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BEEKEEPING
IN ILLINOIS

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Honey bees have a long association with man and are often regarded as domesticated animals. But they are able to live either with or without man's help and specialized hives. Essentially, man must adapt to bees more than bees must adapt to man. No other animal species serves man in as many ways as do honey bees. They are kept for a hobby and for full-time business, they are used as research animals by scientists, and they are valued as pollinators of fruit, seed, and vegetable crops. Because of their social way of life and their adaptability, honey bees survive in most areas of the world. However, to manage them properly for the greatest return, you must understand their behavior and analyze their needs throughout the year.

Beekeeping in Illinois began with the early settlers and farmers who kept bees as a source of honey for home use and for sale. Bees first thrived on the native flowers and trees, and later also on apple trees and large acreages of clover pastures that were planted as farm crops. By 1930 the acreage of sweetclover in Illinois had risen to 850,000 acres and provided large honey crops for an estimated 275,000 colonies (hives) of bees. If the estimates were correct, only California had more bees at that time. Since then the number of colonies has declined steadily to the present number of about 90,000.

Illinois residents have made valuable contributions to beekeeping in the United States. Prominent among them are the members of the Dadant family of Hamilton, Illinois (Fig. 1). Charles Dadant emigrated from France in 1863 and began keeping bees and making comb foundation. By 1867 he was contributing articles to American and foreign journals and soon thereafter began selling queen bees. His son, C. P. Dadant, continued the business and became editor of the American Bee Journal in 1912. This magazine, published since 1866, has served as a sounding board for amateur and commercial beekeepers, and has given sound counsel and information for four generations. The present company, Dadant & Sons, Inc., publishes the Journal and specializes in beeswax and its products as well as in beekeeping equipment. Dadant's hybrid-queen breeding program is the only one of its kind in the world.

The University of Illinois first offered beekeeping instruction about 1917. Professor Vern G. Milum taught two popular courses from 1925 until his retirement in 1962.
Illinois beekeeping has changed rapidly in the 20th century. Commercial honey production now requires more extensive operations than in the early days because nectar sources are more widely scattered. Increased urbanization has reduced the number of bees kept in and around cities. However, small numbers of colonies do well in cities and towns because of the diversity of flowering plants within the flight range of the bees. The increasing acreages of vegetable and fruit crops requiring pollination in Illinois are creating a demand for more pollination service. The commercial beekeeper who provides such a service by moving his hives to the vicinity of the crop to be pollinated helps to increase crop yields while reducing his dependence upon honey production as his only source of income.

Learning to handle and manage bees is fun. It also offers simple rewards such as tasting the first crop of honey and watching a queen bee emerge from her cell. Consider joining the local and state beekeeping organizations. Sharing your experiences can increase your pleasure from bees. Young beekeepers can gain by joining 4-H or FFA and participating in beekeeping projects sponsored by these organizations.
BEES: THE INDIVIDUAL AND THE COLONY

The first step in studying bees is to learn as much as possible about their biology. This information about their life and needs is required to manage and maintain the colonies properly. It is even more important when you must diagnose an ailing colony that may have lost its queen or become infected with disease.

Honey Bee Castes

There are three castes,¹ or groups of individuals, in honey bee communities. These are the workers, the drones, and the queens. All are important to a colony and to the survival of the species.

The castes are easy to recognize after a little practice. The three types of castes are shown in Figure 2. The two kinds of females, queen and worker, are more similar before the queen mates and begins to lay eggs than they are after that time. The overall body size of the queen, and particularly her thorax, is noticeably larger even at that time, but her abdomen is short and pointed, much like a worker's. As she begins to lay, the queen's abdomen becomes greatly elongated, so much so that her wings look short. They cover only about two-thirds of her abdomen. In contrast, the wings of both workers and drones reach the tip of the abdomen when folded. Drones have large, stout bodies with blunt abdomens. There is usually a conspicuous brush of hairs at the end of the abdomen. The drone's compound eyes are easily distinguished from those of the other bees in the hive because they meet on the top of his head. Queens and workers have areas of hair and their simple eyes, the ocelli, between their compound eyes.

