of successful mating and he falls to the ground dead. This allows the queen to obtain 100% of the

drone's sperm. A queen will mate several times on each flight. The succeeding drone will remove the apparatus left in the queen by the previous drone before mating. Back at the hive the house bees remove the apparatus left by the last mating of the day.

Drones are not able to mate until about 16 days of age. When drones have reached maturity, they start orientation flights to learn the landmarks near their hive. Drones tend to congregate daily in the afternoons, in packs called comets. Comets can contain anywhere from a few hundred to thousands of drones. The open areas they frequent are called DCAs (drone congregation areas) and the same area can be used year after year by subsequent generations. One DCA at Selbourne in Hampshire, UK was first described in 1789 and still exists today. Drones may embark on as many as 25 flights during their lifetime with each flight lasting from 30 minutes to an hour. They may



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make several flights in an afternoon, flying back to the hive to re-energize on honey. Drones in DCAs tend to fly at certain heights and within certain boundaries. The drone congregation area can range anywhere in size from 100 to 700 feet in diameter and be 30 to 130 feet in the air. Other insects entering the area are chased by drones. While they will also chase anything thrown in the air above them, they will not chase a queen who is outside of the DCA. The number of colonies represented in a DCA has a direct influence on the genetic diversity of the queen's offspring.

While drones are pretty much considered free loaders as they do no work, they are not totally without some benefit to the hive. Their presence may provide an additional sense of well-being in the hive, as some drones may be allowed to over-winter in the hive. All bees, including the drones, will work to bring the hive temperature back within normal hive limits when they sense a deviation in temperature. Another side benefit is the varroa mite prefers the larger drone brood as it guarantees a longer development period for its own offspring. The number of varroa mites can be kept in check by removing the capped drone brood and destroying it either through freezing or heating the brood comb.

While drones produce no wax, perform no in-house chores, do not forage, nor defend the hive (they have no stinger), they are tolerated by the hive only on the off chance a new queen needs a mate. Come fall they are driven from the hive to die either from starvation, predation, or exposure.



Workers

Workers, like the queen, have 2 sets of chromosomes (32), one set (16) from their mother and one set (16) from their father. Workers are the backbone of the hive upon which the welfare of the entire colony depends. They do all the work and attend to all of the queen's needs. The type of work they perform is dependant upon their age. In a normal colony, the bees do the work best fitted to their age, but they can do any work required after they are ten days old. Despite this well established pattern, the age at which specific tasks are performed is extremely flexible, as bees are able to accelerate, delay or reverse their pattern of behavioral development to meet the needs of the colony.

Workers are house bees for the first three weeks of life. Their various duties include maid, nanny, royal attendant, undertaker, heating and cooling specialist, and guard. Another duty that has recently been documented is that of heater bee.

source: http://westmtnapiary.com/bee_castes.html

The Different Types of **HONEY BEES**



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 oversimplifications 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 U.S.

The Russian bee

The Carniolan bee

The Caucasian bee

The Italian bee

The German bee

Italian honey bees, of the subspecies *Apis mellifera ligustica*, were brought to the U.S. 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.

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 U.S. 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 subspecies *A. m. carnica*, from middle Europe, also has been a favored bee stock in the U.S. 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.

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 U.S., 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 difficult to manipulate.

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.

One of the newer bee stocks in the U.S. was imported from far-eastern Russia by the U.S. 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 U.S. 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.

	<i>Italian</i>	<i>German</i>	<i>Carniolan</i>	<i>Buckfast</i>	<i>Caucasian</i>	<i>Russian</i>
<i>Color</i>	Light	Dark	Black	Medium	Dark	Gray
<i>Disease resistance</i>						
<i>Varroa</i>	-	-	-	-	-	+
<i>Tracheal</i>	-	-	-	+	0	+
<i>AFB*</i>	0	-	+	0	0	0
<i>EFB**</i>	0	0	0	0	0	0
<i>Other</i>	0	0	+	+	-	0
<i>Gentleness</i>	Moderate	Low	High	Low-Mod	High	Low-Mod
<i>Spring buildup</i>	Good	Low	Very good	Low	Very low	OK
<i>Over-wintering ability</i>	Good	Very good	Good	Good	OK	Very good
<i>Excess swarming</i>	OK	OK	High	Low	Low	OK
<i>Honey processing</i>	Very good	OK	Good	Good	Low	OK
<i>Propolis</i>	Low	OK	Low	Low	High	OK
<i>Other traits</i>	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

* AFB = American foulbrood
 ** EFB = European foulbrood

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 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 SMR 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 Midnight 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 Midnight and the Starline.
- * The “Smart” strains are crosses between the SMR strain and other stocks, such as Italian, Russian, and Carniolan.

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.

