THE BIOLOGY OF THE HONEY BEE pdf

1: Honey Bee Program - Bees, Beekeeping & Pollination - Honey Bee Biology

From ancient cave paintings of honey bee nests to modern science's richly diversified investigation of honey bee biology and its applications, the human imagination has long been captivated by the mysterious and highly sophisticated behavior of this paragon among insect societies.

Since my June article, I have spent considerable time discussing the members of a honey bee colony, their external and internal anatomy, their individual and group behaviors, and even their qualities as a superorganism. I am going to wrap up this series by bringing it all together into this single article on honey bee biology. Of course, honey bees and their colonies are complicated organisms. These facts have caused the honey bee to be one of the most studied insects on the planet. Consequently, a short series on various aspects on honey bee biology culminating into this penultimate piece in which I provide a general overview cannot, no matter how hard I try, do justice to the beasts that are the honey bee and its colony. The more I researched to develop these articles, the most I grew to appreciate how amazing honey bees really are. Regardless of the difficulty associated with bringing all of this together into a single treatise, I feel it is important for every beekeeper to have a general understanding of honey bee and colony biology. After all, the best beekeepers know what they are trying to accomplish and what the bees are trying to accomplish. They then work to harmonize the two. No discussion of bee behavior, colony nest architecture, superorganism theory, etc. I hope you find this approach useful. By now, you should have a sense of the difference between the individual honey bee and its colony. I spent quite a bit of time discussing this in my March article on honey bee colonies as superorganisms Ellis b. To summarize that article: Everything an individual bee, from worker to queen to drone, does advances the cause of the colony. Consequently, it will be somewhat difficult to separate the biology of individual honey bees from that of a colony and you might find me switching between the two during this article without announcement. Honey bee colonies want to survive and reproduce. Everything a bee colony does results from wanting to accomplish those two goals. I cannot stress this point enough. The first major desire of a honey bee colony is to survive winter, and to survive it uncompromised, i. The second major desire of a honey bee colony is to reproduce, which they accomplish by swarming. Absolutely everything about honey bee colony biology is centered around those two goals. Of course, there are many possible ways to discuss honey bee biology. Most approach their discussion of this topic in winter because it, outwardly, appears to be the time of year when colonies are dormant. However, I find it most helpful to start a discussion of honey bee and colony biology when a new honey bee colony springs into existence. I call this week 0. As noted in my article on superorganisms Ellis b , that is when a honey bee colony produces a child, when the colony swarms. I have decided to â€¦ This Issue.

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2: Biology of the Honey Bee Colony - eXtension

From ancient cave paintings of honey bee nests to modern science's richly diversified investigation of honey bee biology and its applications, the human imagination has long been captivated by the mysterious and highly sophisticated behavior of this paragon among insect societies. In the first.

Niko and Gudrun Koeniger. Niko Koeniger is the former head of the German bee research institute in Oberursel, Germany and professor of biology at the Goethe University in Frankfurt. Gudrun Koeniger worked as a research scientist and editor of the international bee journal Apidologie. Both have devoted a lifetime to the study of honey bee diversity and biology. Among other things, they worked tirelessly to decipher the intricacies of honey bee mating biology. Their work culminated in a book on the topic written for German beekeepers. In , Niko and Gudrun approached me about producing a revised English version of their German book. Larry Connor of Wicwas Press. Much of what I share in this article is taken from our joint book. Feel free to read the book to discover more information on the mating biology of honey bees if this topic is of interest to you. The full citation for the book can be found in the reference section at the end of the article. Rearing and sexual maturation of queen honey bees Typically, honey bee colonies are headed by a single queen whose primary responsibility is to produce offspring Ellis, c. There are times in the normal lifecycle of a colony when a new queen must be produced. This occurs when a colony swarms Ellis, a or when a queen is lost for whatever reason death, maimed, etc. Queen honey bees result from fertilized eggs that are destined to become female, but not otherwise predetermined to be either a queen or a worker. Worker honey bees in the nest take a female larva that emerges from a fertilized egg and direct her to royalty by feeding her more and better quality food royal jelly â€" Figure 1 than that fed to her sisters who are to become workers. This they can do because the female larvae remain bipotent can become either queens or workers up to 48 hours after emerging from their eggs. This rich food ensures rapid growth of the developing larvae, whose weights increase fold during their first six days of life. Queen honey bees develop in peanut hull-shaped cells that hang vertically from the face or periphery of the brood comb. This means that the developing queens hang upside down while maturing. It takes a queen about 16 days to develop from egg to adulthood, this likely because of the large volume of good food she receives while young. When she is ready to emerge, the queen will use her powerful mandibles to cut through the cell capping, and emerge upside down into the colony Figure 2. The first emerging queen has hit the jackpot, of sorts. She is first in line to inherit the nest and the colony of bees it contains. If she is successful, she will be fed, groomed, and otherwise pampered daily as she progresses through a life that is many times longer than those of her sister workers and eventual offspring. However, she has some work to do before she can receive her inheritance. Newly emerged queens seek out and eat the food necessary to power their upcoming activities, the first of which involves getting rid of the competition. As you might imagine, a colony does not usually attempt to rear only one queen when they intend to swarm or otherwise need a queen. Instead, they invest in the production of dozens of queens, all of which are developing alongside the first queen to emerge. The first queen to emerge, consequently, becomes a stealthy assassin who searches for her developing sister queens so that she can eliminate the threat they pose to her impending assentation to the throne. A newly emerged queen will begin checking all of the brood combs in the nest, doing this â€¦ This Issue.

