The Fascinating Honeybee

It's a beautiful, crisp, sunny day in late October. A gentle breeze swirls the kaleidoscope showers of multi-colored leaves into drifts, foretelling the drifts of white that will soon replace them. Birds sing sweetly, praising the beauty of the day with melodic harmonies. All seems serene and peaceful in the neighborhood. But deep within the recesses of one home, a life and death struggle is taking place: a young male is being cold-bloodedly murdered by his sisters.

The young male is a honeybee. He's only a couple of months old, but he's lived a pretty cushy life – that is, up till now. Male honeybees are called drones, and their sole purpose in life is to mate with a queen honeybee. Drones do not work; they simply eat, loaf, and fly around looking for a queen on her mating flight. But with winter approaching, there will be no queen bees on mating flights for months, and so the drone has outlived his usefulness.

During the long, hard winter, the hive will have to survive on the honey they've stored up during the summer. There will be no other sources of food during the winter, and if they run out of stored honey before spring, the entire hive will perish. So the now useless males will not be tolerated. When their instincts tell them that the time has come, the worker bees – all female, and all offspring of the same mother queen – drag the hapless drones out of the hive. If the outcasts attempt to return to the hive, they are repelled, and so soon die from exposure or starvation. Fewer mouths to feed increase the odds of the hive surviving the winter.

Nature can be cruel, but also fascinating. And few of nature's creations are more interesting than the honeybee.

All the Comforts of Home

Honeybees have an amazing ability to adapt to harsh environmental conditions. The target temperature for the interior of a hive is 95° F, but it has been shown that bees are able to maintain this temperature in the brood nest (where the queen lays her eggs) through an outside air temperature range of -50° F to more than 150° F.

In the wintertime, bees maintain the temperature within the brood nest by forming a cluster, thereby concentrating their body heat in the center of the cluster. As the outside temperature falls or rises, the cluster tightens or loosens in response, maintaining the brood area at target temperature. The outer layer of the cluster consists of bees that are packed very tightly together, with their heads pointed toward the interior of the cluster. The bees in the outer layer are crowded so tightly together that the fine hairs on their bodies interlace, trapping air that serves to further insulate the interior of the cluster. The outer layer bees periodically change positions with interior bees, preventing the exterior bees from eventually succumbing to the cold.

If the outside temperature continues to fall once the cluster has contracted to its tightest, the bees maintain the core temperature by converting stored honey into heat. The bees

consume honey and use it to fuel the constant shivering of their flight muscles, producing heat.

In hot weather, the bees respond by reversing the winter cluster, and increasing the space between individual bees within the hive. If necessary, a number of bees will vacate the interior of the hive and cluster on the outside, reducing the congestion and the body heat within the hive. Honeybees also have the ability to air condition their hive. They do this by distributing water droplets in strategic locations throughout the hive, and using their wings to generate air movement. The bees on fanning duty will orient themselves such that fresh air is drawn into the hive, circulated throughout, and then exhausted. As the air passes over the droplets of water within the hive, the water evaporates, and lowers the temperature of the air through the physics of evaporative cooling.

In extreme heat, individual bees will even hold a drop of water in a thin film across their mandibles, exposing a greater surface area of water to the airflow, and thereby increasing the effectiveness of the evaporative cooling.

Master Builders

Somehow, within the darkness of the hive, thousands of bees work together to create an engineering marvel. Honeycomb is constructed of wax that is derived from the blood of the bee, and secreted in scales from glands on the abdomens of worker bees. The comb is used for storing honey and pollen, and for raising brood. The cells are constructed so that they tilt slightly upward from the base to the opening, preventing nectar and honey from flowing out of the cell.

In the hexagonal geometry of the cells, nature has engineered the optimum compromise between strength and utilization of space. Though the walls of each cell are no thicker than 2 or 3 thousandths of an inch, the comb is able to hold 22 times its own weight. So efficient is the weight to strength ratio of honeycomb construction that man has copied it in thousands of engineering applications.

Are You Talking to Me?

Perhaps no single characteristic more defines a species than the means by which members of the species communicate among themselves. Honeybees are highly social animals, and without effective communication, the complex social structure of the hive would not be possible. There are several means through which honeybees communicate, one of the most interesting of which is dancing.