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A Comparison of Russian and Italian Honey Bees

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*American beekeepers have been using Italian honey bees (*Apis mellifera ligustica*) since they were first imported to the New World in 1859. The standard German honey bee (*A. m. mellifera*), which had been in America for more than 200 years, was by that time ill-tempered, disease-ridden, and less suited for honey bee management. Conversely, the Italian bees were and are excellent honey producers, show a gentle temperament that makes them the most popular race of honey bee in North America, have a moderately low tendency to swarm, and have a bright yellow color that makes queens easy to find.*

But Italian honey bees are susceptible to two deadly parasitic mites, the tracheal mite (*Acarapis woodi*) and the varroa mite (*Varroa destructor*), which were introduced into the U.S. in 1984 and 1987, respectively. Colonies contract these mites through equipment sharing and overcrowding, and, once infested, entire colonies can succumb within one or two years. Beekeepers have relied largely on pesticides to control the mites, but many of these

chemicals can contaminate the honey and beeswax in a hive. The mites also are becoming increasingly resistant to the pesticides, making the chemicals less reliable and, eventually, ineffective. The high colony mortality that accompanies these two mites is a serious concern of the bee industry today, and various types of bees are continually being examined with an eye toward finding a hardy, productive stock that can resist them.

Russian Bee Project

Efforts to find a honey bee that is genetically resistant to the varroa and tracheal mites led researchers at the USDA Honey Bee Research Laboratory in Baton Rouge, Louisiana, to Russia. There, on the far eastern side of that vast nation, in the coastal Primorski region around Vladivostok, they found what they sought—a promising strain of *Apis mellifera*. These Russian bees had been exposed to varroa mites for approximately 150 years, much longer than other *Apis mellifera* strains had, and the researchers surmised that the Russian bees could have developed a resistance to the mites. Indeed, subsequent research has shown that these Russian bees are more than twice as resistant to varroa mites than other honey bees. Moreover, they are highly resistant to tracheal mites, the other mortal enemy of bees. Russian bees also tend to produce as much honey as standard bee stocks, if not more.

A number of American queen breeders now produce Russian queens for sale. These breeders are located all across the country, but most are concentrated in the South and in California. Many of the Russian queens on the market are hybrid daughters of a breeder queen openly mated to any drone, which may come from a variety of stocks within two miles of a particular mating yard. The resulting colonies are genetic hybrids. Recent research has suggested the hybrids are only partially resistant to mites, but studies at North Carolina State University show that partial resistance is statistically significant when the hybrids are compared to Italian bees.

Production of pure Russian queens can be guaranteed only by truly isolating the breeding grounds, as has been done at the USDA's bee laboratory on Grand Terre Island, 25 miles off the coast of Louisiana. Here the drone stock is also controlled.

Management of Russian bees

Russian bees are quite different from standard Italian bees in several ways (Table 1):

- Russian bees do not build their colony populations until pollen is available, and they shut down brood rearing when pollen is scarce. This characteristic makes them suitable in areas where the main honey and pollen flows occur later in the year, such as the mountains of North Carolina. By contrast, Italian bees maintain a large brood area and worker population regardless of environmental conditions. This trait can result in more bees than the hive can feed and may lead Italian colonies to early winter starvation. It also explains the Italian bee's tendency to rob other colonies of their honey stores.
- Russian colonies maintain active queen cells throughout the brood-rearing season. In Italian colonies, the presence of queen cells is interpreted by beekeepers as an attempt to swarm (reduce overcrowding by establishing a new colony) or to supersede (kill and replace) the resident queen. This is not the case with Russian colonies, as the workers often destroy the extra queen cells before they fully develop.
- Russian bees can vary in color, but they are generally darker than the Italians.

Requeening Italian hives with Russian queens can be difficult, and many beekeepers lose their newly introduced Russian queens. Russian queens have a different "odor" than Italians, and parent colonies must become acclimated to this odor before they will accept the newcomers. Beekeepers who intend to go from Italian to Russian bees should requeen a colony in the fall by splitting the hive in two with the use of a double screen (see highlighted information). This will permit the odors to mix but, at the same time, prevent the workers from interacting with the new queen. The old Italian queen should be kept in the lower half, and the new Russian queen should be placed in the upper half in a cage. If a separate entrance is provided to the upper half, only young nurse bees will enter the top portion, and the older foraging bees will return to the lower hive.