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3: Basic Honeybee Biology | Habitat Network

Biology of Africanized and European honey bees, Apis mellifera, in Venezuela [Reprint] by Bolten, Alan B. and a great selection of similar Used, New and Collectible Books available now at www.enganchecubano.com

Videos of Honey Bees Ants, bees and wasps are social insects. This means that they tend to live in colonies where all the individuals are of the same family, often the offspring of one mother. In the more highly organized societies there is a division of labour in which individuals carry out particular duties. The bodies of bees are divided into head, thorax and abdomen, with three pairs of legs and two pairs of wings on the thorax. The fore and hind wings on each side are linked by hooks and grooves so that they move together in flight. The mouth parts consist of a "tongue" or labium, which can be enclosed near the head by the labial palps and maxillae. Nectar, from the nectaries of flowers, can be drawn up the grooved surface of the labium, partly by capillary attraction and partly by the pumping action of muscles in the head. When not in use, these elongated mouth parts are folded back under the head, leaving the shorter, stouter mandibles free in front to chew pollen, manipulate wax, attack intruders etc. The ovipositor through which the queen lays her eggs in the wax cell, is modified in the workers to form a sting. Organization of the colony. There are four species of Apis, the honey-bee, one of which is Apis mellifera, the Western honey-bee, which is the commonest hive-bee in this country. There are three kinds of bee in a colony: The mature queen is usually easily recognized by her large abdomen. A queen bee may live from two to five years and, except for a short period at the end of her life when one of her daughters takes over the colony, she is the only egg-laying female. All the members of the colony, whether drones or workers, are her offspring. She spends all her time laying eggs, perhaps up to a day, each one being placed in a wax cell made by the workers. The queen can feed herself but in the hive the nearest workers turn towards her, lick her body and feed her by regurgitating a special secretion of their salivary glands, called "royal jelly", on to their probosces from which the queen can absorb it. The queen usually mates only once in her life though second and third matings are known to happen and stores the sperms received from the drone in a sperm sac in her abdomen. This store of sperms lasts her for the two or more years of egg-laying, a small quantity being released with each fertilized egg laid. When the store of sperms is used up she may continue to lay eggs but they are all unfertilized and will become drones. By this time one of her daughters has been reared as a queen and is ready to take over the egg-laying. Each egg is laid in one of the hexagonal wax cells and hatches into a tiny, white, legless larva. The larva feeds on substances deposited in the cell by the workers; it grows, pupates in the cell, hatches as an adult bee and finally emerges from the cell into the hive. The eggs hatch after three to four days and by nine days are fully grown and ready to pupate. The workers put a capping over the cells at this time. Ten or eleven days later the capping is bitten away and the adult emerges. The times given above vary with changes of temperature and according to whether the bee is becoming a drone, worker or queen. The drones, who live for about four to five weeks and do not work inside the hive, are fed by the workers or help themselves from the store of pollen and nectar in the combs. Their function is to fertilize a new queen. In the autumn, or when conditions are poor, they are turned out of the hive where, unable to find food for themselves, they soon die. The workers are female bees whose reproductive organs do not function. Among many other tasks they collect food from outside the hive and store it, make the wax cells and feed the developing larvae. Origin of the three types of bee. The wax combs are built hanging vertically with a gap of about half an inch separating each one. The cells in each comb thus lie horizontally. The workers prepare three kinds of cell: The queen cells are larger and made individually, pointing downwards like small acorns from the surface or bottom of the comb. The relative numbers of these three kinds of cell seem to depend on the time of the year, the temperature, the abundance of food and condition of the colony. Normally, the worker cells predominate. Eggs are laid by the queen in the brood area. The area varies, diminishing in the winter and expanding in the summer. The queen moves over the brood area, laying eggs indiscriminately in any of the three types of cell she encounters, by placing her abdomen in the cell and depositing a single egg. The eggs placed in the larger, drone cells, are not fertilized, and this results in the eggs developing into a male bee or drone. In the queen and worker cells, fertilized eggs