The Workers

The worker bees (Fig. 3) are the largest group of bees in the hive — up to 60,000 in midsummer. They develop in the smallest cells in the comb of the colony from fertilized eggs laid by a queen. They are imperfect females and under normal hive conditions they do not lay eggs. The young, grub- or worm-like larvae receive large quantities of food

¹ All specialized terms are defined in the Glossary.
The three honey bee castes. The worker bee is at top left, the drone is below the worker, and a marked queen is the large bee at right. (Fig. 2)

A worker bee. (Fig. 3)

that surround and support them for the first few days after they hatch from the egg. As the larvae grow, they consume all the excess food. The nurse bees then feed them small quantities of food at frequent intervals. About 5 days after hatching, the larva is sealed in its cell where it spins a partial cocoon and begins the body changes, or metamorphosis, that produce the pupa and finally the adult worker bee. The cell capping on worker cells is flat or only slightly convex. There are about 55 worker cells to the square inch, including both sides of the comb.
About 21 days after the egg was laid, an adult bee emerges from the comb by chewing a hole in the capping. She is soft and downy, and is not yet capable of making wax, stinging, or flying. She will spend more than half her life doing hive duties in a rather flexible sequence that is governed by the colony’s needs. Usually this begins with cell cleaning and feeding and caring for the brood (the immature stages of bees) (Fig. 4). Other typical duties include comb building, removing debris, and guarding the entrance (Fig. 5). Although we think of bees as being very industrious, the workers spend many hours patrolling the hive and sitting idle on combs. The patrolling probably serves to inform bees of the needs of the colony and also produces heat to maintain the warmth of the brood nest where the young bees are reared.

Young workers begin to fly from the hive when they are 15 to 20 days old. At first they take short flights in front of the colony, often

A young worker bee feeding a larva. (Fig. 4)
Worker bees on guard at the hive entrance. (Fig. 5)

on warm afternoons. These flights acquaint the bee with the appearance of the hive and its immediate vicinity. The term “play flights” has been given to this activity because the bees bob and weave in the air while facing the hive.

Workers forage first for either pollen or nectar. They may change from one to the other but usually collect pollen first and nectar later. The nectar collectors may also collect water when the colony needs it, and a few bees collect plant resins called propolis or bee glue.

Workers live 4 to 6 weeks during the active season. Those reared in the fall may live as long as 6 months so that a new generation can be developed before they die in the spring. The colony uses large quantities of honey and pollen as food but the bees usually store more honey than the colony needs. Only this surplus production should be removed by the beekeeper (see page 55). The young worker bee needs pollen to develop the glands that are used to make the secretions fed to developing larvae and to the queen. Adult bees can survive without pollen, but they are soon unable to rear young bees. Wax is produced by glands on the underside of the abdomen of house bees. It is secreted only when the colony is obtaining considerable quantities of nectar or is being fed sugar or honey by the beekeeper.

The Drones

The male bees, or drones, appear in the colony in late spring (Fig. 6). No certain number is produced and colonies may have only a few hundred or as many as several thousand. They help to produce
heat in the colony and may be of value by affecting the "morale" of the colony or in other ways that are still not known. However, since they consume food and take up space, their numbers should be kept at a minimum by using full sheets of comb foundation and maintaining combs with few drone cells.

The drones are produced from unfertilized eggs usually laid by a queen but occasionally by workers whose ovaries have developed (laying workers). A normal queen lays drone eggs in cells that are larger than worker cells. When sealed, the cells have distinct, rounded cappings (Fig. 7). Both laying workers and queens unable to lay fertilized eggs produce drones in worker-sized cells. Those that survive are normal, small drones, but many of them do not grow to maturity in the smaller cells. Drones require 24 days to develop from egg to adult.

Another type of drone is produced in some honey bee colonies. However, they are never seen as adults because the worker bees remove them from the comb a day or two after the larvae hatch. These drone larvae hatch from fertilized eggs that have a matching pair of hereditary factors called sex alleles. The eggs are laid in worker-sized cells by a queen that mated with one or more drones having a sex allele the same as one of hers. Eggs with a single allele are unfertilized and usually laid by the queen in large cells of the comb where they produce normal drones. Fertilized eggs with two different sex alleles produce normal worker bees.
Worker bees on sealed brood. The worker cells are at the top left and the drone cells at the bottom right.

