BEEKEEPING IN MINNESOTA

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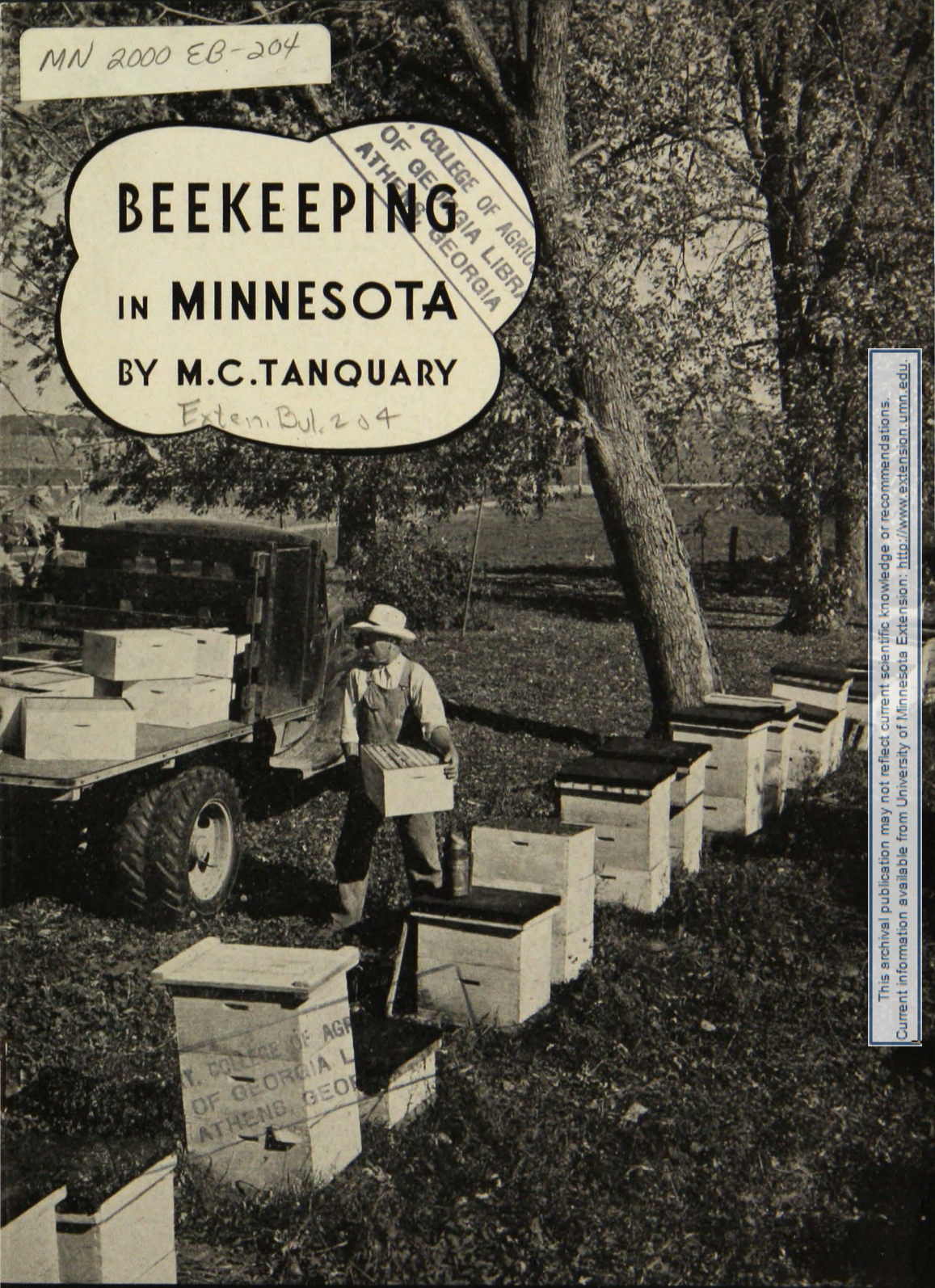

AGRICULTURAL EXTENSION DIVISION—UNIVERSITY OF MINNESOTA

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Beekeeping in Minnesota

Directions for Colony Management Through the Year

BEES have been kept in Minnesota for nearly a century, but only in comparatively recent years has the keeping of bees developed into an industry that forms a definite phase of the agriculture of the state. It is a minor industry, to be sure, but because of its interrelation with other phases of agriculture, of greater importance than the size of the annual honey and wax crop indicates.

Because complete records are not given in census reports and in the records of county assessors, it is difficult to determine exactly the number of bee colonies in the state. From available records it is estimated that there are from 12,000 to 15,000 people in Minnesota who have from one to more than a thousand colonies each, which brings the total for the state to well over 200,000 colonies. These produce annually an estimated crop of from 7 to 20 million pounds or more of surplus honey and a hundred thousand pounds or more of beeswax.

Bees Aid Crops

Because of their efficiency as pollinators of various farm crops, particularly fruit trees, clovers, and such garden plants as cucumbers, melons, squash, and pumpkins, the value of bees as pollinators is estimated to be from 10 to 20 times their value as producers of honey and wax. Many orchardists and seed growers find it impossible to produce paying crops without the use of bees, and each year make arrangements to have a sufficient number of colonies at hand during the blossoming period.

Beekeeping is perhaps better adapted as a sideline for the farmer or for the business or professional man in town than as a sole means of livelihood. A few colonies may be cared for at odd times with ease. Only a small investment is necessary to have a few colonies, and the bees are valuable both as producers of honey and wax and as pollinators.