are laid. For the first three days after hatching, all the larvae are fed on a protein-rich, milky secretion, called royal jelly, which comes from the salivary glands of workers of a certain age. The grubs in queen cells continue to be fed on royal jelly for the rest of their lives, but those in drone or worker cells are "weaned" onto a mixture of dilute nectar and pollen. If a one-to-three-day old larva is transferred from a worker to a queen cell, it will receive the diet of royal jelly and develop into a queen. Thus, though there is no difference between the eggs and young larvae in queen and worker cells, their different treatment by the workers results in their becoming quite distinct types of bee. Exactly what aspects of their feeding cause this is not known for certain. After three days, worker grubs cannot be reared as queens, even if they are placed in queen cells and fed on royal jelly. Drones, then, develop from unfertilized eggs in wide cells, queens and workers from fertilized eggs which are fed differently as larvae. Life of a queen. When a new queen emerges she is fed by the workers. She bites a hole in any other occupied queen cells that she finds and some observers believe she stings the occupants. In any event, the workers usually tear down the other queen cells that have been bitten into and destroy the occupants. For a few days the queen leaves the hive for short flights lasting, at first, only a minute but gradually lengthening to about 15 minutes. During these flights she learns the geography of the district around the hive. On one of these flights she is pursued by drones, but not necessarily from her own hive; in fact, they do not follow her from the hive but are already waiting outside. One of them catches the queen and mates with her, depositing in her vagina sperms which eventually find their way into her sperm sac. She now returns to the hive, and soon after begins to lay eggs. When, at the end of her life, the queen ceases to produce these pheromones, some workers start to lay eggs which, being unfertilised, produce only drones. They do, however, start building new queen cells. The tasks undertaken by a worker bee depend partly on its age and partly on the immediate needs of the colony. After hatching, she is fed by other workers and spends a good deal of time standing still on the comb. She does, however, clean out cells from which bees have recently hatched by removing the cast larval cuticles. On the fourth day she feeds on honey from the store cells and eats a good deal of pollen. Between the third and fifth day she feeds older larvae by placing nectar, water and pollen in their cells. The pollen that she eats is rich in protein and helps her salivary, brood food glands to become active, so that by the fifth day they can secrete the brood food or royal jelly which is fed to the younger larvae. After ten or twelve days these glands cease to function effectively but wax glands on the underside of her abdomen begin to secrete wax which the worker uses for comb-building and repair. By this time she is also beginning to leave the hive for short flights during which she learns the position of the hive and the topography of the surroundings. Between the twelfth and twenty-first days these reconnaissance flights continue; while in the hive, the worker collects pollen and nectar from the incoming field bees and stores it in the cells. She also processes the nectar and begins its conversion to honey, and cleans the hive by removing the dead bees and detritus from its floor. After three weeks of hive duties the worker becomes a forager and spends the daylight hours collecting water, nectar, pollen and propolis see below and carrying it back to the hive. This work she may continue for about three weeks before she dies. The "schedule" given above is by no means rigid, and observers have recorded bees doing several of the duties mentioned at the same time, as well as old bees performing "nurse" duties, and young bees foraging. Some of the duties may be missed out altogether. For example, only a few of the young foragers do duty as guard bees, protecting the hive from invasion by robber bees. The foraging workers collect nectar from the nectaries of flowers. The nectar is drawn off from the nectaries by the long labium. It is pumped up and swallowed into the honey sac, a region of the gut from which it can be regurgitated on reaching the hive. Nectar is a watery sugar solution when collected, but it is processed by the house bees to whom it is passed. These workers repeatedly swallow it, mix it with enzymes and regurgitate it. The enzyme action and the evaporation of water result finally in its conversion to honey. Nectar contains very little protein, and the pollen collected by the foragers makes up this deficiency. The pollen collected on the head, and removed by the front legs, is mixed with a little nectar and passed to the back legs which have combed pollen from the abdomen. The rows of bristles on the legs assist this combing action. The pollen press, in the joint between the tibia and tarsus of the hind legs, squeezes the pollen which is passed to it from the pollen comb of the opposite hind leg. The pollen and nectar paste is thus pushed by the press into the pollen basket on the tibia, where it is retained by the fringe of setae. All this may

be done while the bee hovers in the air or while hanging from the flower. The forager returns to the hive with the two packs of pollen and pushes them off into an empty cell or into one with some pollen already in it. The younger house bees then break up the pollen masses and pack them down into the cell. When the cell is full it may be covered with a little nectar and sealed over. Both pollen and honey sealed in the store cells are eaten by the bees in the winter months when no other food is available. Water is collected and used to dilute the nectar with which the larvae are fed, but there is no evidence of water being stored. Propolis is a resinous substance that the bees collect from trees and sticky buds. They use it for sealing small cracks and gaps in the hive. When the size of the colony reaches a certain stage, usually in Spring or Summer when the nectar flow is at its greatest, the queen and a great many workers, leave the hive in a swarm. The swarm comes to rest in a great cluster on a tree branch or similar situation. Scout bees, who may have left the hive some days before, seek out a suitable situation for a new nest and return to the swarm and communicate this information, whereupon the whole swarm moves off to the new site.

4: Mating Biology of Honey Bees - American Bee Journal

Winston's Biology of the Honey Bee, though dated given the mass volume of new information concerning honey bees available today [], provides an excellent overview of the biology and life history of honey bees. Well worth reading if you are a beekeeper.