The production and loss of these drones, called diploid drones, is detrimental to a colony because as many as half of the fertilized eggs do not produce worker bees. The colony fails to develop the large population needed for honey production. A spotty brood pattern when no disease is present may indicate this problem and the colony should be requeened.

Young drones are fed by workers for the first few days of their lives. After that time they help themselves to the stored honey and fly in search of queens on warm afternoons. Drones are attracted to certain small areas where they congregate and patrol while flying 30 to 50 feet above the ground. It is here that they usually meet and mate with queen bees.

When flowers cease to provide nectar for the colony, either in the fall or, more rarely, at any time of the year, the workers no longer tolerate the drones. Workers remove developing drones from the comb and begin to harass the adults, the oldest ones first. The drones are rarely stung but they are pushed and pulled so much that they have
difficulty eating. Ultimately, all the drones in a queenright colony are driven from the hive and die. The Italian race tolerates them longer than the Caucasians, and queenless colonies allow them to stay for an indefinite period.

The Queen

The queen (Fig. 8) is responsible for all the qualities of her colony. The fathers of the workers are not present. The workers share the queen's motherly duties by caring for the young, but her genetic or hereditary makeup, and that of the drones she has mated with, determines the size and temper of the colony, the color of the workers and drones, disease resistance, honey-producing ability, and all the other characteristics of the colony.

Queens develop from fertilized eggs or from young female larvae not over 3 days old. In a colony with a good, young queen, the eggs destined to be new queens are laid in special cells, or cell cups, that hang vertically on the comb (Fig. 9). Worker and drone cells are on a horizontal plane. The young queen larva develops much like a worker but does so more quickly, in only 16 days, and more completely. She receives glandular secretions, called royal jelly, in excess quantity throughout her life. Queen larvae float in a bed of food. This greater quantity of food together with other differences in quality and content,
make the resulting queen a perfect female with a complete reproductive system.

When she emerges from her cell, the young queen is practically ignored by the workers. Very quickly, however, they are attracted to her and begin to feed and groom her. They even bite and chase her within the hive during the first few days. After about a week the queen is agile and physically ready for her mating flight. She leaves by herself, usually between noon and 4 p.m., and probably flies a considerable distance from the hive. It seems likely that queens visit drone-congregation areas because they mate with many drones in a short period. The average queen makes more than one mating flight and mates with as many as 10 different drones. This system of mating reduces inbreeding and thereby increases the efficiency of the colony.

The mated queen begins to lay a few days after completion of her flights. Her egg production increases rapidly to as many as 2,000 eggs per day. This high output, equal to the queen's own weight, is made possible by the high-protein diet of glandular secretions provided in large quantity by the worker attendants.

If a queen is removed or killed in a colony, the workers can produce a replacement if they have worker eggs or larvae not more than 3 days
old. They usually select several larvae whose cells are then modified into queen cells. The development of such queens is the same as the development of those that begin life in a queen cell.

Queens lay eggs in greatest numbers in the spring and early summer. They gradually cease to lay in the fall and do not begin again until January or February. Winter brood rearing is normal and takes place in most colonies that have adequate stores of honey and pollen and a good population of worker bees.

Queens may live as long as 5 years but are most productive during the first 2 years. A common cause of failure is inadequate mating that results in the production of too many drones when the queen is unable to fertilize the eggs she lays in worker cells. At that time the colony usually tries to replace her by a process called supersedure. An old, failing queen and her young daughter may continue to live and lay eggs in the same colony for a considerable period.

Length of Development

The three honey bee castes undergo the same type of development, known as complete metamorphosis. Each one takes a different length of time to develop as follows:

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<th>Queen</th>
<th>Worker</th>
<th>Drone</th>
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<tr>
<td>Egg is laid</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Egg hatches</td>
<td>3rd</td>
<td>3rd</td>
<td>3rd</td>
</tr>
<tr>
<td>Cell is capped</td>
<td>8th</td>
<td>8th</td>
<td>10th</td>
</tr>
<tr>
<td>Adult emerges</td>
<td>16th</td>
<td>21st</td>
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The Races of Bees

Throughout the world there are many races of bees that have developed slightly different body characteristics, biology, and behavior. In the United States two races of bees are most common—the Italian and the Caucasian. The Italian bees have yellow or brown bodies with varying numbers of dark bands toward the end of their abdomens. They tend to raise young bees early and late in the year and need more honey for maintenance than do the dark races. The Caucasian bees are black with gray bands of hair. They conserve their honey somewhat better and use more propolis than the Italian bees. Both races are usually gentle and the bees are quiet on the combs. Carniolan bees are a dark race with characteristics somewhat similar to the Caucasians.