Bees Increase Income

The amount of nectar produced each season by the flowering plants of Minnesota is sufficient to provide for several times the number of colonies now kept here. The income from such colonies would increase the annual agricultural cash income of the state by many thousands of dollars.

This bulletin is published in response to the many inquiries for information on how to establish colonies of bees and how to care for them most efficiently. It is planned not with the idea of laying down a set of rules to be followed, but to give the basic reasons for procedure so that the beekeeper may modify his system according to locality, times of honey flows, and his inclinations.

WHEN TO START WITH BEES

Beekeeping should be started only in the spring or early summer unless there is a special reason for doing otherwise, as when one has an opportunity to purchase colonies at greatly reduced prices. In late summer or fall the honey crop may already have been removed, the bees may not be in proper condition for successful wintering, and the hazards of wintering may cause a heavy or even total loss of bees before spring. Then, too, some of the most disagreeable work connected with beekeeping comes in taking care of the bees at the end of winter before the spring honey flows.

HOW TO START

There are several ways in which one may make a start with bees. One may hive stray swarms caught during the spring and early summer, take bees from bee trees, buy full colonies or nuclei from some near-by beekeeper, or buy package bees or nuclei from beekeepers in the southern states who specialize in the business of rearing queens and producing bees for shipment to the northern states.

The first two methods are sometimes good, but they depend upon favorable opportunity. The last two are the methods usually followed. Their advantages and disadvantages will be discussed separately.

BUYING FULL COLONIES

ADVANTAGES.—By buying established colonies from a dependable source, one has the advantage of obtaining at first hand from the former owner and at the time it is needed much valuable information on the proper care of bees.

FIG. 1. BEES ARE EVEN MORE VALUABLE AS POLLINATORS THAN AS PRODUCERS OF HONEY

The hives are already assembled, and the colonies are organized. As the need arises one may get further information on management and may be able to purchase additional equipment and supplies.

DISADVANTAGES.—The hives may be old and of different sizes and types. The hive parts may not be interchangeable. The combs may not be good worker combs built on full sheets of foundation. The queen may be old or from a poor strain of bees; the bees may be unusually cross or have some other undesirable qualities. The colonies may be weak or lack sufficient stores. By far the greatest disadvantage, however, is the possibility of getting bees or equipment infected or contaminated with some bee disease, in which case the purchase is an expensive one no matter how much of a bargain the price seems to be.

These disadvantages may be largely overcome with a knowledge of what constitutes a good colony of bees and with an inspection certificate from the state apiary inspector showing the colony to be free from any bee disease. For the protection of the buyer, Minnesota, as well as most other states, has a law forbidding any one to sell bees in hives or used bee equipment without a certificate showing freedom from disease. If there is any doubt as to whether or not the colony is affected with disease, one should write first to the State Entomologist, University Farm, St. Paul, Minnesota.

PACKAGE BEES AND NUCLEI

The term *package bees* refers to bees that have been removed from their combs and from the hives and placed in a screened cage for transportation. The package is designated as 2-pound, 3-pound, or 5-pound, according to the net weight of the bees contained. The number of worker bees in a pound varies depending on size of the bees and the amount of feed they contain when they are weighed, but usually they number from 3,500 to 4,000. A commercial package should contain one young, mated queen, no drones, all the rest being workers, and these should also be as young as it is possible to get them. Although the better shippers screen them out as much as possible when preparing their shipment, a few drones are generally found in all packages since some drones are in all colonies in the South during the normal shipping season. Sometimes worker bees alone are desired. The package is then designated as a queenless package.

What a Nucleus Is

The term *nucleus* (plural *nuclei*) refers to bees on one or more combs enclosed in a box or shipping cage. The nucleus is designated by the number of combs, e.g. as one-frame, two-frame, nucleus. A nucleus contains not only a queen (unless it is a queenless nucleus) and adult worker bees, but the combs may contain brood in some or all stages and stores of honey and pollen. A nucleus is in reality a small colony since it contains everything found in the full colony of bees, but in smaller numbers. Nuclei are used not only for shipment to northern beekeepers but are made up by both northern and southern beekeepers for increase or for mating nuclei in queen-rearing or for reservoirs for holding extra queens. Very small nuclei placed on miniature combs are referred to as baby nuclei and are used by some queen breeders as mating nuclei.

Some northern beekeepers prefer to purchase nuclei rather than package bees, claiming as advantages (1) less trouble in installing, for it is necessary only to lift the combs with adhering bees out of the nucleus shipping box

and place in the hive, and (2) a nucleus builds up into a full colony more rapidly than does a package since brood is already present and the queen has been accepted and sometimes is laying en route.

Package Bees Popular

The great majority of northern buyers, however, prefer package bees. The transportation charges are much less because of the lighter weight. Many more adult bees are furnished with packages for the same cost, and it is bees that the beekeepers want. They believe that even though the nuclei may seem to build up more rapidly at the start because of the presence of some brood, the packages will overtake the nuclei during the second month and develop into strong colonies sooner. There is practically no danger of bringing in brood diseases with package bees. Although there is little danger of getting brood diseases from nuclei purchased from reliable shippers since neither package bees nor nuclei may be shipped without a certificate of inspection showing freedom from disease, the possibility of disease in its incipient stages not being found during inspections make the risk a little greater in nuclei than in packages. Canada and some states in this country forbid the importation of bees on combs or of any used bee equipment.

One must remember, of course, that a package of bees is not merely a package of bees, nor a nucleus merely a nucleus, since there may be great differences in quality in both packages and nuclei. These differences may be what determines the success or failure of one's start in beekeeping. Variation in quality may depend on the strain of bees within a race, the age and quality of the queen, number and age of the worker bees, method of preparation at point of origin, and length of time and conditions of transportation. In the case of nuclei, there are also the factors of quality of the combs and the amount of stores of both honey and pollen provided.

