How Bees Keep Warm in Winter

Entomology

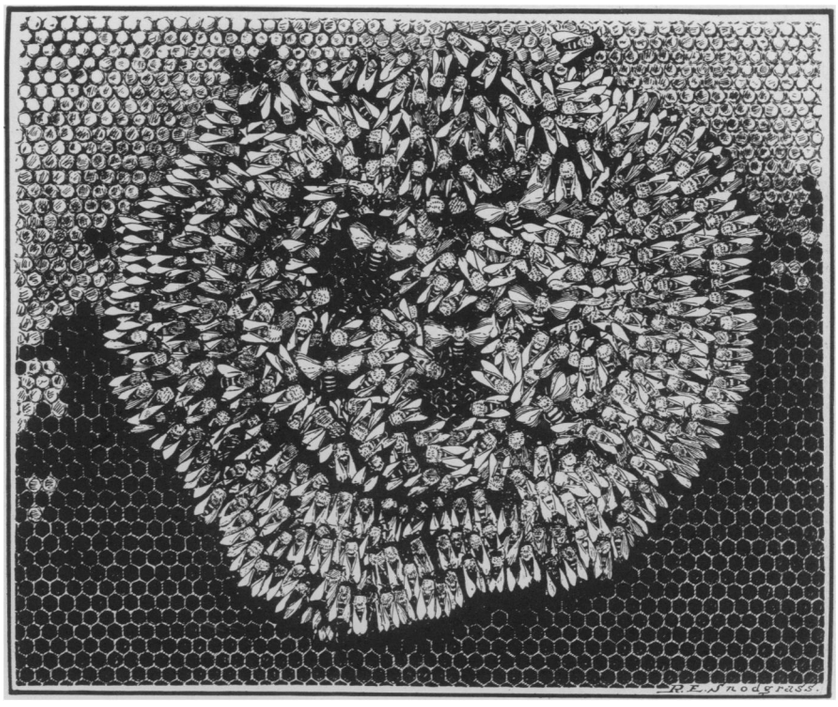
By MARJORIE MACDILL

When the last of the asters and goldenrod are gone and the thrifty ant is all set to hand out unfeeling sarcasms to her shiftless neighbor, the erstwhile giddy grasshopper, then the honey bee knows that her sunshiny peregrinations from flower to flower must give way to more restricted but none the less strenuous activities within the darkened hive of winter.

Before modern industry developed the great sugar plantations of the tropics, the only readily available source of concentrated sugar was honey. Since a perennial sweet tooth seems to have been an integral part of human nature ever since man was a man, his intimate association with the honey bee antedates his knowledge and interest in any other insect. For thousands of years he ran a neck and neck race with the bears in locating and looting bee trees until sometime, probably in the New Stone Age, he turned apiarist by inducing the honey makers to live near his dwelling in sections of hollow logs, empty baskets and earthen vessels. Bees have been kept by savage tribes throughout the ages wherever the climate has been such that the industrious insects could endure. Bees figure in inscriptions on Egyptian monuments dating back to the fortieth century before the Christian era, while there is documentary evidence that the same people under the Pharoahs could get their fill of honey at the very reasonable rate of five cents per quart.

In spite of the venerable antiquity of bee lore, however, scientists continue to discover new secrets of the mysterious community of the hive that their predecessors barely suspected. One of the most vexing problems of the beekeeper on which recent research has shed much helpful light, is how to get the colonies through the winter without sustaining heavy losses from the cold.

Now, despite the advent of the ice cream cone, the all day sucker, eskimo pies and the more ambitious confections retailing at $2.00 a pound, honey still retains its place among the gustatory foibles of the children of men and no synthetic art of the chemist has ever been able to duplicate its delectable flavors. Some $80,000,000, roughly estimated, is realized every year from the sale of the products of the bee in this country alone. Of this amount fully ten per cent. has been lost annually from the bees' inability to withstand the cold weather



HEADS UP, bodies parallel, the bees on the outside of the winter cluster, form an insulating shell around the squirming insects inside

Such a valuable industry has naturally been a subject of numerous investigations on the part of Uncle Sam's trained research workers. The Bee Culture Laboratory of the U. S. Bureau of Entomology, located just over the District of Columbia line at Somerset, Md., is one of the most complete outfits devoted exclusively to the study of bees in existence. And it is here that much of the scientific prying into the hibernal customs of the bees has taken place.

Honey bees, unlike their more primitive wild relatives, do not go into a true state of hibernation.