The honey bees available in the United States are the result of crossing and selection of bees from many different races in addition to those mentioned above. Beekeepers should try queens from different queen breeders to learn more about the behavior and honey production
of different strains of the same race. Most strains are gentle when handled under the proper conditions. If you have bees that are not gentle, requeen them immediately with a queen from a gentler strain. There is no relation between temper and honey production.

**Characteristics and Activities of the Colony**

Honey bee colonies are often regarded as a single organism because they undergo changes as a group that compare with the changes and development of an individual. To understand and manage honey bees you must be familiar with the development of the colony and the seasonal changes in it.

The brood nest, where the queen lays eggs and young bees are reared, is the heart of the colony. It may be a small circle of cells on one side of a comb or as large as 20 or more full combs (frames). It is usually oval or circular so that the bees may surround it readily in cool weather. The entire area of developing bees, but not the rest of the hive, is kept at a temperature of about 95° F. The worker bees produce heat to warm the brood nest to this temperature. They ventilate and evaporate water or nectar to cool it to 95° in hot weather.

The bees store pollen, their protein food, in the cells immediately surrounding the brood (Fig. 10). In this location it is near at hand to

![A comb with sealed brood in the center surrounded by a ring of light-colored pollen. Outer cells of the comb contain honey in open cells.](Fig. 10)
feed to developing larvae and to be eaten by newly emerged adult bees. The nectar and honey are stored beyond this band, or shell, of pollen.

In the fall, the brood nest and the majority of the bees are in the lower combs of the hive. The honey for winter food is above them and there must be pollen stored within the cluster area for winter use. During the winter the bees in a hive of adequate size (at least two deep hive bodies) move upward as they gradually eat the stored honey. In early spring the brood nest is most often in the top part of the hive with empty combs beneath it. If nothing is done to change this arrangement, the bees will slowly occupy the lower combs, and the queen will expand her laying to all areas of the hive. However, the direction of natural expansion is upward so the beekeeper usually rearranges the hive, as explained on page 45.

Theoretically, one set of 10 deep combs is sufficient space for a prolific queen. In practice, 18 or 20 combs used in two 10-frame hive bodies provide more suitable conditions for a large brood nest, perhaps because it can be more nearly spherical in shape. The colonies need additional room for their rapidly increasing number of adult bees by late April or early May in central Illinois. The nectar and pollen gathered from fruit blooms and dandelions may contribute to the crowding. The bees continue to store pollen near the brood nest and honey in the combs above it throughout the honey season. Without sufficient comb space, the workers gradually will fill the cells of the brood nest with honey. This is highly desirable in the late summer to provide food for winter, but it is harmful earlier in the season when the greatest possible number of cells is needed for rearing young bees. The crowded brood nest restricts the queen's laying.

The success and adaptability of the honey bee colony is the result of several means of communication, both simple and complex. The simpler system of communication is based upon the exchange of food (Fig. 11), and on odors within the hive. The queen's glands secrete attractive substances and odors that are removed from her body and shared by the workers of the colony. The materials keep the colony together and prevent the workers from laying eggs and building queen cells. If there is an insufficient supply, or if it is not distributed evenly in a crowded colony, the bees construct queen cells to produce a new queen. Another system is used to alert and alarm the colony. Disturbed and injured bees secrete a volatile material known as isopentyl acetate that smells like banana oil. It attracts and excites bees and prepares them to defend the colony by stinging the cause of the disturbance.

The more complex communication system of the colony consists of elaborate movements made on the combs by foraging bees. They are
Worker bees exchanging food on a comb containing honey. The two bees in the center are responding to smoke by eating honey from open cells. (Fig. 11)

usually called dances or the “language” of the bee because the movements and sounds produced give other bees information about the odor, distance, direction, and quality of a source of nectar. Field bees learn the daily movement of the sun in the sky and apparently measure distances by the energy they use in reaching the source of food. These dances and the responses of the house bees and inexperienced forager bees make it possible for a colony to quickly find and collect the best sources of nectar. Field bees actually recruit others to come to the same flowers for food. A similar system operates for pollen sources.