The remarkable growth of the package-bee industry in recent years has brought with it great advances in overcoming many of the difficulties that were first encountered in the production, preparation, and transportation of package bees. At the same time there has come increased knowledge and skill on the part of northern beekeepers in proper handling, and a growing appreciation of the vital part that package bees are coming to play in the entire bee and honey industry of the country.

Package bees may be used to establish new colonies, to replace winter losses, to strengthen weak colonies, and for pollination purposes.

Keep Hives Filled

Until the development of the package-bee industry, the northern beekeeper frequently had to use the season following heavy winter losses to refill his empty equipment by making increase. He thereby had to sacrifice much and sometimes all of the honey crop of that season and be faced with the possibility of a repetition of the same bad luck the next winter. The development of better knowledge of wintering requirements for bees in the North, and the possibility of getting package bees to replace colonies that die during the winter, and to strengthen all weak colonies in the spring have removed one of the greatest hazards in beekeeping. *A cardinal principle in beekeeping management is to have all hives filled with strong colonies of bees at the beginning of the surplus honey flow.* Empty beekeeping equipment is not only a dead investment but deteriorates rapidly when not in use.

WHEN TO ESTABLISH PACKAGE BEES

The best time to establish package bees in Minnesota varies with the different parts of the state and varies somewhat from year to year. In general one may say that the best time is just at the beginning of the period of the fruit tree and dandelion bloom or a week or two earlier for those accustomed to handling bees and who know how to provide for them under unfavorable conditions. This is about the middle of April and up to April 25 for the southern part of the state, the last week of April and early May for the central portion, and from the first to the twentieth of May for the northern part. Of course, package bees may be put out any time up to the middle of the season and still build up into strong colonies the same year but would not be able to produce so much surplus honey as they would if put out earlier. For those not accustomed to handling bees, it is well to choose a date late enough to be sure of plenty of bloom and fairly warm weather as bees may be handled much better under those conditions.

SIZE OF PACKAGE

Packages of the 2-pound and 3-pound size are almost universally used for establishing new colonies. Of these the 2-pound size is much more popular except where most of the surplus crop is produced in the early part of the season as in the white clover, alsike, and the basswood sections. The 3-pound package builds up more rapidly, is better in the early producing regions, and is a better package for the beginner since it may be put out later in the season when conditions are more favorable and still develop into a strong colony in time to take advantage of the surplus flow. By keeping careful records for a few seasons, the beekeeper can determine the best average date and the best size of package for his particular locality.

Order Packages Early

A good package of bees, established at the right time under optimum conditions and properly provided for, will frequently produce as much honey as an overwintered colony. This is true to such an extent that many beekeepers in the northern states and in Canada make a practice of killing all their bees at the end of the honey flow, removing all the honey except a sufficient amount to serve as feed the following spring. They then order package bees to refill their hives the next season. On the average, package bees will not produce quite so much honey as overwintered colonies. Those who follow this practice, however, consider that the difference is more than made up by the freedom from the worry and expense connected with providing proper wintering conditions and the exacting and sometimes disagreeable early spring work with overwintered colonies. A precaution to be taken is to make certain that one can get packages the following spring. This can be done by placing an order several months in advance.

NUMBER OF PACKAGES

One can start with any number of packages. However, whether beekeeping is conducted as a hobby or as a business, it requires a certain temperament or certain attributes of the beekeeper that enable him to enjoy the work and make a success of it. Apparently only a comparatively small proportion of people possess those qualifications sufficiently to cause them to continue in the work. For this reason, and because the beginner, unless he

has had previous experience with bees, is likely to make many costly mistakes, it is well to start with a small number. Five is a good number because bee supply companies usually pack their hive parts in units of five and that is the smallest number on which one can ordinarily get a quantity discount. Five are enough to test one's territory and one's interest in beekeeping and to get worth-while returns in honey production.

The hives should be assembled during the winter or early spring so that everything is ready when the packages arrive. The bee-comb foundation should be ordered early, but not received and put in the frames until a short time before using. The wax is brittle in cold weather and may easily be injured by handling at low temperatures.

The exact date of shipment of the packages and the time required for transportation should be known. Arrangements should be made with the express agent ahead of time to notify one immediately of the arrival of the packages so they may be picked up at once and taken where they are to be kept until installed.

If on arrival any of the packages contain only dead bees or have an undue proportion of dead bees, the express agent should be asked to sign a bad-order receipt describing the condition, giving the cause if apparent. The shipper should be notified of the loss. He will replace the packages at once, and the bad-order receipt will enable him to collect from the express company unless the loss is the fault of the shipper.

A cellar or basement is a good place to keep the bees before installing, for it usually affords the right conditions, darkness or dim light, quiet, no strong air currents, and a low enough temperature to prevent undue excitement or activity. The bees should be fed liberally with sugar sirup, made by dissolving white granulated sugar, beet or cane, in an equal volume of water. A good way to make the sirup is to pour boiling water over the sugar and stir until the solution is clear. The feeding may be done by brushing, or sprinkling, or spraying the sirup on the cages. The packages should not be disturbed then until evening.

Package bees may be put into hives any time of day, but the best plan is to begin the operation late enough in the evening so it may be completed just before dark. The reason for this is that there will be less excitement among the bees, very little flight, and consequently little danger of bees drifting from one hive to another and making colonies of unequal strength.

PROCEDURE IN INSTALLING PACKAGE BEES

The installation of package bees consists in transferring the bees from the screened cage to the combs of the hive. Ways of accomplishing this will suggest themselves to the man experienced in handling bees. Two methods suitable for the beginner as well as for the experienced beekeeper are described here, and as the operator becomes more familiar with the ways of bees he may vary some of the steps according to conditions and his inclinations.