Table 1. A comparison of various colony characteristics of Italian and Russian honey bees

Characteristic	Italians	Russians
Varroa mites	More susceptible	More resistant
Tracheal mites	More susceptible	Highly resistant
Brood rearing	Continuous throughout the summer	Usually only during times of pollen availability
Robbing	High	Low
Queen cells	Only during swarming or queen replacement	Present most of the time
Pollination skills	Small difference from Russian bees	Small difference from Italian bees
Temperament	Gentle, less defensive; not likely to sting	Gentle, less defensive; not likely to sting
Color	Light	Dark

The Russian queen should be released from her cage after seven to ten days and permitted to lay eggs for four weeks. During this time, the odor of the Russian queen will co-mingle with that of the Italian colony. If the Russian queen continues to lay eggs and is being tended by the workers, she has been accepted. After this acclimation period, the Italian queen can be removed, and the colony can be reunited. If the workers do not accept the new queen during the four weeks of acclimation, the requeening process has failed, and the workers kill her. But the colony will still have the original Italian queen, and the entire hive will not be lost.

Hybrid bees tend to lose their initial desirable traits over subsequent generations. Because many commercial Russian bees are hybrids, the queen should be marked with paint to distinguish them from succeeding generations. If the colony contains an unmarked queen, she is probably homegrown and a second-generation hybrid and should be replaced with a new marked Russian queen as soon as possible to preserve the hive's resistance to the mites.

When requeening a Russian colony with a Russian queen, it probably will not be necessary to use the extended acclimation period outlined above. Queens usually come in the mail in cages made of wood and wire-mesh. The exit hole is blocked with a hard candy-like substance that the bees must eat through to release the queen. This usually takes several days, after which the queen has acquired the colony "odor" and is readily accepted by the workers. As noted above, requeening an Italian honey bee colony with a Russian queen takes longer because of the Russian queen's very different odor.

Conclusion

Russian honey bees can be a valuable tool in controlling the depredations of varroa and tracheal mites and also in reducing, but not necessarily eliminating, the need for chemical treatments to control these mites. However, the beekeeper must understand how to manage bees of this new stock properly, as they are quite different from the widely used Italian honey bees.

Suggested reading

- De Guzman, L. I., T. E. Rinderer, G. T. Delatte, J. A. Stelzer, L. Beaman, and C. Harper. (2001). An evaluation of far-eastern Russian honey bees and other methods for the control of tracheal mites. *American Bee Journal*, 141: 737-741.
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- Rinderer, T. E., L. I. de Guzman, and C. Harper. (2004). The effects of co-mingled Russian and Italian honey bee stocks and sunny or shaded apiaries on varroa mite infestation level, worker bee population and honey production. *American Bee Journal*, 144: 481-485.

Requeening Italian colonies with Russian queens

The requeening procedure has frustrated many beekeepers because standard introduction techniques often are not successful when requeening Italian colonies with Russian queens, as the colonies may reject the new queens. Italian bee colonies need more time and separation to become acclimated to Russian queens.

Step 1: Split the colony in half, with the two halves separated by a double screen.

Step 2: Place the old queen in the bottom half and a caged Russian queen in the upper half.

Step 3: Release the Russian queen from her cage after 7 to 10 days.

Step 4: Once the Russian queen has been accepted and has laid eggs for one month, kill the old queen, and reunite the two halves (remove the screens).

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Many different species of stinging insects are often mistaken for honey bees, or casually referred to as “bees”. Being able to distinguish honey bees from wasp or other bee species is important to make appropriate decisions about potential control. The following is an overview of some non-honey bee stinging insects in North Carolina.

Generally, wasps tend to be more slender and with fewer hairs on the body than bees. Wasps also tend to feed on other insects, while bees tend to primarily feed on floral sources (pollen and nectar). There are social and solitary species in both groups.

Yellow Jackets

Yellow jackets are small wasps with distinct yellow and black markings. They are very agile flyers, and they construct small tan nests made of paper, usually within a cavity or void. Common locations for nests are in lawns, particularly in sandy exposed areas, as well as at the bases of trees or shrubs. In wooded areas, they are common in rotted logs or stumps. Occasionally, yellow jackets will nest in attics or wall voids of houses or storage buildings. Cinder block openings are another common place they have been known to inhabit. Small holes leading to large covered cavities are ideal for yellow jacket nest sites.

Biology

An individual yellow jacket queen begins building a nest alone in the spring. She takes on this task by herself, but once she has produced enough workers to take over nest-building and foraging duties,



Photo by NCSU Apiculture Program

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she focuses on egg laying. The workers expand the nest, forage for food, and feed the young. They also guard and defend the nest. Like other predatory wasps, their diet consists mainly of other insects such as flies and bees. The insects continue to enlarge the nest until fall when there may be 600-800 yellow jacket workers. Frequently, it is not until this time that the nest is noticed, although it has been there for many weeks. In the late summer, the colony produces reproductives. The mated female reproductives will serve as the next generation of queens the following spring. The males cannot sting, due to lack of a stinger. Nests are abandoned by wintertime and the future queens seek shelter alone, in protected places under tree bark, in old stumps, or sometimes attics. The current year's nests are not reused the following spring.