The colony selects a new home when it swarms by using a system of communication similar to the one used for food. In this case the field bees evaluate the hollow tree, cave, or hole in a house, and induce other bees to come and inspect it. The site agreed upon as best is selected for the new home of the swarm.
BEEKEEPING EQUIPMENT

Honey bees have been kept by man in a wide variety of hives. In the early days of the United States the most common hive was the section of a hollow tree, called a “gum” or “log gum,” with a slab of wood to cover the top of it. In Europe the straw skep hive was common and one model used in Greece had movable combs. In most other early hives it was not possible to remove or exchange combs easily because the bees glued everything firmly together and their combs were not surrounded by wooden frames. In 1851, L. L. Langstroth designed an improved hive that utilized a principle discovered earlier and now called the “bee space.” He made a hive in which the frames hung within a box so that they were surrounded on all sides by a space of ¼- to ¾-inch. Bees leave such a space open but smaller spaces are usually filled with propolis. In larger spaces bees build extra comb. Langstroth’s design is now used in all modern beekeeping equipment and, although the dimensions and some details have been changed, the hive is still called the Langstroth hive.

Bee hives have often been designed and built without regard for the needs and habits of the honey bee colony. Probably the best design for a colony was the large hive developed by Charles Dadant. It provided a large, deep brood chamber with plenty of room in which the queen could lay, and shallower supers for honey storage. However, the price and promotion of smaller hives offered for sale during the period from about 1885 to 1900 made them more popular. These small hives have since been blamed for the reduction in the numbers of farm apiaries because farmers removed too much honey from them, allowing colonies to starve during the winter. The 10-frame Langstroth-style hive has gradually become the standard hive used in the United States. It is essentially a compromise between the needs of the bees and a size one man can handle and move. As commercial beekeeping becomes more mechanized, there is less reason to limit the hive size and shape just for convenience in lifting and moving hives. But the amateur beekeeper will continue to need a hive whose parts he can lift, and the 10-frame Langstroth with shallow supers fills this need.
Many beekeeping enthusiasts are attracted by unnecessarily elaborate equipment or feel a need to modify the basic Langstroth design. Most items designed for this purpose are of little value. Knowledge of bees and the ability to manage them are the two essentials of success with bees. It is the strong colony of bees, properly managed, that makes the honey, not some special piece of hive equipment. Use standard items of equipment to enjoy beekeeping to the fullest extent. If you should want to sell or exchange the equipment, you can do so more easily with conventional hives.

**Hive Parts and Selection of Equipment**

A bee hive is composed of one or more wooden shells called hive bodies within which hang the combs in wooden frames. The space between the cover and the bottom board can be expanded or reduced to meet the needs of the colony during the year. Hive bodies in which a brood nest is located are usually called brood chambers. Hive bodies located above the brood chamber are called supers, simply because of their location above the brood nest. The hive may be made up of any combination of hive bodies of the same or different vertical dimensions, or depths. Traditionally, beekeepers have used brood chambers at least 9⅛ inches deep, but honey bee colonies will live just as well when given sufficient combs of shallower dimensions. Amateur and commercial beekeepers should seriously consider using hives composed entirely of 10-frame hive bodies 6⅛ inches deep. They provide complete interchangeability, are lighter in weight, and are easier to manipulate. All the parts of a hive should be the same width, preferably 10-frame. The parts of a bee hive are shown in Figure 12.

Bee hives are available from many different companies (see page 128) or you can make your own. If you prefer to build them, make sure that all dimensions of the hive bodies conform to those of commercially built hives. Otherwise the bees will fasten the parts together so firmly that you cannot manipulate them easily. Hive covers and bottom boards need not necessarily be of the same pattern as commercial ones. Simpler ones can easily be made at home.

Beekeeping suppliers and catalog stores offer basic equipment kits for beginners. The kits contain only the basic tools and equipment needed to get a swarm or package of bees started and to provide hive space for them for about a month in the spring. Purchase additional equipment at the same time in order to be ready to provide space for the colony to expand during the season. Without additional hive bodies
Parts of a typical bee hive. The parts have been separated and identified for easier recognition.  
(Fig. 12)
the bees will soon become crowded and swarm. They may never de-
velop a sufficient population and a supply of honey to survive the
winter. In that case you will have to start over the next year. If you
do it right the first time with adequate equipment, you may soon be
wondering what to do with all the honey.