Method No. I

Place the hives on their permanent locations, which should have good wind protection. Remove four or five combs from one side of each hive. In the evening feed all the package bees again all the sugar sirup they will take, and place one package in each of the hives in the space provided by the removal of the combs.

Then start with the first hive, remove the feeder can, and pull up the queen

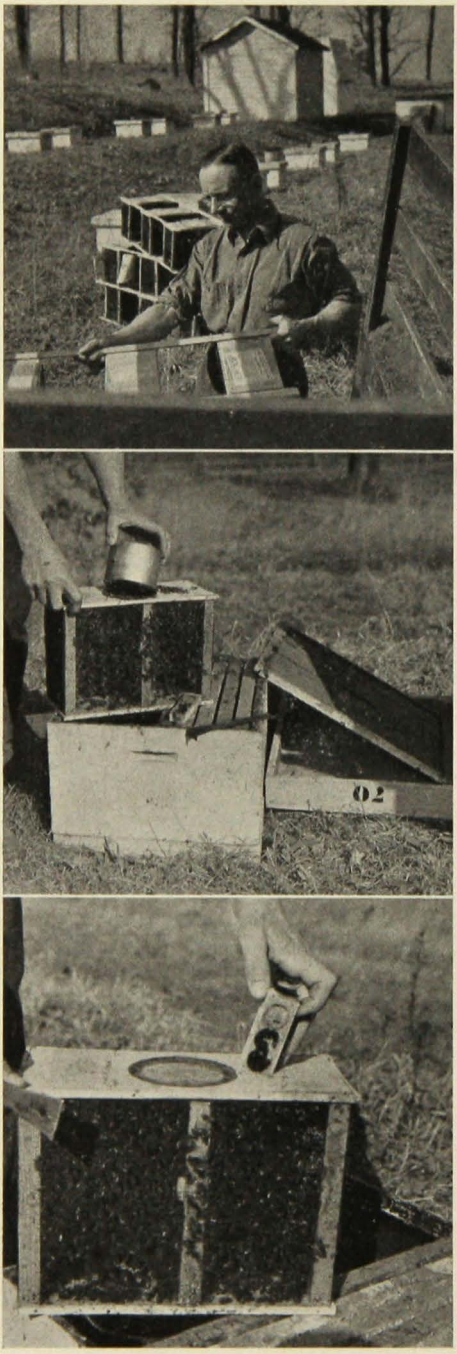

FIG. 2

ABOVE—RECEIVING PACKAGE BEES
CENTER—REMOVING THE FEEDER CAN
BELOW—TAKING OUT THE QUEEN CAGE

cage which is suspended by a wire through the same opening or enclosed in a special opening near the feeder can. Examine carefully to make sure the queen is alive. Remove the small piece of cardboard from the end of the queen cage, and with a small nail or match poke a hole through the candy in that end of the cage. Be careful not to injure the queen. The hole should not be large enough to allow the bees to come out of the cage at once, but it will allow the package bees to release the queen during the night or the following day.

Place the queen cage, screened side up, on top of the shipping cage next to the first comb, or wedge it between the first and second combs with the opened end of the cage uppermost. It is advisable to shake a pint or more of bees on the queen cage to hasten the transfer from the shipping cage to the combs. If the weather is cool, more bees should be shaken on the queen cage to prevent the queen from becoming chilled.

Sufficient feed to last for a week or more should have been provided before this time. If combs containing honey and some pollen are available, placing two combs near the shipping cage so the bees will find it without delay is the best method. If there is no honey, but empty combs are available, two or three combs may be filled with sugar sirup by holding them at an angle and pouring or spraying the sirup into them.

If only frames of foundation are available, several pounds of sugar sirup may be provided by a pepper-box feeder made by punching half a dozen or so small nail holes in the lid of a

FIG. 3

ABOVE—REMOVING CARDBOARD FROM QUEEN CAGE

CENTER—MAKING OPENING THROUGH QUEEN CAGE CANDY

BELOW—PACKAGE INSTALLED AND HIVE READY TO CLOSE

friction top pail, or through the zinc top of a Mason fruit jar from which the porcelain plate has been removed. This feeder, filled with the sirup, is then inverted over the top bars near the queen cage and an empty full-depth super placed on the hive for protection. If an inner cover is used, it should be placed over the lower hive body and the feeder can placed over the hole in the inner cover. If no inner cover is used, the top bars may be covered with cardboard or newspaper with an opening cut out to fit the feeder can. This arrangement conserves heat for the bees.

The hive cover is then put on, and the bees should not be disturbed for from several days to a week in order to give the queen a chance to get her brood nest well started and become fully accepted. The other packages are installed in the same manner in rapid succession. By doing the work smoothly and quietly and in the late evening, there will be little drifting. No smoke is needed nor should it be used in installing package bees. In about a week, the cages are removed and the combs replaced.

Method No. II[1]

The packages are first cared for and the hives prepared in the same manner as in Method I. The feeding is done with a pressure spray pump which wets the bees considerably, and they lap up the sirup from each other's body. The combs that are removed

[1] First described by Dr. C. L. Farrar in Cir. E-427 of Bureau of Entomology and Plant Quarantine, U.S.D.A. April 1938.

when preparing the hives to receive the packages are taken from the middle instead of from one side as in Method I. Then the screen is cut away from one side of the shipping cage and the bees are dumped on the bottom board in the space left by the removal of the combs. The queen is also sprayed with sugar sirup and then removed from her cage and dropped among the other bees. With wings and bodies wet with the sticky sirup, there is little or no flight.