Behavior

Yellow jackets, in particular, may be late-season pests around picnics, trash cans, and humming bird feeders as they forage. The only way to control this situation is to locate and destroy the nest, which is rarely possible. As an alternative, keep all outdoor food and drinks covered, except while actually eating. (see *Beekeeping Note 1.08*, "Reducing the Likelihood of Stings During Outdoor Activities"). Hummingbird feeders can be fitted with mechanical guards or a coating of petroleum based chest rub on where the insects land. It is also important not to spill sugar water when filling the hummingbird feeder. Trash cans should be kept covered or have a flap over the opening. Defensive behavior of yellow jackets occurs in response to nest defense. If the nest is not in the immediate vicinity, the likelihood of stings is greatly reduced.

Control

The first decision to make is whether control is actually necessary. In spite of their reputation, yellow jackets are actually beneficial because they prey on many insects that we consider to be pests. They also serve as food for bears, skunks, birds, and other insects. It is important to also note that these colonies die out each year. If a yellow jacket nest is built in a secluded area, you may choose to simply wait until the colony dies out in late fall or early winter. The nest will slowly deteriorate from weather or from attack by hungry birds. If a nest is located where people may be stung or if you (or others) are hypersensitive to wasp stings, then colony destruction may be appropriate. Control is best achieved by applying a pesticide directly into the nest opening. This can be done at anytime of the day, but near dusk, most of the wasps are more likely to be inside the nest. You can use any of the aerosol "Wasp & Hornet" sprays that propel insecticide in a stream about 10-12 feet. Direct the spray into the nest opening and then move away from the area in case any of the wasps emerge from the nest. You may need to repeat the treatment on the following evening. Do not use a flashlight while spraying, as this will attract the angry wasps



Photo by NCSU Apiculture Program



Photo by NCSU Apiculture Program



Photo by Don Hopkins, NCDA&CS

near you and will sting anyone nearby. Finally, **do not pour gasoline down the hole of a nest.** This is extremely dangerous, as it is a flammable hazard and does immense damage to the surrounding environment.

If the nest is in a wall void or other inaccessible area in your home, you may consider hiring a pest control operator to do the work for you. If the nest is in a wall, it may be desirable to remove it after spraying to avoid attracting carpet beetles that can subsequently invade the nest and eventually attack garments made wool, silk, or fur. Yellow jacket traps (commercial or otherwise) have not shown to be of any value in reducing a yellow jacket problem in the southeastern U.S. In trash disposal or recycling areas, closed containers and the use of PDB (paradichlorobenzene) blocks may help repel some insects.

Paper Wasps

Paper wasps (*Polistes* sp.) are long-legged, reddish-brown to black insects with slender, spindle-shaped abdomens. They may have differing degrees of yellowish or brown striping, and they can vary in size. Paper wasps are commonly confused with muddauber wasps, which are dark blue or black metallic-colored wasps that build mud nests and are not prone to sting. Adult paper wasps typically prey on caterpillars and are considered quite beneficial. However, they will sting in defense of their nests.