With an average lifespan of only two to five weeks for summer bees much can be accomplished, including; raising thousands of larvae, gathering pollen, secreting wax comb, creating pounds of honey and royal jelly, and protecting the hive. These honey-producing pollinators are constantly at work. Below, get just a taste bee biology and, if raising honeybees is on your bucket list, explore our article on beekeeping. For more in-depth information and the latest honeybee research explore Bee Culture , a website devoted to science-based beekeeping. They are eusocial animals, living cooperatively in a colony and organized into hierarchical castes with different corresponding responsibilities. A complex system of chemical cues helps to create the conditions that dictate the sex and caste of new bees. Worker bees pictured left are female bees, born from fertilized eggs, that engage in the majority of the work: Drones pictured center are male bees produced from unfertilized eggs whose sole responsibility is to reproduce with queens at surrounding hives. They are only produced when the hive is growing, usually during peak pollination season, and before a swarm or when the queen is running low on sperm. Drones die once they reproduce. All drones from the same hive are clones of the queen since they are produced without genetic material from a male bee. There is only one laying queen per hive and she can live several years under healthy conditions. She mates mostly with drones from other hives. When her health is weakening or the hive is preparing to swarm, she will emit pheromones to help create new, virgin queens which can start new colonies. She mates with various male drones generally drones produced from other hives and stores their sperm to be used throughout her life. A queen bee is larger than workers or drones and her chemical signals usually dictates the activities of the other bees. Queens are, however, not immortal. Hives can find themselves queenless, usually due to a swarm event where the queen leaves the hive with the swarming bees see more about this below , or the natural death of the existing queen. Worker bees, with the help of the queen, are able to create the conditions for the emergence of a new virgin queen. Workers are all genetically similar in that they share common ancestry with the queen. The sperm from multiple drones provides genetic diversity. Worker bees are equipped with stingers and pollen sacs, but unlike the queen, they are unable to reproduce. Instead, the female workers help to care for young, collect and process pollen, produce honey, guard the hive, and engage in general hivekeeping think housekeeping. Bees can signal when the hive is too hot, too cold, when a potential threat is close, when more pollen needs to be collected, when nectar stores are high or low, the direction of food and water sources, etc. Bee colonies have a unique way of reproducing themselvesâ€”swarming. Swarming is when approximately half sometimes more of the worker bees leave the colony with the laying queen to seek out a new place to build another hive. Think of it like a household with multiple generations of families living under one roofâ€”it gets kind of crowdedâ€”inspiring some of the household to go off and build a new house. The queen leaves behind virgin queens in the hive, one of which will become the new laying queen. These cups are usually created at the bottom of the frames in the hive. Recent studies reveal that despite long-standing claims that this liquid concoction of water, proteins, and sugars has special components that virgin queens need to become queens, it might be the opposite. Instead, what virgin queens do not have access toâ€”pollen or honeyâ€”is what makes they develop into virgin queens. Once the virgin queens emerge, they are are not immediately recognized as the queen bee until they are fertilized by drones and emit the proper pheromones. Virgin queens will seek each other out and attempt to kill one another until just only one remains. The swarming can last from several hours to a few days and will subside when the bees find a suitable new goldilocks location to move in to. That is, a space that is not too small, but not too big to accept as their new homeâ€”a notch in a tree such as the one pictured in Graham, Arizona , an old building wall, or a rock crevice, are preferred locations. Once a destination is chosen, the entire swarm will move in and begin producing wax comb while the queen will begin to lay new eggs. Love them or fear them, there is no doubting their efficiency, complexity, and

beneficial pollination services. Next time you are in your gardens and a honeybee lands on a nearby flower, take a minute to acknowledge these amazing insects. For more in-depth information and the latest honeybee research, explore Bee Culture or connect with other local beekeepers.

5: Honeybee Biology

1. Introduction 2. The Origins and Evolutionary History of Bees 3. Form and Function: Honey Bee Anatomy 4. Development and Nutrition 5. Nest Architecture 6.

This is essentially the same for a solitary insect, but in choosing a year-round colonial habit, honey bees are obligated to possess efficient behaviors in foraging, recruitment, food hoarding, and cold temperature survival. Moreover, the colony must reproduce as early as possible in the season to permit the new colony enough time to make a nest, forage, and store food for its winter needs. Some social species have solved the problem by rejecting colonial life over winter; in these species it is only the newly-mated queens that survive winter, entering a state of hibernation over the cold months and emerging the following spring to single-handedly forage and establish a new colony. Examples of these so-called annual colonies are found in the bumble bees and most social wasps. Overwintering With that background we can now examine the annual cycle of a colony of Apis mellifera, and I begin in the dead of winter. At this point, the bees are clustering in the center of their nest to conserve heat. Their precautions against winter chill actually began months or even years before when the colony chose its nest site. Cavities in old-growth trees, with high insulating properties, constitute the natural nest site for European Apis mellifera. Deep inside this nest, individual bees make the cluster contiguous in spite of the intervening combs by entering empty cells head-first; in this way the only distance separating bees is a thin comb mid-rib, not the entire comb. In the center of the cluster are the queen and a cadre of workers that are actively generating heat by consuming honey and shivering their thoracic flight muscles. The heat dissipates outward through the mantle bees who conserve the heat by clustering more or less tightly depending on ambient temperature. Over-heating is also a risk, and the mantle bees regulate this by opening channels through which cool air can flow into the cluster. Thus, winter temperature maintenance is a dynamic process of heat generation, conservation, and compensatory cooling. It is also energetically costly, requiring continuous withdrawals from limited food stores. For this reason, the cluster is never far away from stored food, and in a typical winter nest the clustering bees cover and occupy open cells while immediately above them is an arc of stored pollen and above that an arc of stored honey. The cluster is capable of moving slowly usually up or laterally, rarely down to access fresh food stores. Spring and the reproductive cycle There is no brood the first half of winter, which means the cluster can tolerate relatively wide temperature swings at its core. But once the winter solstice is passed, usually when temperatures are coldest, the colony now does the unthinkable â€" begins building up for its reproductive phase. In the center of the cluster the queen begins laying eggs and immatures begin developing. Temperature swings can be tolerated no longer and this signals an increase in the rate of food consumption and heat generation. It is no surprise that the greatest risk of colony starvation and freeze death happens in mid- to late-winter. Moreover, it is no surprise to learn that many colonies fail at this high-stakes gamble. It is sad but true, winter starvation is the norm not the exception for Apis mellifera. But under a happier scenario, the colony is able to accommodate its reproductive rate with its food stores. And once the earliest nectar sources become available the colony can supplement its precious stores with new provisions. At this point colony growth leaps forward rapidly: This pattern of reckless growth continues for several weeks, limited only by the daily ebb and flow of food resources. It is aimed at one thing: The process necessarily involves the production of queens, and a point is reached, usually around mid-spring, when the colony begins rearing queen cells. The process is fitful, and over the course of weeks a colony may tear down its swarm cells if foraging turns bad, only to start them again once fortunes improve. But if all goes well a day will come when the colony has several queen cells in various stages of construction, including some nearly ready to emerge. The actual event tarries until afternoon â€" nearly always a warm day with a good nectar flow in progress. Groups of workers begin a frenzied wave of running action around and around the interior of the nest. The old queen mother is bitten, jostled, and otherwise worried into a state of excitement. The queen alights on some object, usually a tree branch, and her pheromones orient the cloud or swarm into an increasingly tighter radius as bees discover the queen and begin alighting on the branch around her. Before long a conspicuous ball of bees forms on the branch Fig. This is a temporary staging situation and