The combs that were removed are now replaced, being lowered slowly to avoid pressing down too much on the cluster of bees on the bottom board. Food should be provided as in Method I and the hive then closed and left undisturbed for several days. In using this method, one need not wait until evening as the bees do not fly to any extent for several hours anyway. Some beekeepers prefer to use warm water in wetting the bees down, and then provide feed by one of the other methods.

Protect Bees Against Cold

If packages are received during an unusually cold spell of weather, it is better to keep them in a basement or a suitable room, keeping them supplied with all the stores they will consume, until warmer weather. The period when package bees should be received is a period during which occasional cold spells may occur, and the beekeeper must be prepared to care for the bees properly under any conditions.

If the package is made up of bees from the same colony as the queen which accompanies them, or if the queen has already been introduced and has been accepted, she may be loose in the package instead of in a queen cage. The usual precautions for queen introduction at the time of installation are then not necessary.

QUEEN ACCEPTANCE AND SUPERSEDURE

The queens accompanying package bees are young queens that usually have been reared in colonies or nuclei other than have the bees in the package, hence certain precautions must be taken to assure acceptance of the new queen by the package bees.

There are two underlying principles, one or the other of which is used in most methods of queen introduction. One is to keep the queen protected in some way from a possible attack, among the bees to which she is being introduced until she has acquired the same odor as the other bees, and then releasing her so quietly and as a part of the normal activities of the colony that the bees accept her without question.

This is the principle involved in Method I of installing package bees. The queen will already have been with the package for three days or more, so all that is necessary is to delay the release of the queen long enough for the bees to recover from the disturbance due to the unusual conditions associated with transportation and installation, to establish their normal activities, and become adjusted to their new home. For some time, however, the new queen seems to be accepted on probation only. Any unusual disturbance, such as a sudden opening of the hive, rough handling of the combs, or the failure of the queen in any way to measure up to requirements necessary for gaining the approval of the colony, may cause the bees to "ball" the queen. The term *balling*, as used in beekeeping, describes the peculiar actions of worker bees when a group of them attacks the queen, surrounding her on all sides, so that she is the center of a ball of workers, who are biting and pulling at her legs, wings, and antennae, and worrying her until she is killed and carried out of the hive.

The second principle, utilized in other methods of queen introduction, is to disorganize the colony so completely that the workers will not notice the new queen as she is suddenly dropped in among them. The queen and the workers recover from their excitement gradually and at the same time the attention of the workers is fully occupied in re-establishing normal conditions. By the time the excitement is over and the work of reconstruction is under way, the queen is already laying and in a high proportion of cases is accepted.

Bees Select Own Queen

The term *supersedure* refers to the action of a colony of bees that for any reason replaces its queen with another of its own rearing. This is the normal method by which colonies in nature are kept queenright, in which case most supersedure is due to failure of the queen because of age.

In modern beekeeping, particularly those phases of it connected with transporting bees long distances and requeening with queens reared by special methods and enclosed in cages for varying lengths of time, a great many new factors are introduced, some of which, or some combinations of which, produce an undue amount of supersedure of young queens. Because so many factors are involved, it is as yet impossible to say just what factors bring about supersedure.

No doubt supersedure is an expression on the part of the workers of dissatisfaction because of the failure, or the apparent failure, of the queen. This real or apparent failure of the queen may be due to any one factor or a combination of several factors, such as inherent weakness in the strain of bees; poor methods of queen rearing; adverse weather conditions prevailing when queens were reared and prepared for shipment; injury at point of origin, during transportation, or at point of delivery; improper method of introduction; adverse conditions due to weather; improper handling and providing for at time of installation of package bees; too early or too rough handling of the colony before the queen is completely accepted; an unbalanced condition of the colony with respect to the relative amounts of brood and adult workers of various age groups; or possibly some other factor or factors as yet unsuspected.

Whatever the cause, the losses due to supersedure are sometimes serious and must be considered in one's plans to use package bees. The extent of the losses varies from year to year and in different parts of the country. Some years supersedure is extremely prevalent over wide sections of the country running as high in some yards of 50 per cent or even higher. In other years in the same territory, it will run as low as from 1 to 5 per cent with individual yards showing no loss whatever. This seems to indicate that one factor is the influence of climatic conditions either in the region where the queens are produced or where the package bees are received.

How To Reduce Losses

The possible causal factors suggest precautions the taking of which may reduce annual losses from supersedure to a negligible minimum. (1) Try to obtain queens which you have reason to believe have been carefully reared from good stock. (2) Examine each queen to note any evidence of injury or poor condition. (3) Use great care in the handling of the queen and the package bees at the time of installation. (4) Refrain from opening the hive for several days after installation, and for the first few weeks plan to have as little disturbance as pos-

sible. (5) Always have a sufficient number of additional queens on hand to make up for a normal loss. (Many package shippers will without extra charge ship an additional 5 per cent of the number of queens in the order, about a week or ten days after the date of the original shipment.)

Some beekeepers make a practice of ordering a few queenless packages to arrive about two and a half or three weeks after the packages are installed so that about one pound may be given to each colony, thereby correcting any unbalanced condition so far as relative numbers of age groups is concerned, and at the same time greatly accelerating colony development.

REQUEENING

Most beekeepers prefer to requeen their colonies before the queens begin to fail because of age. Some requeen regularly each year, and some every other year. Others requeen only as the queens show evidence of beginning to fail, but since it is an expensive matter to have a queen fail during the build-up period this is ordinarily not a good plan. Queens may live as long as seven or eight or even nine years, but after the first season the proportion of failing queens increases.