Honeybees, of course, must forage for their food. At any one time, as many as 35% of the foraging bees of a colony will be serving as scouts, searching for new, untapped sources of nectar and pollen. With a potential foraging area of more than 200 square miles, the scouts need to be able to communicate their findings to other members of the colony, and they do this by dancing.

Through variations of the speed at which the dance is executed, the pattern of the dance, and acoustic signals emitted by the dancing bee, the distance and direction to a food source can be communicated. Movements by the dancing bee relative to gravity are translated into bearings relative to the sun by the audience bees. Samples of the nectar from the new source that are distributed by the dancing bee, along with the fragrance of the new source clinging to the dancing bee's body, further assists in identifying the new source. Many plants yield nectar or pollen only during a specific time of day, and even this bit of information about the new source is communicated by the dancing bee, since the dance only occurs during the time of day that the source is available.

Remarkably, all of the information transfer that occurs through dancing takes place within the depths of the hive, in total darkness. None of the bees are able to see the dance. The bees are able to sense the movements of the dancer by touch – with some of the audience bees even mimicking the dancer – and also through a perception of the air movements created by the dancer. It's thought that bees are able to sense the direction of movement of the air particles set in motion by the dancing bee.

It's interesting to note also that nature has built a defense mechanism into the dancing method of communication. Scout bees, upon discovering a new source, will make a number of trips to the new source before announcing the discovery to the hive. Therefore, the scout bee may succumb to any natural toxins or pesticides present in the new source, or to extraordinarily heavy predator activity that may be in the vicinity of the new source before communicating the find. This delay may spare the hive the losses it might otherwise incur if the scout bee divulged the discovery immediately.

What's That Smell?

Pheromones - a chemical or mixture of chemicals that serves to transmit a particular message or signal - are a primary means of honeybee communication. Honeybees secrete many different pheromones, and these play crucial roles in helping to regulate the activities of the hive.

A pheromone released during the process of stinging spreads an alarm signal throughout the hive, and serves to mark the sting victim as the target for bees responding to the alarm. Queen pheromones identify the queen to other members of the hive, and help drones to locate her during mating flights. Foraging honeybees even mark flowers that are found to be inadequate sources of nectar or pollen with a scent that basically says "don't waste your time here" to any bee that may visit that flower later. Conversely, pheromones deposited on a flower by the feet of a foraging bee may inform a later visitor "there's good stuff here!"

In Name Only

The term "queen bee" is somewhat of a misnomer. The queen of a honeybee colony is not a ruling monarch; her sole duty is to lay eggs. She makes no decisions beyond choosing the cells in which to lay her eggs. With only one queen per hive, all of the bees in the colony are the offspring of the queen. She is fed and groomed by her daughters, and her every

need attended to. But when the day comes that she is no longer productive enough to satisfy her daughters, they turn on her and commit matricide. In a rush, the queen is suddenly covered with bees ripping at her wings, tearing at her legs, and attempting to sting her. Once she is dead, her body is disposed of by removing it from the hive, and a new queen is reared to take her place. Long live the queen!

How Sweet it is

The primary reason that mankind has historically held the honeybee in esteem is, of course, honey. For many people throughout history, honey has been the only sweetener available. And though the modern world offers many alternative sweeteners, honey remains a prized commodity.

Much as with hot dogs or sausage, however, it may be best to enjoy honey without knowing the details of how it's made. But for those who are interested, honey is the regurgitated nectar of flowers, carried from the flower to the hive in the bee's honey stomach where it is mixed with some enzymes from the bee's saliva. When the foraging bee returns to the hive with her load of nectar, she transfers it to a young worker bee that begins the process of "ripening" the nectar. The nectar is ripened by reducing the moisture content of the watery nectar, transforming it into the thick, syrupy consistency of honey.

The ripening process is begun when the house bee repeatedly ingests and regurgitates the nectar, exposing it to the drying air, and then finally depositing it in a honeycomb cell where it will continue to ripen until the cell is sealed with a wax capping. Fortunately, the delightful taste of honey helps to excuse its somewhat unsavory genesis!

A little bit of honey is the fruit of a massive amount of labor on the part of the honeybees. One single pound of honey requires 2 million visits to flowers, representing a cumulative flight distance of more than 55 million miles. One single teaspoon of honey represents the life's work of 12 honeybees.

We value honeybees for the honey and wax that they provide, and we also depend upon their pollinating activities in the production of many of our foods. But they also help to make the world a fascinating place to live.