lasts only a few hours. From the cluster, scout bees confirm the location of a nest cavity and before long the swarm takes wing again and enters its new home. There is evidence that the nest scouting process begins days in advance of the actual swarm, so that the function of scouts on the day of swarming is more accurately described as reorientation relative to the new position of the swarm. Cells opened at the tip indicate that a queen emerged from them normally. Once established in the new cavity, there is one over-riding objective: The bees, engorged with honey from the parent nest, immediately begin secreting wax scales and forming them into the combs necessary for brood production and food storage. Comb building must continue even after the initial honey supplies are consumed and since the stimulation of wax glands requires continuing supplies of nectar, colony growth can be stalled if floral resources temporarily dry up. The queen begins egg laying as soon as combs are built â€" within hours. In the remaining weeks of spring and summer, combs are built, brood reared, a forager force produced, and food gathered. But turning our attention back to the day of swarming, there is another drama playing out back at the parent colony â€" queen succession, by no means a neat and tidy affair. In the simplest scenario, the first of the emerging daughter queens engages in a campaign of fratricide, personally killing each of her rival sisters in their cells. It is easy to identify aborted queen cells because they are opened from the side. Cells opened at the tip indicate that a queen emerged from them normally Fig. Once her rivals are eliminated the new queen takes her mating flights and begins laying eggs, and the parent colony settles down to rebuilding its foraging force and storing up a winter food supply. If a colony is especially populous it may swarm not once, but twice or even three times. Each swarm requires a queen, the old mother in the case of the first, and a daughter in the case of the later. The workers regulate this process by protecting, or not protecting, queen cells from rival sisters. But once the reproductive impulse is satisfied the workers cease protecting queen cells, the last surviving daughter assumes headship of the colony, and the colony spends the rest of the season preparing for winter. Supersedure cells on the comb face, not along the comb edge. It is important for a beekeeper to know the difference between queen cells made to replace a failing queen â€" called supersedure cells â€" and those made under the swarm impulse. Supersedure cells can occur any time in the active season when a queen is failing or is lost. Because they are made in response to a time-specific event â€" the loss of a queen â€" they tend to be uniform in age. They tend to occur on the comb face, not along the comb edge Fig. They also tend to result in comparatively poor queens because their construction is not necessarily associated with resource-rich times of year. Swarm cells, on the other hand, are more numerous, occur at various stages of maturity, and are associated with early spring nectar flows Fig. Foraging regulation and recruitment Over the course of twelve months a honey bee colony ranges in population from about 10, to 60, insects. This translates to an average biomass of ten pounds, the size of a small dog. This dog-sized entity needs at least pounds of accumulated honey and pollen to survive winter. So far so good. But what makes these numbers impressive is the fact that honey bees have so few weeks of a week year in which to harvest that nutrient income. In most temperate regions the nectar season is brief, measured in weeks not months. Therefore, honey bees must be efficient foragers. Honey bees express this efficiency in at least two notable ways: Swarm cells are numerous, occur at various stages of maturity, and are associated with early spring nectar flows. There is evidence that certain cohorts of bees in the nest are able to appraise the resource needs of the colony and communicate that need to foragers by way of a feedback loop. It works this way: This enthusiastic reception encourages foragers to continue foraging for the same resource. But if, on the other hand, the greatest need is for water, then foragers with nectar are not relieved as quickly as those carrying water. A lackluster reception at the nest encourages foragers to switch to a different resource. Foraging efficiency is also displayed in one of the most celebrated attributes of honey bees â€" nestmate recruitment. Honey bee foragers, upon discovering a new resource, return to the nest and recruit nestmates by means of a dance language that communicates symbolically the distance of the resource from the nest and its location. Dancers communicate the relative richness of their resource by giving nectar taste samples to their sisters and varying the tempo of the dance: Since any given colony has hundreds or even thousands of scouts and foragers dispatched at any time, there may be competing dances occurring on different parts of the comb. But foragers are able to assess the dances and concentrate on those communicating the richest resources. Because the network of recruiters is pervasive and responsive, spreading amoeba-like throughout the habitat,

the colony is a model of rapid response. Once a rich resource is discovered a foraging force can be marshaled within minutes. The sum effect of foraging regulation and nestmate recruitment is a high pitch of foraging efficiency at the colony level. Foraging efforts are focused on those resources most needed by the colony, and the recruitment network assures rapid exploitation of any resources available. Back to table of contents for First Lessons in Beekeeping: Honey Bee Biology Source:

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6: The Honey Bee (Apis mellifera), life-cycle structure and behavior. Biology article by D G Mackean

A lecture given by Jamie Ellis at the National Honey Show entitled "Biology of the Honey Bee". The National Honey Show gratefully acknowledge the sponsorship of the Garfield Weston Foundation.