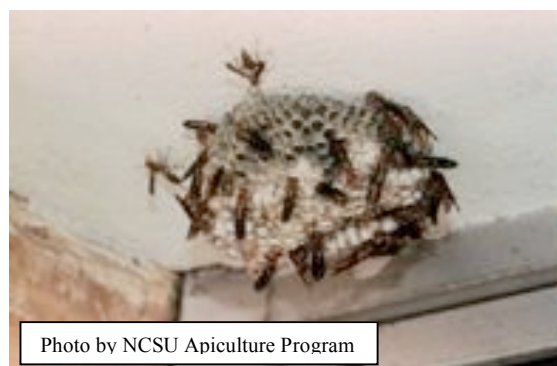


Photo by NCSU Apiculture Program

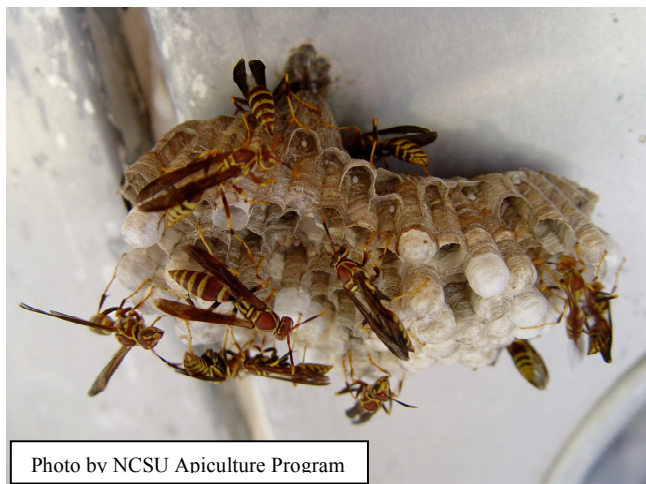


Photo by NCSU Apiculture Program

Biology

In the spring, female reproductive paper wasps construct grey, papery honeycomb-like cells under eaves, overhangs, window sills, awnings, deck railings, or open barns. They are connected to the base by a single stalk (called the 'petiole'). Once the first few cells have been constructed, the foundress will lay eggs which hatch within a few days. The female wasps will feed chewed-up caterpillars and other soft arthropods to their young larvae until they seal their cells and pupate. Once enough new female worker wasps have emerged,

they take over the duties of food collection, nest construction, and defense, while the queens remain on the nests and produce more offspring. During the spring and summer, colonies continue to grow to 6-8 inches in diameter with several dozen wasps. Stinging may be more likely during this time.

Behavior

In the early fall, colonies begin to produce males and reproductive female wasps. These reproductive females, which constitute next year's queens, mate with males and leave the nest in search of protected spots in which they spend the winter. Overwintering queens seek shelter in hollow trees, under bark, in wood piles, attics, chimneys, barns, under siding, or other similar cavities. The remaining worker wasps eventually die and the nests are abandoned. These old nests are not reused next year.

On any warm day during the cold season, the wasps may become more active. If they are resting in an attic, wall void, or crawlspace, the wasps may be attracted to light coming through a gap in the baseboard, a wall fixture, or around an AC vent and enter inside the building. Once inside a dwelling, the wasps may be found crawling on the floor and furniture, or they may be attracted to light shining through windows. Since there is no nest or young to defend, the only real danger of being stung is from accidentally stepping on or pressing against one. Homeowners sometimes become unnecessarily concerned when they observe numerous wasps beating against the windows on a warm winter day. This behavior is not fully understood, but poses no threat. Taller houses and upper stories seem to be more attractive. Crane and tower operators are often dismayed by the large numbers of wasps which may congregate around these structures when the temperature is favorable.



Photo by NCSU Apiculture Program

Control

It is important to remember that paper wasps are actually beneficial insects, since they prey on many garden pests (particularly caterpillars). However, if the wasp nests are considered to be a hazard, they can be destroyed in the evening with an aerosol insecticide that is labeled for “hornets or wasps”. As with any colony of stinging insect, it is important to conduct control at night and turn off any flashlight or light source that might be on during this time. The paper wasps may be attracted to the light and sting anyone nearby. Small nests, with only one or a few wasps, may be knocked down with a broom. In homes, attic vents should be properly screened to exclude overwintering queens. If they are already present, a total-release aerosol may be used on a warm day. Follow the product label instructions concerning how many cans are needed for the size area you are treating. Never exceed this number of units, and always be careful using these products near open flames, as they could ignite.

Wasps that enter a dwelling may be swatted, stepped on, or sucked up with a vacuum. They can also be carefully collected in a jar and released outside. Workers on towers or tall structures need to be extra vigilant for wasp nests. Work may need to be scheduled during cool temperatures.

Workers should wear long sleeved shirts, long pants, gloves, and a hat. A beekeeper’s veil may be worn to protect the face and neck, as long as doing so does not pose a work hazard.

Photo by NCSU Apiculture Program



Photo by NCSU Apiculture Program

Carpenter bees

Carpenter bees are large, black and yellow bees commonly seen during the spring hovering around porch rails, decks, deck furniture, and underneath the eaves of houses. They can be distinguished from bumblebees in that the carpenter bee has a hairless black abdomen. The carpenter bee is so-called because of its habit of excavating tunnels in wood with its strong jaws. They leave a round, half-inch hole in wood boards. There is usually a pile of fresh sawdust and a yellow trail of waste on surfaces below the hole. Wooden decks, overhangs, and other exposed wood on houses are prime targets. Painted and treated woods are less preferred by carpenter bees, but they are still susceptible to attack.



Photo by NCSU Apiculture Program

Carpenter bees, like their distant relatives the carpenter ants, differ from termites in that they do **not** consume the wood as food. They simply excavate tunnels for nesting sites.