Time for Requeening

The best time for requeening varies somewhat with the times of the principal honey flows in the different parts of the state and with the system of management. A vital point to keep in mind is to have a good young queen laying at her capacity and at the capacity of the colony for caring for her brood during the six to eight weeks preceding the surplus honey flow in that location.

Some try to attain this by requeening in the early spring during the first build-up flows. This has the advantage of giving vigorous young queens during that vital period which not only will lay well but will have less tendency to swarm that season. Since the colonies are less populous then than at any other time of year, there is much less labor involved in hunting out the old queen, in handling supers, and in checking later for acceptance. It has certain disadvantages. Queens are half again as high in price at that season in the South and it is too early to rear one's own queens in the North. If there is supersedure, it causes a break in the brood rearing which is reflected in colony strength at the time of the surplus honey flow and therefore in the size of the crop.

Some plan to requeen shortly after the surplus flow begins. The greatest advantage of this time is that the slight break in brood rearing is not significant, since most of the eggs will have been laid to produce workers for gathering the crop for the current season, and there is more than enough time for the new queen to produce young bees for the winter. By this time beekeepers in the North may have reared their own queens, although many of them feel that it is cheaper to purchase queens at the reduced prices prevailing at that time in the South than to take the time from their honey-producing operations to conduct their own queen-rearing work. A disadvantage is that the colonies are much more populous, and since some supers will already have been added it requires much more time and effort to locate the old queen and to check for acceptance later.

Requeen During Flow

Fall requeening is practiced by beekeepers in some parts of the country where one can depend upon a fall honey flow. Requeening should always be done when there is a honey flow, if possible, as otherwise the proportion of acceptance is likely to be much lower.

Methods of Requeening

The same methods described for queen introduction in connection with the installation of package bees may be used in requeening, except that in the plan given in Method I it is better not to provide for the release of the queen quite so soon as she will need more time to acquire the odor of the colony. Precaution must be taken that the old queen is not present, that there are no virgins, laying workers, or queen cells in the hive, for in such case the new queen will be killed immediately. If the colony to be requeened is queenright, leave the old queen in the colony until the new queen is on hand.

Some beekeepers requeen at the same time they dequeen, combining the two operations in one. Some prefer to dequeen the day before, but there is danger that queen cells may have been started in that length of time, and it is necessary to check for their presence.

There is some evidence that within about one hour after dequeening, the colony realizes its queenless condition and shortly after this the workers begin a reorganization of their activities in preparation for rearing another. On this assumption the best time to introduce the new queen is one or two hours after dequeening, particularly if using a method of queen introduction such as described in Method II for installing package bees, completely disorganizing the colony at the time the new queen is given.

A variation of this method is known as the *smoke method.* The colony, after being dequeened, has its entrance reduced to a small opening about two or three inches in width and is then smoked vigorously through this entrance which is then closed for from two to five minutes. It is then smoked a second time during which the new queen is allowed to run in at the entrance. If applied during a honey flow, a high proportion of acceptance may be expected.

Another method of introducing the queen and releasing her immediately is called the *honey method.* The colony is not disorganized, but the hive is opened as gently as possible, and the beekeeper gouges a small depression in a patch of sealed honey near the brood nest. He then daubs the queen all over, liberally but gently, with the liquid honey, even pressing her lightly into this honey well for a moment, and then allowing her to walk off, making sure that she is able to stay on the comb. If the colony has been queenless for at least an hour and no queen cells or virgins are in the hive, the queen is usually accepted. Variations of these methods as well as other methods are used by many beekeepers.

Requeening by using ripe cells taken from a colony that is preparing to swarm or to supersede, or cells developed especially for the purpose by some queen-rearing method, is practiced by many beekeepers. Queen cells are produced under one of three different impulses: (1) queenlessness, (2) supersedure, (3) swarm impulse. The first is the basis of all queen-rearing work. Requeening with the use of cells is not possible in early spring because of lack of drones for mating. It is not desirable during the build-up period because of the longer break in brood-rearing. It is best used after all the eggs have been laid that will provide workers for the surplus flow. The break in brood-rearing may even be an advantage in some cases by preventing the development of adult bees which would mature too late to help harvest the honey crop, and too early to be of the best age for wintering. These would be largely boarders, consuming part of the surplus gathered by earlier-reared workers.

Various methods have been devised for rearing a queen in or over a queen-

right colony without interfering with the normal activities of the colony and having the new queen already established and laying before removing the old queen. Such methods require a greater knowledge of bees than the beginner usually possesses, however, and require more individual colony attention than most commercial beekeepers can afford or are willing to give.

Marking Queens

In connection with requeening or for other reasons concerned in one's plan of management, it is frequently desirable to mark the queen in some way. This may be done by touching a drop of some suitable paint to the thorax, colors being used to denote different strains or times of requeening.

Clipping the wings of queens is also used for this purpose. For example, if one requeens regularly every other year he may clip all queens of odd-numbered years on one side and those of even-numbered years on the other. Clipping queens is also an aid in case of swarming since the clipped queen cannot fly and the swarm is likely to return to the hive. In clipping, great care should be taken not to injure the queen. She may be held gently between the thumb and forefinger of one hand while with small sharp scissors about three fourths of the two wings on one side are snipped off. It is wise to practice on a few drones before trying to clip a queen.