Plan to use at least two 9½-inch deep hive bodies, or three 6½-inch
deep ones, for the colony brood chamber. Above this brood chamber
you need two to four hive bodies, or supers, for honey storage. Avoid
comb-honey production in wooden sections until you have gained some
experience. Cut comb honey in standard shallow supers (51\(\frac{1}{8}\) inches
deep) is easier to produce with little or no experience and without the
special manipulations and equipment needed for section comb produc-
tion (Fig. 13). Dadant-depth supers (6½ inches deep) are a good
choice for extracted honey production. They are of a reasonable size
to handle and you don’t need as many of them as of the standard shal-
low supers to hold the crop. Many beekeepers in the western states use
only deep supers. Although they have to handle heavier units, up to
90 pounds, they handle smaller numbers of units and all the equipment
is interchangeable.

A full shallow comb of honey. The comb and frame may be sold as a unit or
the comb may be cut into pieces for cut comb or chunk honey. (Fig. 13)
Of the several styles of frames, those with a wedge top bar and split or slotted bottom bar are the least trouble for the beginner to use. He can put the foundation quickly into this frame and it will stay secure when the wedge is nailed in place. The nailless top bar frame is easy to assemble and can be used with plastic-base or metal-bound foundation.

Comb foundation consists of beeswax sheets embossed with the worker cell pattern. When provided with frames containing a sheet of foundation, the bees add additional wax to finish it into a full comb. They must have incoming food, either nectar or sugar syrup, to secrete wax and build comb. Without the available food, the bees may cut holes in the foundation and fail to make it into comb. For this reason you must be sure to feed any new colony started with sheets of foundation. Also, put foundation on established colonies only during a nectar flow or while they are being fed. There are two basic types of foundation distinguished by their relative thickness. Brood foundation, plain, wired, or with a plastic base, is used in deep frames for the brood chamber and in all frames used to produce extracted honey. Its thickness helps make strong comb that can withstand many years of use. The plain and wired foundations make the best combs when placed in wired frames. The comb in an unwired frame may fall out when is is handled on a hot day. Plastic-base foundation with metal ends, and metal-bound, wired foundation produce good combs without any frame wiring. Thin super and cut-comb foundation give the delicate texture to honey that is to be eaten in the comb. They are used without any wires or reinforcement so that the filled honey comb can be cut from the frames ready to eat.

Hive covers come in two basic styles. One is metal-covered and telescopes down over the sides of the hive body (Fig. 14, top). It must be used with a flat inner cover to keep the bees from attaching it too tightly to remove. The two covers provide some insulation and ventilation for the top of the hive. They create problems when the hives are moved because they do not allow the hives to fit closely enough together when tied down on the truck. They are also heavy and their initial cost is greater than that for a plain, flat wood or metal cover. The plain wood cover (Fig. 14, bottom) provides less insulation, but it saves time in opening the colony, stays in place without a weight on top, costs and weighs less, and is best suited for migratory beekeeping.

The hive bottom, or bottom board, as it is called, is also made in two basic types. One is reversible with a deep side and a shallow side to give either a 3⁄8-inch or a 7⁄8-inch entrance to the hive (Fig. 14, top).
A one-story hive with a telescoping cover and a reversible bottom board is shown at top. Another one-story hive with a simple, homemade, two-cleat cover and bottom board is shown in the bottom illustration. (Fig. 14)
The other type provides a $\frac{3}{8}$-inch entrance and has cleats at front and back that rest on the ground (Fig. 14, bottom). Hive bottoms should be nailed or stapled to the first brood chamber if the hives are moved. Otherwise the hive bodies are just stacked one above the other on the bottom board. Bottom boards will last much longer when treated with a wood preservative such as pentachlorophenol before being painted.

Hives placed on a hive stand, bricks, or other support are a little more convenient to work with and the bees are less bothered by weeds and grass in front of the hive entrances. Hives set on the ground are not damaged if the bottom boards are treated with a preservative, and most commercial beekeepers do not use stands, especially if they move the hives regularly.