For thousands of years, humans have plundered natural honey bee colonies to get honey, bee larvae and beeswax. In more recent centuries, bee plundering has given way to bee management. Today, honey bees are kept in artificial hives throughout the United States, and a large and sophisticated beekeeping industry provides valuable honey, beeswax and pollination services. A large section of the industry, well represented in Georgia, is devoted to producing queens and bees for sale to other beekeepers. Although many people make a living from bees, most beekeepers are hobbyists who have only a few hives and who simply enjoy working with these fascinating insects. Honey Bee Castes Honey bees, like ants, termites and some wasps, are social insects. Unlike ants and wasps, bees are vegetarians; their protein comes from pollen and their carbohydrate comes from honey which they make from nectar. Social insects live together in groups, cooperate in foraging tasks and the care of young, and have different types, or "castes," of individuals. In honey bees there are two genders, the females of which are further divided into two castes â€" sterile workers and fertile queens: Workers - Reproductively underdeveloped females that do all the work of the colony. A colony may have 2, to 60, workers Fig. Queen - A fully fertile female specialized for producing eggs. When a queen dies or is lost, workers select a few young worker larvae and feed them a special food called "royal jelly. Therefore, the only difference between workers and queens is the quality and quantity of the larval diet. There is usually only one queen per colony. The queen also affects the colony by producing chemicals called "pheromones" that regulate the behavior of other bees Fig. Drones - Male bees. A colony may have 0 to drones during spring and summer. Drones fly from the hive and mate in the air with queens from other colonies. Drones are kicked out of the hive during the winter months Fig. Developing young honey bees called "brood" go through four stages: The types of bees have different development times Table 1. These intervals, however, are literature averages and do not always apply locally. For example, it is common for worker bees in Georgia to emerge in 19 days and queens in

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7: The Biology of the Honey Bee by Mark L. Winston (, Paperback) | eBay

Honey Bee Biology Seasonal cycles of activities in honey bee colony A colony of honey bees comprises a cluster of several to 60, workers (sexually immature females), a queen (a sexually developed female), and, depending on the colony population and season of year, a few to several hundred drones (sexually developed males).

The other is interested in securing a large honey crop to sell at the market. Both goals involve large honey supplies, but the beekeeper wants to accomplish this without permitting colony-level reproduction which is a road-block to maximum honey crops. A solid grounding in bee biology is necessary to be a successful beekeeper. Social life The agenda of a honey bee colony is this â€" to reproduce itself and survive next winter. A peculiarity of the honey bee and other social insects is that they have chosen a colonial life structure to help them do this. Female worker honey bee Fig. Female queen honey bee Most people have an intuitive sense of what the term social insect means; there is something fundamentally different between a wasp colony in my carport and a cockroach family under my sink. By social insect entomologists mean a species that possesses all three of the following characteristics: By cooperative brood care we mean that females of the species share the burden of rearing the young, whether their own or others. By overlapping generations we mean that some offspring remain at the nest to help their parents rear more siblings. In nature it is possible to find species that exhibit only one or two of the three defining characteristics, but one that possesses all three simultaneously for at least part of the year is termed truly social, or eusocial. All species of honey bees are eusocial, as are all termites and ants. Bumble bees are considered primitively eusocial because they achieve a truly social state only after the solitary overwintering queen rears her first batch of brood in early spring. Wasps display a range of life histories from solitary to eusocial All this means that when we discuss honey bee biology it must be discussed on two levels: Individuals reproduce, develop, interact with their environment in a way to optimize survival, senesce, and die. It just looks different. The biology of individuals Fig. Male honey bee, often called a drone There are three types of individuals in a honey bee colony: The fact that there are two different types of female is an example of what is called a caste â€" a functionally different form of the same sex. One often reads that workers, queens, and drones constitute three honey bee castes. This is not true; they constitute two sexes, the females of which are divided into two castes. Some things in common Fig. The queen deposits an egg singly in the bottom of a beeswax cell Fig. The larva is an undistinguished white grub and quite active although this movement is undetectable to a casual observer. The three types of bees share some fundamental characteristics. Bees, as members of Class Insecta, share with other insects a body plan comprised of three major regions: The head houses a large share of the sensory organs, chief of which are the eyes and antennae, as well as the mouth parts comprised of sucking parts together called the tongue and chewing parts. The middle body region, the thorax, houses the locomotory appendages, the legs and wings, and the muscles for powering them. The abdomen is the chief repository for organs of digestion and reproduction. Bees belong to that group of insects that engage in complete metamorphosis â€" that is, insects in which an individual passes through four developmental stages: In the case of honey bees, the queen deposits an egg singly in the bottom of a beeswax cell Fig. The larva is an undistinguished white grub and quite active although this movement is undetectable to a casual observer Fig. As worker bees place food in its cell, the larva moves forward to consume it; hence, the larva adopts a C-shaped posture during its feeding career. A few days later when the feeding phase is over the larva enters an intermediate stage known as the prepupa Fig. The pupa looks superficially like an adult. The three major body regions become apparent for the first time, but there is no pigmentation, hair or wings, and the individual moves little or not at all. In the remaining days of development, the pupa darkens gradually and develops hair and wings and after a few days chews through its cell capping and emerges as an adult Fig. In general the number of days from egg to adult is 21 for the worker, 24 for the drone and 16 for the queen, but these numbers vary by race and location. Worker cells are by far the majority, tend to occupy the central regions of a comb face, and have uniformly flat cappings Fig. Drone cells are larger in diameter, the cappings more rounded or bullet-shaped Fig. Queen cells are the least numerous, totaling at most around 20 per colony. They are the size and shape of a peanut and comprise the only brood