J. I. Hambleton, chief of the Bee Culture Laboratory at Somerset, describes their winter activities as follows: "When the weather is cold enough for frosts the bees gather together inside the hive in a large, more or less spherical cluster. The bees on the outside of the cluster are packed close beside each other with bodies parallel and heads up, together constituting an insulating shell inside of which there is no definite arrangement. These interior bees keep perpetually moving in a restless series of twisting, turning, wiggling gymnastics that are really heat producing exercises. The heat so manufactured is never permitted to run down below 57 degrees Fahrenheit in the exterior insulating shell. This activity is kept up all winter. In cold countries—and bees are kept as far north as Alaska—the hives have to be protected by heavy packing of insulating materials such as sawdust or straw in order to keep the bees from working themselves to death before spring comes."

In order to understand why bees are likely to wear themselves out keeping each other warm, it is necessary to explain a little bit about the physiology of the bee from the time it is first hatched as a larva. All bee babies are fed at first on a remarkable infant food secreted from the forehead of the worker bee. This concentrated substance is known as royal jelly and contains perfectly balanced proportions of the essential food elements, protein, carbohydrate and fat. This (*Turn to next page*)

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food is so rich that scientists at the bee laboratory have found by actual weighing experiments that a worker larva fed on it for six days will increase her weight 1,500 times, an astonishing rate of growth hardly surpassed by any other species. The royal larva that is selected to be a queen increases in weight 2,500 times in five and a half days.

However, in the usual order of things, drones and workers are not fed on this regal diet more than three days. Honey and pollen are their fare thereafter until they are grown up. But the queen subsists on it throughout the larval period, which is shorter for her than for either of the other two social castes. It should be borne in mind that the circumstances that make one of the countless larvae into a queen do not depend on food alone. The size and shape of the cell of the queen larva are also factors. Not even the gravest emergency of the hive can transform a worker larva into a queen by appropriate housing and food, if the larva is more than three days old. After that it is too late.

"When the adult bee," resumed Mr. Hambleton, "emerges after living on this highly concentrated diet, she is possessed of her maximum strength. She lives on honey, one of the most efficient energy-producing foods known, but she cannot rest or replace wornout tissue like the higher animals or human beings. She is like a tiny, highly perfected living machine destined for a duration of life, under active summer conditions, of about six weeks. Consequently if she uses up her alloted fund of energy too fast doing her bit keeping the colony warm during the winter, she will die before spring. For these reasons it is very important that there should be plenty of young strong workers in the hive thoroughly capable of standing the strain of keeping up their endless heat producing gymnastics throughout the dark months of winter.

"In order that the colony should be supplied with plenty of young unworked bees in late fall, the wise beekeeper sees that the queen has plenty of space in which to lay eggs at the end of summer and early fall by preventing the workers from filling up all the cells with honey. Old queens do not lay as many eggs as the summer working season draws to a close, so many beekeepers replace the queen in their colonies every year. The average queen lives two or three years, though she may last as long as seven. A young and vigorous queen, however, is the best guaranty of plenty of young unworked bees to keep up the hive temperature through the winter months, for most of the old bees die before spring."

The right sort of food is also a very important consideration. Peculiar seasonal variations take place in some of the digestive functions of honey bees during the winter that makes a diet of readily digestible honey of imperative importance for the health of the hive. In general the best honey for winter stores, Mr. Hambleton pointed out, is that gathered during the peak of the honey season of mid-summer. White clover and alfalfa are among the best varieties for this purpose while basswood is not so good.

If the hive becomes afflicted with digestive disturbances from the wrong sort of food, the bees lose their ability to maintain the correct temperature. Their restless activity increases to the point of frenzy with the result that the temperature becomes too high. If it should go up as high as 93 degrees, the queen, deluded into thinking summer has come, starts laying eggs and the colony is doomed. No brood can be raised in the winter time when there are no flowers to furnish pollen and honey for them to eat, but the worker bees wear themselves out in the vain attempt, feeding them from their own accumulation of winter stores.

The scientific work on which the knowledge of interior temperatures of the winter cluster of bees is based, was done under the direction of Dr. E. E. Phillips, formerly in charge of bee culture investigations.

Many attempts were made throughout the history of bee culture to establish the temperatures inside the hive in winter, but most of them failed because mercury thermometers could not be inserted into the cluster without disturbing the bees so that the temperature would react abnormally. Dr. Phillips, assisted by George S. Demuth, was able to solve the problem by the use of specially constructed electrical thermometers fastened permanently in place in the hives undergoing tests, which could be read in the (*Turn to next page*)

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laboratory without going near the bees themselves. These thermometers gave records accurate within 0.09 degrees Fahrenheit and within 0.05 Centigrade.