**Assembly of Equipment**

New bee equipment is usually purchased "knocked down" (KD) or unassembled. The directions and diagrams furnished by the manufacturer are easy to follow, but a few details sometimes cause difficulty. A common error is to nail the sides of the hive bodies with the handholds on the inside. The frame rests (shoulders cut into the inside top of the hive ends) also cause some difficulty. They require a metal strip (rabbet) or a small wooden strip to be fastened on top of them to give the proper spacing of the frame.

Frames are made in several slightly different patterns but assembled in the same way. An exception is the nailless top-bar frame (Fig. 15) that locks together on top and requires nailing only on the bottom. You can assemble small numbers of frames individually. For larger quantities, a frame-nailing device or jig will make the job easier and faster (Fig. 16). Drive nails down through each end of the top bar into the end bars and a second pair through the end bars into the shoulder of the top bar (Fig. 17). This cross-nailing greatly strengthens the frame. Glue and power-driven staples are also used to assemble frames. Water-resistant casein glue and other new types are easy to apply with a plastic squeeze bottle. The bottom bar needs two or four nails depending on the style of frame. Frames with one V-shaped edge on the end bars are assembled with the V facing you on the left end and away from you on the right end.

Wiring frames properly is a difficult task for the beginner without some equipment and instruction. It is essential to produce strong combs that will not sag and warp in warm weather or fall apart in the extractor. Thread at least two, and better four, horizontal wires through the ready-made holes in the end bars while the frame is in a
Assembling a nailless top-bar frame with a sheet of metal-bound comb foundation.  

(Fig. 15)

Assembling frames in a wooden jig. The jig is inverted to put the bottom bars in place.  

(Fig. 16)
wiring device (Fig. 18). Draw the wire tight enough to make a high note when you pluck it. Start and end the wire by wrapping it around a small nail driven into the edge of the end bar. The wire may also be fastened by stapling. Only No. 28 tinned wire is suitable for wiring

Cross-nailing the end and top bars of the frames.
(Fig. 17)

Wiring a frame in a homemade wiring device. The frame is held under tension while being wired; when the tension is released, the wires are tightened.
(Fig. 18)
frames. Plastic-reinforced foundation with metal ends, and prewired, metal-bound foundation can be used in unwired frames.

Fit the foundation into the frame so that the upper edge rests in the notch in the top bar and the lower edge lies in the slot of the bottom bar. Nail the wedge strip so that the nailheads are beneath the top bar when it is hanging in the hive (Fig. 19). Here they cannot later be accidentally hit with an uncapping knife. Place the wired frame and foundation on a board cut to fit within the frame. Roll a heated spur embedder along each wire, pushing it about half way through the wax.

Nailing the foundation cleat in place in a frame.
(Fig. 19)

A simple device for embedding wires into comb foundation. When the copper contacts at each end of the wooden piece touch the wires on the frame end bar, the heated wires sink into the wax.
(Fig. 20)
For large numbers of frames, use an electric embedder with a resistance coil to heat the wires so they sink in the wax (Fig. 20). Use it briefly and carefully at first to avoid cutting the foundation into strips with overheated wires, or melting the wax where wires cross.

**Tools, Clothing, and Specialized Equipment**

Three essential beekeeping tools are shown in Figure 21. The smoker is your most important tool. With it you are master of the bees as long as you use it properly and keep it lit. The $4 \times 7$-inch size is the

![Three important tools in beekeeping. The bee brush is at the top, the hive tool in the middle, and the smoker at the bottom.](Fig. 21)
best of the three sizes available. Smaller ones are too small even for beginners and the large size is designed for commercial beekeepers.

Hive tools are all-purpose levers for prying hives apart and for scraping. The 10-inch length gives the best leverage when hives are heavy and stuck tightly together.

A bee brush is used to remove bees from combs of brood or honey, particularly those bees that don’t come off when the comb is shaken. Since queen cells may be damaged by shaking, a brush is a necessity in queen rearing. If a brush isn’t handy, a handful of long grass can be used as a substitute.

It is not necessary to wear extra layers of clothing when working with bees but it is a good practice to dress properly, at least until you gain experience. Bee gloves, either cloth or leather, help to put you at ease in handling frames of bees. Simple gauntlets let you use your fingers more easily than do gloves, yet cover your wrists and the open-

A pair of gauntlets in use. They can be used alone or with a pair of gloves. (Fig. 22)
ing in your sleeve above the cuff (Fig. 22). A muslin sleeve with elastic in each end makes a good gauntlet. Make it long enough to reach from your thumb to above the elbow. Or cut the toe or foot from a large, white, cotton sock and pull it over your sleeve with the knitted top on your wrist.