cells oriented in a vertical posture relative to the comb face Fig. The biology of workers Fig. Worker cells are by far the majority, tend to occupy the central regions of a comb face, and have uniformly flat cappings. Drone cells are larger in diameter, the cappings more rounded or bullet-shaped. Of the three bee types, workers are the most numerous, behaviorally diverse and interesting. It is workers that care for the queen, feed the brood, clean and defend the nest, forage for food, recruit nestmates to food sources and make the kind of decisions popularly ascribed to the queen. For example it is workers, not the queen, who determine the types of resources â€" protein, carbohydrates, propolis or water â€" needed by the colony and communicate that fact to the workers engaged in foraging. Similarly it is workers, not the queen, who decide if and when the colony reproduces â€" a complicated process called swarming. Just as they are the most behaviorally complex, workers are the most anatomically complex. To carry liquid loads of nectar or water, workers suck up liquids into their honey stomach â€" the first chamber of a three-chambered stomach, and regurgitate their loads back at the nest. On their hind legs they have a complicated structure called the pollen basket in which they carry pollen loads. The most famous worker anatomical specialization is their persuasive sting assembly comprised of a venom gland and barbed stinger. Glands occur on other parts of the body for producing brood food, beeswax, and pheromones â€" external hormones that regulate the behavior of other bees. It should come as no surprise that workers, not the queen or drones, have the greatest cognitive powers, displaying remarkable ability to exchange information, learn, make decisions and navigate. Workers are notoriously poor egg-layers, and they deposit eggs either multiply or singly in an irregular pattern inside cells. As one of the two female castes in the honey bee colony, workers have functional ovaries and are capable of producing eggs and progeny. However, workers are not capable of mating, and in the ants, wasps and bees this condition results in eggs that have half the normal number of chromosomes which, in turn, results in progeny that are exclusively male. In a normal colony with a queen called queenright , this type of worker reproduction is limited by the interaction of queen pheromones and brood pheromones that collectively suppress activation of worker ovaries. But in queenless colonies there is no such pheromonal suppression, and a condition of laying workers results. Workers are notoriously poor egg-layers, and they deposit eggs either multiply or singly in an irregular pattern inside cells Fig. The biology of queens Fig. Queen cells are the size and shape of a peanut and comprise the only brood cells oriented in a vertical posture relative to the comb face. In the beginning, any female egg has the potential to develop into either a queen or a worker. It all depends on the kind of diet the young larva receives after it hatches. If the colony wishes to rear queens, nurse bees choose one or more young female larvae and begin feeding them a special glandular secretion called royal jelly which triggers development of queen-like characters. This window of opportunity is brief. The larva must begin its royal jelly diet within a few hours of hatching and continue the diet uninterrupted its whole larval feeding career. There is a direct relationship between the duration of the royal jelly feeding regimen and quality of queen that results. A queen whose royal jelly diet is delayed or truncated will be sub-optimal in her queen-like morphology and performance. In controlled laboratory feeding conditions it is possible to rear bizarre intercastes â€" individuals with varying degrees of worker-like or queen-like traits simply by varying the days spent on royal jelly. The royal jelly triggers development of queen-like characters such as full-sized ovaries, the ability to mate and store sperm, and glands for producing queen pheromones. The egg-laying proficiency of queen bees is legendary, with numbers up to per day not uncommon. Within the first two weeks of life, a newly-emerged queen takes a succession of mating flights during which she mates with up to twenty drones on the wing. She is able to store their sperm in an organ called the spermatheca over which she has muscular control to release, or withhold sperm. As an egg passes down her median oviduct, the queen can fertilize it and produce a female, or withhold fertilization and produce a male. The egg-laying proficiency of queen bees is legendary, with numbers up to per day not uncommon Fig. The ability to fertilize eggs seems to deteriorate in aged or failing queens, with the result being a disproportionately large amount of drone brood in the colony, intermixed in uncharacteristic fashion with worker brood Fig. The ability to fertilize eggs seems to deteriorate in aged or failing queens, with the result being a disproportionately large amount of drone brood in the colony, intermixed in uncharacteristic fashion with worker brood. Workers constantly lick and groom the queen, pick up her pheromones and pass them on to other workers. In this manner, queen pheromone is constantly