To insure uniformity the readings were made consecutively on a carefully calibrated instrument at the rate of two a minute, an impossible feat with widely scattered mercury thermometers. After the investigators had studied the temperature of various fixed points within each hive, they found it was possible to use the temperature readings as a substitute for direct observations, and to follow closely the activities of each bee cluster without opening the hives or even going near them.

Through this piece of research it was found that 57 degrees Fahrenheit was the critical temperature of the outside layer of the bee cluster in winter. If the bees are kept where the temperature goes above this point they break the cluster and leave the hive. If for any reason they fail to keep it up to this point for any length of time they die of the cold. Consequently it has been found advisable, explained Mr. Hambleton, to keep colonies in dark cellars where a constant temperature of around 45 to 47 degrees can be maintained. This has proved to be the golden mean, neither too low nor too high, at which the bees seem to survive best.

When bees are kept out of doors all winter it is necessary to pack up the hive with insulating materials like straw, ground cork, or sawdust. Many bees are saved if this is done before the first killing frost of autumn. Beekeepers are urged by the bee specialists to find out from maps of the U. S. Weather Bureau the average date of the first hard frosts in their community and fix up their bees accordingly. Sometimes it helps if the honey made from the fall flowers is taken out and more digestible clover honey or even artificially made sugar syrup substituted, so that a supply of the right sort of food is assured. A single colony consumes as much as 45 or 50 pounds of honey in a winter. The packing is not removed until the frosts of spring are over and the early flowers are in blossom, in May or June usually, except in regions well to the south.

There are in all about 10,000 described species of bees occurring in all parts of the world, of which about 2,000 species are found in Europe alone. When the North American forms have been more thoroughly studied, they will (*Turn to next page*)

Alaska's Golden Age Unearthed

Archæology

Alaska, like Greece, had its golden age, when the people attained the high point of their culture and then dropped to a less admirable level. Evidence of this prehistoric golden age in the Arctic has been brought back to the Smithsonian Institution by Henry B. Collins, Jr., who conducted an expedition to St. Lawrence Island this summer for the Smithsonian and for the American Association for the Advancement of Science.

On the narrow strip of land called St. Lawrence Island, Mr. Collins found a remarkable mound about 20 feet high and large enough to be the site of a compact village. The mound was composed of trash, the refuse and sweepings from an entire village over a period of many centuries. Animal bones and broken tools, bits of ivory and whalebone, pieces of wood carved in fantastic designs, all were mixed in with a binding of earth and permanently hard and frozen from the cold climate.

The most surprising moment in the digging came when the frozen bodies of some of the oldest inhabitants were discovered encased in ice. Six children had been buried there in the side of the mound, each one dressed carefully in his fur and feather garments. The place where they lay happened to become filled with water, which froze, thus preserving the bodies through many centuries. This is the only time that human bodies have been found in such condition, Mr. Collins states.

Ruins of houses made of driftwood and whalebone were in the top layer of the great mound, Mr. Collins said, in describing his excavation of the site. Digging to the bottom of the mound, he found the ruins of the homes of the oldest inhabitants. To reach the most deeply buried deposit, where the oldest layer of ruins lay, Mr. Collins had to dig six feet below the reach of the storm tides. In other words, he explains, the land has sunk since those houses were built on the beach, and this in itself indicates the passage of considerable time.

This oldest layer of houses dates back to pre-Russian days, the ethnologist declares. They are surely 300 years old, and more likely are nearer to being eight centuries old. The village is the most extensive Eskimo settlement ever excavated.

Many harpoons and other tools and weapons were brought back to the Smithsonian collection. Objects displaying the finest art in carving and design were taken from the lowest and oldest level of the mound. These were made in the days of the highest Eskimo culture. The precision of the lines and the fine designs used indicate that these inhabitants were far more clever with their hands and had a keener sense of beauty than any of their descendants in the Arctic. Whether they were some of the "first Americans", some pioneer Asiatics who brought knowledge and skill to the new world, cannot yet be stated, Mr. Collins says. But it is certain that the Eskimos of historic times have lost a heritage of finer things, as the simpler carvings in the top layers of the mound show.

Present-day Eskimos, possibly direct descendants of the artists, came to the island and helped the scientist excavate. In some cases they were able to enlighten him as to the use of the peculiar articles discovered in the deserted village.

New Metal Cuts Glass

Physics—Mechanics

A new metal so hard that it will bore smooth holes in concrete, or cut screw threads in a glass rod, was exhibited for the first time at the convention of the American Society for Steel Treating in Philadelphia. With present-day tools such feats are difficult or even impossible.