MANAGEMENT OF COLONIES ESTABLISHED WITH PACKAGE BEES

After a package of bees is installed and the queen is accepted and laying, it is considered a colony although it will be several weeks before it is a fully developed colony. The management of a yard of such colonies is relatively simple as compared with the management of a yard made up of overwintered colonies since there will be much greater uniformity of development. The simplicity of management of a yard of package bees is one important factor considered by those who kill their colonies each year instead of wintering them. There is greater uniformity in queen performance and colony behavior and less labor because the entire yard may be considered largely the unit for operation rather than the individual colony. The management of such a yard, through the build-up and supering season, is perhaps the most enjoyable of all work connected with beekeeping. It is only necessary to check occasionally for queen supersedure and for queen performance, to watch for appearance of any bee disease, to see that there are always ample stores, and that additional room is provided fast enough to keep pace with the increasing size of the colony, and to check for any indication of swarming. The entrance should be constricted at the beginning and enlarged as the weather becomes warmer and the colony more populous.

Study Bee Life

The entire planning and management of the apiary from the installation of the package bees until the crop is produced should be based upon a knowledge of the honey flows of the locality and a knowledge of colony development, which in turn is based on one's knowledge of the biology of the bee. This is fundamental. It is only by careful study of all phases of bee biology, including the life history of the colony and the life history of the individual, its anatomy and physiology, its behavior and reactions under all possible conditions, the enemies that attack it, and all the diseases to which it may be subject in the different stages of its

life history, that one can hope to attain the greatest efficiency in bee management.

Fortunately, one may start on a small scale with a limited knowledge, and by following a more or less rule-of-thumb procedure in management for the first season, and by combining study and careful observation as he gains experience, attain a fair measure of success from the start. Further progress will depend upon willingness to study and to do the things that study and observation show should be done, *at the time they need to be done.* Perhaps in no other line of agriculture does one's success depend to a greater extent on doing the right thing at exactly the right time. Two other factors have a great influence on the beekeeper's success—his location and the weather. The first he can at least partially control. The second he can only attempt to foretell, and by keeping careful annual records plan his operations so as to be able to take greatest advantage of the possibilities.

FEEDING

For the best results it is necessary not only that a colony have sufficient stores to take care of its daily needs, but that it always have a reserve of stores beyond its immediate needs. The colony reacts as though it senses the danger of diminishing stores falling below a minimum of safety, and as the danger point approaches brood rearing is diminished and colony development checked. This minimum amount of stores will vary with the time of year, the size of the colony, and the consequent daily food demand. For the average colony during the build-up season, it is well not to allow the stores of honey to go much below 15 pounds.

Three good methods of feeding have already been described in connection with the installation of package bees, the giving of combs of honey and pollen from a disease-free source, the use of the pepper-box feeder, and the comb filled with sugar sirup.

A number of other methods are used, and various types of special feeders have been devised which are listed in bee supply catalogues and are readily obtainable.

Do Not Disturb Colony

Some important points to be kept in mind in feeding bees are: replenish the feed with little or no disturbance to the colony, prevent heat escape while feeding or checking the need for feed, have the feed kept warm by the colony heat, and avoid attracting bees from other colonies, thereby starting robbing. An objection to feeding liquid honey instead of sugar sirup is the fact that it tends to cause robbing. Honey should never be fed unless it is known to come from disease-free colonies.

Stimulative Feeding

Stimulative feeding is the giving of a sirup, even when additional food is not needed, in order to stimulate more rapid brood rearing. The sirup is much thinner than that given for stores. This plan is practiced only to a limited extent in the North, but more extensively by southern queen breeders and package-bee producers. It is advisable in northern honey production only during a dearth of nectar flow in the build-up season to prevent a slowing down of brood rearing at a critical period, or during queen rearing or queen introduction when there is little or no honey flow. Some beekeepers have used this method to advantage during a dearth of nectar flow to prevent the developing of robbing, particularly in territories where bee diseases are present.

Outside Feeding

Except in emergencies when no feeders are available, outside feeding for stores is not advisable as it is certain to excite the bees to robbing. The strong colonies get more than they need and the weak ones get little or nothing. The objection to outside stimulative feeding is not so great, but in this case the sirup should be sufficiently weak so that no excitement is caused.

Food Chamber

The feeding of bees is a disagreeable and expensive job. Excepting when new colonies are established, or for special reasons such as those already mentioned, or in periods of unusually protracted dearth of nectar flows, or for the substitution of sugar sirup for honey of poor quality for wintering, feeding is merely a means of partially making amends for previous poor management. The best and most economical feed for bees is a generous supply of honey left in the hive.

Good management demands that the beekeeper study his particular locality each year, noting the nectar flows and the periods of dearth as these vary with the location. He should make sure that there is always a sufficient reserve of stores in the hive. A single-story, ten-frame standard hive is ordinarily too small to permit this, so it is advisable to use a two-story or a story-and-a-half hive, or a large hive, such as a modified Dadant or a Jumbo, as the minimum room to be provided at any time. Many beekeepers always leave a super even on the large hive. The deep or the shallow super placed on top filled with stores is sometimes referred to as a food chamber, because it should always contain an amount of feed in excess of the needs of the colony. It is a "capital reserve" which the bee colony would provide for itself were it not interfered with by man, and it is insurance against a "depression" in nectar supply.

Water and Pollen

During the brood-rearing season bees need an abundant supply of both water and pollen in addition to honey or sugar sirup. The apiary should be so located that water is available within a fairly short distance during the flying season. Pollen furnishes the protein food, and bees cannot rear brood for any length of time without this or some substitute for it if sufficient pollen is not available. It is particularly important that combs with plenty of pollen be left in the hive in the fall so it is available for early brood rearing before pollen sources are present in the spring.