Biology

Carpenter bees overwinter as adults, often inside old nest tunnels. In North Carolina, they typically emerge in April and May. The males are usually first to appear. Males can be distinguished from females by a whitish spot on the front of the face. The males do not have stingers, but they are extremely territorial and will harass any insect or human that comes into the area. Females can sting, but rarely do so unless confined in your hand or are highly agitated. Newly emerged females feed on plant nectar then begin constructing new tunnels after a few weeks. The entrance holes start upward (or inward) for about one-half inch or more, then turn horizontally and follow the wood grain. The larval galleries typically run six to seven inches, but may exceed one foot in length. Occasionally, several bees use the same entrance hole, but they have individual galleries branching off of the main tunnel. If the same entrance hole is used for several years, tunnels may extend several feet in the wood. Inside her gallery, a female bee gradually builds a large pollen ball that serves as food for her offspring. She deposits an egg near this pollen ball and then seals off the section of tunnel with chewed wood. The female constructs additional cells in this manner until the tunnel is completely filled, usually with six to seven cells (depending on length of the tunnel). The adult bees die in a matter of weeks, but the eggs hatch in a few days and the offspring complete their development in about 5 to 7 weeks. Adults begin to emerge later in the summer. Although the bees remain active by feeding on pollen in the area of their nest, they do not construct new tunnels. Some may be seen cleaning out old tunnels which they will use as overwintering sites when the weather turns cold.

Damage

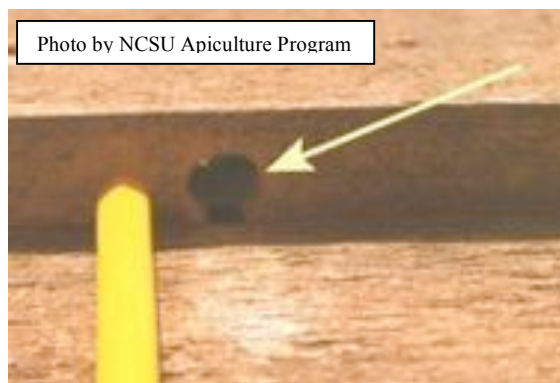
Typically, carpenter bees do not cause serious structural damage to wood unless large numbers of bees are allowed to drill many tunnels over successive years. Old barns may be particularly susceptible to carpenter bee damage over a course of many years. The bees often eliminate their wastes before entering the tunnel. Yellowish-brown staining from voided fecal matter may be visible on the wood beneath the hole. It can be a chore to clean this waste material off of glass or car paint. Woodpeckers may damage infested wood in search of bee larvae in the tunnels. In the

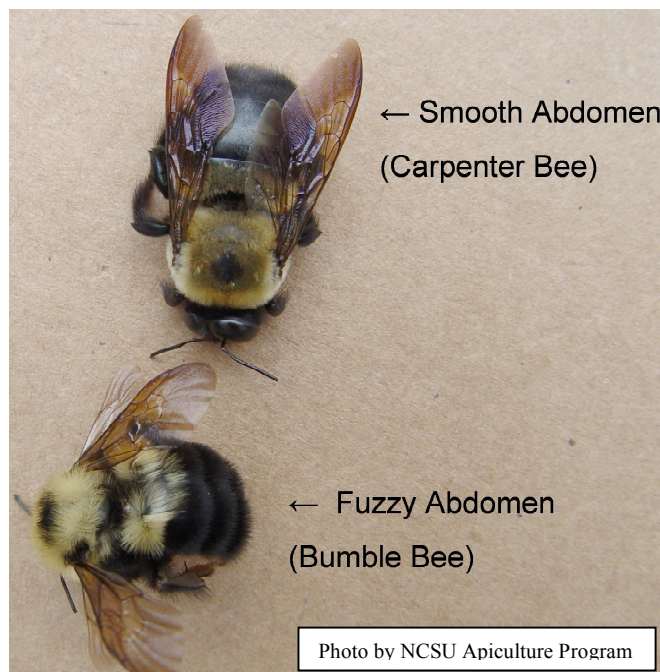
Photo by J. K. Barnes, Univ. Arkansas



Photo by NCSU Apiculture Program

Photo by NCSU Apiculture Program





case of thin wood, such as siding, this damage can be severe. Holes on exposed surfaces may lead to damage by wood-decaying fungi or attack by other insects, such as carpenter ants.

Control

Preventing carpenter bee damage is difficult (or nearly impossible) for several reasons. First, protective insecticide sprays applied to wood surfaces are effective for only a short period, even when repeated every few weeks. Since the bees are not actually eating the wood and they are active over several weeks, they are rarely exposed to lethal doses of the pesticide. Second, since virtually any exposed wood on the house could be attacked, it is difficult and usually impractical to try applying a pesticide to all possible sites

where the bees might tunnel. Trying to spray bees that are seen hovering about is not a sensible (or particularly safe) use of pesticides either. Swatting hovering bees will often prove to be just as effective.