White or tan clothing is most suitable when working with bees. Other colors are acceptable but bees react unfavorably to dark colors and fuzzy materials. Be especially careful to cover your ankles or wear light-colored socks. Angry bees often attack ankles first because they are at the level of the hive entrance. Any bee on the ground tends to crawl upward and may go up your leg with peaceful intentions until you squeeze her. Use bicycle clips, inner-tube bands (Fig. 23), or string to fasten your pants legs.

A folding wire veil or a round wire veil, worn with a hat, is a good all-purpose choice for the beginner. A nylon-fabric veil is cool and easy to carry, but it is more easily damaged in use. Wear the veil on a hat with a wide brim and pull the excess material away from your neck when putting it on (Fig. 24).

A queen excluder is a grid of accurately spaced holes or wires through which workers can pass, but not queens or drones. The steel-wire excluders, either metal or wood bound, are best. The zinc ones are suitable only for temporary use or for special purposes such as making cages or covering hive entrances.

An inner-tube band for closing pant legs when working with bees. The band closes and pulls down the pant leg. (Fig. 23)
Always use standard hives without modification or accessories. Special bottom boards and covers, queen and drone traps, and other similar equipment usually increase the cost of keeping bees without providing proportionate returns. It is proper management, not specialized equipment, that leads to success in beekeeping.
SPRING MANAGEMENT: STARTING WITH BEES

When and How to Start

Spring is the ideal time to begin keeping bees. In Illinois the best months for this are April and May, depending on the area of the state, when fruit trees, dandelions, and early flowers are in bloom. The reasons for starting at this time are that the spring blossoms and the lengthening days help to get the bees off to a good start and the early start allows the colony to increase its population in time to store honey from the clovers that begin to yield nectar about the first 2 weeks in June in central Illinois.

Established colonies. A beginning beekeeper should start with at least two colonies but not more than four or five. With more than one colony you have the advantage of being able to exchange brood, bees, and combs in case one of the colonies needs some help. With too many colonies you may have only enough time to keep them supplied with supers, and not be able to enjoy learning the details of the activities in any of them. The beginner can purchase established colonies from a local beekeeper but he should do so with care. Hives offered for sale may be homemade, with poor combs and, sometimes, the bees may be diseased. There is nothing wrong with good homemade equipment built to proper dimensions, but hive bodies and frames made without regard for the proper bee space are worthless. The amount of honey in the hive that you buy is not as important as the quality of the equipment as long as there is at least a small reserve supply. The bees themselves can be improved at slight expense by requeening the colony. Buy established colonies only after they have been inspected and found free of disease by an apiary inspector from the Illinois Department of Agriculture.

If you buy full-sized colonies, you will lose the opportunity to watch the fascinating early development of the colony that you have if you buy package bees or small nucleus colonies of three to five frames. Also, newly established small colonies are easier for the beginner to observe and manipulate than are the larger ones. In part, this is because of his reaction to the number of bees present and also because
of the greater number of guard bees and field bees in the larger colony. They are not necessarily meaner, but more bees react when large colonies are handled. Consider this difference when you begin with bees because it is essential that you open the hive regularly and learn about the inside activities of the colony.

**Package bees.** Package bees (Fig. 25) are shipped in screened cages from apiaries in the southeastern United States and in California. Order them early, in January if possible, in order to have the best chance of receiving them on time, preferably in April. A 2-pound package with a queen will produce as good a colony as a 3-pound package if it is fed well and gets off to a good, early start. If a package colony is put in a hive completely filled with foundation, it must be fed continually with sugar syrup for as long as a month. Package bees installed on combs must also be fed unless there is considerable honey in the combs. The food will not be wasted because it will be used to produce combs and to feed developing young bees. Spring flowers and spring weather cannot be depended upon to provide natural food for such colonies. Use syrup made from equal volumes of water and granulated white beet or cane sugar. A gallon can or large jar above the colony makes a better feeder than the entrance type. (See page 79.)

![A 2-pound package of bees.](Fig. 25)