The new material, known as carboloy, and consisting of tungsten carbide, a compound of tungsten and carbon, and cobalt, a metal like nickel, is the invention of Dr. Samuel L. Hoyt, of the research laboratory of the General Electric Co. It is so hard that it will cut glass like a diamond, and will even scratch a sapphire, which is next below the diamond in the scale of hardness. Ordinary steel tools are quickly worn down when held against an emery wheel, but the new metal itself wears down the wheel.

One important use for it described by Dr. Hoyt is in the cutting of materials containing metal inserts, as the fiber and metal gears used in automobiles to give quietness. Cutters of cobalt and chromium alloy, the best previously used for this work, require sharpening after machining 150 parts, but carboloy tools have cut 11,000 before they required redressing.

Doctors in Old Egypt

Medicine

ALEXANDRE MORET in *The Nile and Egyptian Civilization* (Knopf):

Medicine, then, was intimately bound up with religious beliefs and magical arts. . . .

Remedies are often accompanied by incantations, allusions to some deity—Isis, Thoth, Horus, Ra, Anubis, Imhetep, Amon-Ra—who was cured by the same prescription, and will come to the aid of the physician. To speak these spells "in the right voice" made a cure fairly certain.

Luckily for the reputation of the Egyptian physician, a papyrus has recently been analysed which reveals a more scientific spirit. The Edwin Smith Papyrus discusses surgical cases, classifying them in order, from the head downwards, in a methodical manner very different from the fanciful exposition of the medical papyrii. In the portion preserved there are ten observations for the head, four for the nose, three for the jaws, five for the temporal region, five for the ear, lips, and chin, six for the throat and cervical verterbrae, five for the clavicular and scapular region, nine for the thorax and breasts, and one for the backbone; the rest is missing. Each case is set forth methodically. The complete exposition of a case comprises: 1, Statement—Remedies for a given case; 2, Observation—If you examine a case presenting so-and-so; 3, Diagnosis—Say of it, "It it such-and-such a malady"; 4, Prognosis—If it is mild, say, "It is a malady which I can treat"; if it is doubtful, "It is a malady which I can combat"; if it is incurable, "It is a malady for which I can do nothing"; 5, Treatment—For a wound in the temple, "Apply fresh meat the first day; then treat with an ointment and honey until healed."

In only one case out of forty-eight, is a magical charm added to the treatment. . . .

We need not be surprised that Herodotus proclaims the triumph of medicine in the country. In Egypt, he says, medicine is specialized, like oracles. "Each physician deals with one malady, not more. And the whole place is full of physicians. Some are established as healers of the eyes, others of the head, others of the teeth, others of the region of the belly, and others of internal complaints." Now, this specialization, which, after all, proves a scientific method, was very ancient; in the Old Kingdom, Pharaoh had physicians "for his two eyes."

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probably prove to be more numerous. Only 500 species, or five per cent., are social, that is, live in organized communities. The remainder are solitary forms of many families some of which are very large and widely distributed. In this huge group the honey bee stands in much the same relation to the other members of the family as man does to the other animals, a fact that has to a certain extent obscured a real knowledge and understanding of the honey bee itself. Much fable, superstition and sontiment have clouded over the accurate observations necessary for the clear understanding of this valuable and highly interesting insect.

Entomologically speaking, the bees are considered merely as a group of wasps which have forsaken a carnivorous diet of caterpillars, grubs, spiders, etc., and turned vegetarian, subsisting entirely on pollen and honey. One specialist in this group of insects has designated them as "flower wasps" while many German entomologists refer to them as "Blumenwespen."

The long and intimate association with flowers has left its stamp on all the organs and habits of the bees, while botanists believe that a great many flowers have been modified in structure, arrangement and color in adaptation to the bees for the purpose of cross pollination.

The solitary bees and those social bees with less complex systems of living than the honey bee have a much more ruthless, less intricate way of insuring the survival of their species over the cold months. Among the social wasps and the bumble bees the whole colony dies at the onset of cold weather with the exception of a few hardy young queens that have appeared in the brood late in the fall. These hide themselves away in cracks or other protected places and after emerging in the spring, lay eggs and tend the young larvae until they are old enough to collect honey and otherwise survive her majesty, who now concentrates exclusively on the serious business of egg laying. From such a simple form of communism have the honey bees evolved by some mysterious process their highly organized and perfected method of survival.

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None of the many schemes to dispel fog artificially has proved commercially practical.