Treating each individual nest hole can be very time consuming, but can reduce further nesting activity. Products containing carbaryl (Sevin®), cyfluthrin, or resmethrin are suitable for carpenter bee control. A list of chemicals for use against carpenter bees can be found in the *NC Agricultural Chemicals Manual*. Avoid inhaling the insecticide or contaminating your clothing with the spray. **Always stand upwind from the surface you're treating.** Treated tunnels should be sealed with a small ball of aluminum foil and caulked after 24-36 hours. Since active or abandoned tunnels may be used as overwintering sites, or they can be re-used next spring for nesting, it is important that they be sealed permanently. Depending on the particular situation, treatment may be best performed at night, as the female will guard the nest and sting anyone that poses an immediate threat. The insecticide treatment is important because it kills both the adult bee as well as any offspring as they attempt to emerge later. Simply plugging untreated tunnels with wire mesh or similar material might trap bees inside, but more resourceful bees will simply chew another exit hole.

Bumble Bees

Bumble bees are social insects that live in small colonies in the ground. Some of the more common bumble bees encountered around the home and garden are the common Eastern bumblebee *Bombus impatiens*, the American bumble bee *Bombus pennsylvanicus*, and the Prairie bumble bee *Bombus griseocollis*.



Biology

Bumble bees are large-bodied bees with horizontal black and yellow stripes running across the abdomen. They have longer faces and a more pronounced proboscis than carpenter bees. The bumble bee has a hairy abdomen, as apposed to the carpenter bee, which has a shiny abdomen. They are not very fast fliers, and they can be clumsy around flowers. The different species in NC vary in size. The queen is usually larger than most of the other bees in the colony. Males have no stinger and have a rounded abdomen. Bumble bees nest in colonies that can contain up to 200 or more individuals, and they are very important pollinators of both crops and wildflowers.



The bumble bee colony is made up of three types of individuals: the queen, female workers, and males. The reproductive females are the only bees from the nest that overwinter. They can be seen in the spring feeding on flowers and looking for new places to start a colony. Bumble bees prefer abandoned animal holes in the ground, but they have also been known to nest in rotten tree cavities, stump holes, used bird houses, and some human structures where there is soft nesting material present. Nectar is collected and stored in one or two small sac-like “honey pots” built from wax and

pollen. The workers enlarge the nest and, by midsummer, the colony will have 20 to 100 workers. The colony produces reproductives (new queens and males) in the late summer, when they leave the nest to take mating flights. The successfully mated queens fly to the ground and hibernate 2 to 5 inches deep in the soil or logs. The production of reproductives signals the end of the colony’s life. The overwintering queens emerge the next spring to complete their life cycle.

Control

Bumblebees are a very important insect species, so control should only be done if it is absolutely necessary for personal protection. Locate the nest during the day when the bees are active, then come back at night and apply an aerosol pesticide designed for wasps and hornets. Like many other colonies of stinging insects, care should be taken to turn off any hand-held light sources before applying pesticides.

Cicada Killer

Cicada Killers (*Sphecius speciosus*) are members of the wasp genus *Sphecius*, which is composed of 21 species world wide. These insects are closely related to ants, bees, and other Hymenoptera. The cicada killer draws the attention of many people due to its large size and habitat preference, such as yards and lawns. The cicada killer is a large black and yellow wasp,

ranging from 1-1/8 to 1-5/8 inches long. They have small yellow markings on the thorax, plus six yellow markings on their large abdomen, three on each side. Their heads and wings are a reddish color.

Biology

The cicada killer is a solitary wasp species, unlike paper wasps and yellowjackets. The cicada killer pupates and overwinters underground in tunnels excavated by the parents the previous summer. In North Carolina, they normally hatch out between June and July. The males emerge earlier than the females, and mating occurs after the females have hatched. The females usually mate with more than one male. They mate in designated mating areas where the males congregate, known as leks. After mating, the female cicada killer begins searching for an area to dig her burrows. These areas are usually near the edges of woods where they can readily find cicadas, their food source. The soil cannot be very moist and must be well drained. Because of this habitat preference, it is not uncommon for cicada killers to inhabit grassy lawns around human habitats. The female, after choosing the nest site, begins to dig a burrow usually are not much deeper than a foot that can reach up to three feet long.

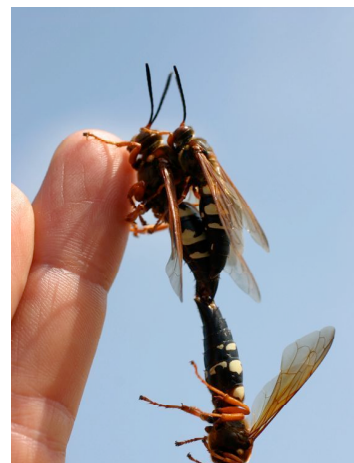


Photo by Chuck Holliday, Lafayette University

A female cicada killer hunts adult cicadas, large plant-feeding insects that create loud, familiar sounds in the summer. She grabs her prey and paralyzes it, dragging or slowly carrying the cicada back to the entrance of her nest. She then will lay an egg on the second leg of the paralyzed cicada. The cicada does not die right away; rather, it is eaten alive by the developing wasp larva. The cicada remains alive so that the insides do not spoil. The larva hatches, eats the cicada killer, and then pupates over winter, finally emerging the following summer. The adult wasps feed on sap and nectar.