circulating throughout the colony exerting its profound behavioral and physiological effects on the inmates. This stabilizing effect is easily demonstrated when a beekeeper removes a queen; the colony shows visible signs of agitation within 30 minutes. The biology of drones Fig. Some beekeepers have made a life hobby of monitoring drone congregation areas. In explaining immature development and the mating behavior of queens I have almost by default exhausted the biology of drones. Drones are good for little besides mating with queens. Drones stay in their natal colony for the first couple weeks of life, living off the largesse of nest bees before reaching maturity at which point they begin participating in daily afternoon flights. These tend to be gregarious affairs in which large numbers of drones from numerous colonies pool together to fly in a comet-like mass around the neighborhood. The paths followed by these drone comets tend to be the same year after year and are associated with permanent landmarks such as prominent trees, hedgerows and the edges of forests. Some beekeepers have made a life hobby of monitoring drone congregation areas Fig. The persistence of drone congregation areas is especially distinctive when one considers that short-lived drones have no chance for inter-generational learning, as for example with salmon who are spawned in the same pool as their parents. Young queens on their mating flights seek out drone congregation areas and fly through them, inciting a frenzied chase during which she copulates with several drones. It is apparent that drone congregation areas are an effective strategy for both drones and queens to optimize mating success. Back to table of contents for First Lessons in Beekeeping: Honey Bee Biology Source:

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There are three types of individuals in a honey bee colony: female workers, female queens, and males often called drones (Figures). The fact that there are two different types of female is an example of what is called a caste - a functionally different form of the same sex.

The queen basically keeps the workers uninterested in reproduction on their own by secreting a pheromone. This chemical is spread from body to body among the workers starting with those tending the queen. The other job of the queen is to lay eggs and this task consumes all her conscious effort. You might wish to calculate this rate down to the minute and you will see that she has no time to eat or fly around. A group of five to ten workers feed her a small bit after she lays about 20 eggs. In fact, if she stops making pheromone or laying eggs, one of her most recent eggs will be moved to a specially prepared queen cell to produce a replacement queen. The newly hatched queen destroys any other unhatched queens, fights to the death any hatched queens, may destroy her mother, and then takes her mating flights. The mating flight follows a pattern. The virgin queen flies to a congregation area where hundreds or thousands of unrelated drones await. The drones pursue the queen and several mate with her in flight. The drone mounts the queen, inserts his endophallus, and ejaculates his semen. During ejaculation, the male falls back and his endophallus is ripped out of his body and remains attached to the queen. The emasculated drones die very quickly with their abdomens burst in this fashion. The one or few mating flight s in her first few days of life are her last. Should the old queen run out of sperm, a new queen will be produced through the intervention of the workers. The Specialized Drone Bee Drones are tolerated in the hive only when there is a possibility that they may mate with a queen. Thus a few are tolerated in spring and fall, more in the summer, but none in the winter. The workers keep the drones out of the hive to starve to death in the autumn. Drones, like queens, lack the body parts to effectively harvest nectar or pollen to feed themselves. Drones also lack a stinger of any kind. They are designed for mating only. If the drone succeeds in this, it dies. Thus all surviving drones are virgin. The Important Worker Bee Workers, as their name implies, do most of the "work" around the hive. They secrete wax from glands on the abdomen and fashion the honeycomb and broodcomb from it. This comb contains hexagonal cells large enough to hold a developing worker or drone, a small quantity of honey, or pollen. When the cells are filled with honey, pollen, or a pupa, a worker caps the cell thereby sealing the contents inside. The workers tend the queen and young drones as well as the young brood. All bees develop through a complete metamorphosis: It then goes into a resting stage, the pupa, which lasts for another few days in a capped cell until the bee emerges as an adult. This process takes days depending on season and class of bee. As mentioned previously, workers feed the young larvae and seal the pupa into the cell. They also feed the emerged young adults until they are old enough to fend for themselves. The young worker tends larvae and uses its wings to help ventilate the hive. As it gathers strength, it will start cleaning out old used cells for reuse, may tend the queen or young drones, or work on capping cells. Depending on the season, and after a few days have passed, the worker works at gathering operations. The bee will fly out of the hive and visit flowers in search of nectar and pollen, or will visit trees for harvesting resin to make propolis. The propolis is used as glue and caulk to seal cracks in the hive. Pollen is stored in broodcomb cells and is the main supply of protein and vitamins for the hive. Nectar is placed in honeycomb cells and the bees tending the honeycomb evaporate the water from the nectar by rapid wing movement to create ventilation. A mixture of honey and pollen is called "bee bread" and is the food for most larvae and bees. The larger cell for growth, larger food supply, additional carbohydrate, and more worker secretions results in the development of a queen. The workers defend the hive with their sting. Rather than developing extensive ovaries, the worker bee develops a barbed stinger and a muscular venom pouch. When it is necessary to kill an intruder, a worker pushes the tip of the stinger into the surface of the intruder. The muscular barbed stings quickly saw their way into the skin of the invader and the venom pouch begins to contract rhythmically to pump venom into the intruder. Generally the bee pulls herself away, leaving the venom pouch and sting in the invader; the worker soon dies because of the abdominal rupture. Thus stinging for honeybees is an act of self-sacrifice. Unlike many other hymenopterans, honeybees

are not likely to sting unless provoked.

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A few years ago, I had the distinct pleasure of meeting Drs. Niko and Gudrun Koeniger. Dr. Niko Koeniger is the former head of the German bee research institute in Oberursel, Germany and professor of biology at the Goethe University in Frankfurt.

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