It is not uncommon for the female cicada killer to drop the cicada that she is carrying, due to weight and distance. One may occasionally find a paralyzed (but not parasitized) cicada on the ground, unable to move yet still alive. Most of the time these paralyzed insects are eaten by ants and birds.

Control

If you have cicada killers in your lawn, chances are that they will be there year after year. Cicada killers choose lawns due to the various conditions that are presented. They enjoy southern facing hills with well drained soil. Adequate fertilizer and lyming of the soil, combined with consistent watering, can render your lawn inhabitable for this species.



European Hornet



Japanese Hornet: Not found in US

European Hornet

The first reported specimen of *Vespa crabro* was reported around 1840 in the state of New York. Since that time, it has worked its way south along the east coast and has spread throughout the eastern United States. Other names for *V. crabro* include the brown hornet or the giant hornet. The European hornet is often mistakenly called the Japanese hornet, but in fact the Japanese hornet is not found in the United States but rather is restricted to the mountains of Japan and Asia. The European hornet is the largest true hornet found in the United States.

Description

Adults resemble yellow jackets, but are much larger (about 1½ in.) and are brownish red with a dull yellow abdomen. Queens, which may be seen in the spring, have more red than brown, and are larger than the workers. Nests are typically built in hollow trees, but they are often found in barns, sheds, attics, and wall voids of houses. They are usually not noticed until the colony has reached a large size. This can present a problem to the human inhabitants due to the defensive nature of *V. crabro*. Unlike its cousin, the bald-faced hornet, European hornets rarely build nests that are free hanging or in unprotected areas. Frequently, the nest is built at the cavity opening, rather than deep within. The outside of the exposed nest will be covered with coarse, thick, tan, paper-like material fashioned from decayed wood fibers. The hornet mashes it up with its mandibles and mixes it with saliva to form a pulp that they can shape into a layer for the nest. Nests built in walls may emit a noticeable unpleasant aroma.

Biology

In the spring, each individual queen emerges from hibernation and begins nest building. She builds the nest, forages for food to feed to the larvae, and defends the nest all on her own. Once a queen has produced enough workers to take over these duties, she remains inside the nest producing more offspring. The workers (all of which are females) forage for food and feed the young, as well as expand and defend the nest. Their diet consists mainly of large insects such as grasshoppers, flies, and even yellow jackets. They can also exploit a honey bee hive for dead or weaker bees. They continue to enlarge the nest until fall when there may be 300-500 (occasionally up to 1,000) workers. European hornets have a long seasonal cycle. Reproductives (males and females) are produced well into the fall. These reproductives mate and the females will serve as the next generation of queens the following spring. As winter approaches, the workers die off and the future queens abandon the nest and seek shelter in protected areas such as under loose bark, in rotting stumps, and other similar hollows. Every year, the queens select new sites to build new nest and do not reuse abandoned nests. In the fall and winter, these nests

can sometimes be viewed from far away in trees or in sheds. It is important to note that the colonies die over the winter and the nests can be removed afterwards.

Behavior

Unlike most other stinging insects, European hornets also fly at night. They can be attracted to lighted windows in homes and may repeatedly fly into the glass with quite a lot of force. This may cause some people to falsely conclude that they hornets are trying to break the glass to enter their home. The hornets are also attracted to porch lights, so the hornets may sometimes be a nuisance for certain outdoor activities. Hornet workers are sometimes noticed chewing bark from thin-barked trees or collecting oozing sap of trees.

Control

Control is best achieved by applying a pesticide directly into the entrance of the nest at dusk or night. Use any aerosol "Wasp & Hornet" spray that propels the insecticide about 10-15 feet. Direct the spray into the nest opening for 5-10 seconds, then move quickly away from the area to avoid any of the hornets that may emerge from the nest. You may need to repeat the treatment the following evening. When spraying, it is advisable to wear a dark long-sleeved shirt and long pants. Do not hold a lit flashlight or stand near car headlights or other lights; the wasps may fly towards them after being agitated. If the nest is in a wall or other inaccessible area in your home, you may want to hire a professional pest control operator to do the work. Whenever possible, remove the nest from the wall. If the wasps are damaging the twigs of ornamentals or fruit trees, a treatment containing carbaryl (Sevin®) to the affected areas of the plants would be advisable. Re-treatment may be needed every 7-10 days, depending upon weather conditions.

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