COLONY OPERATION

Once a colony of bees is established it should be given only the minimum amount of attention necessary for its proper development. There is always a tendency on the part of the beginner to disturb his colonies too frequently. While these frequent examinations may not be justified from the standpoint of the good of the bees, or the economics of bee management, they may be at least partially justified for the first season from the standpoint of the education of the beekeeper, for there is the possibility of learning something every time a hive is opened. The more one understands bees and beekeeping, the less time will need to be devoted to actually working with the bees. The work of that limited time, however, will need to be carefully planned in advance and efficiently executed.

While the beekeeper with many colonies cannot always choose the best times for working his bees, the beginner can usually do so. The ideal time is during a honey flow and at the time

of day when the largest number of workers are in the field. Under such conditions, and with a gentle strain of bees, one may frequently work for a considerable period without a veil, but it is always advisable to be provided not only with a veil but with those two indispensable tools of the beekeeper, the smoker and hive tool. In addition, the beginner should be equipped with a pair of gloves until he gains self-confidence and should dress so as not to leave too much of his body vulnerable to the attack of the bees.

When opening a hive a gentle puff or two of smoke should be blown in the entrance to disarm the guards, and a little more smoke given when the cover is first pried up. After that an occasional puff across the top bars is all that is necessary or desirable under usual conditions. To lessen the danger of killing the queen or unduly disturbing the workers, a comb from near one side of the hive should first be removed to allow a wider spacing of the combs of the brood nest before any of them are removed.

Check These Points

Before opening the hive, the beekeeper should have a mental picture of what the colony should show to measure up to the standard of a perfect colony on that particular date; that picture will vary, of course, according to the date of examination and the times of honey flows for that particular locality. Ordinarily it will take him only a moment or so to check what he finds against what his standard for that date demands in the way of number of frames of bees and brood, the performance of the queen, the amount of stores of honey and pollen, the presence of queen cells, evidence of the strength of the honey flow, and amount of available room for expansion of the brood nest and for the storage and ripening of nectar. If he is inspecting for bee disease, the examination will require a longer time.

The beekeeper must then decide on the steps necessary to bring the colony to a condition which will correspond with his standard.

FIG. 4. GOOD WIND PROTECTION IS NECESSARY FOR A BEE YARD

EQUALIZING

It is not often that a colony, especially one established with package bees, is ahead of the standard required at any particular date during the build-up season. However, in case it is, another colony can usually be found that is below the standard. Both colonies may then be helped by taking a frame of hatching brood with adhering bees from the strong colony and giving to the weak one, making sure, of course, that the queen is not on the transferred frame. By hatching brood is meant not merely sealed brood but sealed brood which is old enough so that a large proportion of it will emerge as adult bees within a few days. A little experience and careful observation will enable one to determine the approximate age of the brood. It is surprising what a tremendous difference such a boost will make in a week's time in a weak colony. The transferring of combs from one colony to another for any purpose is permissible only when it is known that there is no disease.

JUDGING THE QUEEN

The queen is sometimes referred to as the soul of the colony, and it is certain that upon her more than upon any other one factor depends the quality, the characteristics, and the possibilities of the colony. Within her small body are held all the factors that are to determine whether the colony, if given the right conditions otherwise, will be weak or strong, be made up of bees that are cross or gentle, light or dark, indolent or industrious, susceptible to disease or disease resistant, with a tendency to swarm or nonswarming. These factors also determine whether the bees succumb easily to the depredations of other bees or the wax moth or are good defenders of the hive, whether they are short lived or long lived, poor housekeepers or good housekeepers, poor winterers or good, robbers or nonrobbers, gatherers of an excessive amount of propolis or not, builders of excessive burr comb or not. Within the queen's body is determined whether the bees have short tongues or long, have large nectar-carrying capacity or not, are quiet or run nervously over combs, are poor comb builders or good, have brood scattered over the hive or a compact brood nest, cap their honey white or water colored, and have other characteristics desirable or undesirable.

The beekeeper cannot, therefore, begin any too soon to try to learn to become a good judge of a queen. Some indication is given by her appearance though this is frequently deceptive. More is given by her behavior, her performance, and her results as shown by her colony. Care must be taken not to misjudge a queen under unfavorable conditions. For example, a good queen may be found in a weak colony if such colony has been under hard wintering conditions or has been deprived of stores. The small amount of brood in the colony would then be due to the lack of ability of the workers to care for the brood, not to the lack of capacity of the queen in egg laying. It is as important to have good stock in a queen bee for honey production as it is to have it in a dairy herd for milk production or in a flock of poultry for egg production.

WEAK COLONIES

A colony sometimes remains weak for an undue length of time during the build-up season owing to any one or more of several reasons, such as a poor queen, refusal to accept new queens introduced to it, and lack of stores. If this lack of development persists in spite of efforts to strengthen it, it is better to unite it with a moderately strong colony than to try to keep it

going. A weak colony requires more care and attention during the season than a normal one and in the end usually yields little or no return. If the queen is poor, she should be killed and the hive body placed on top of a strong colony. If this is done during a honey flow, no special precautions need be taken. Otherwise one or two sheets of newspaper punched with a few small holes should be spread over the top bars of the strong colony and the hive body containing the weak one placed on this.

When a queenless colony fails to requeen itself, it becomes hopelessly queenless and develops laying workers. It then becomes much more difficult to requeen. In this case, some beekeepers follow a practice of carrying the hive several rods away and shaking all the bees out and returning the hive to its original location under the impression that the laying workers will not find their way back. However, this has been proved not to be a valid assumption. If it is still desired to requeen, a frame or two of young brood may be given and another attempt made. The honey method of requeening described on page 13 has given good results. Toward the end of the season colonies that have remained weak and queenless in spite of extra help given them should be killed rather than united with queen-right colonies, since they contribute practically nothing to the welfare of the good colony and consume additional stores.

SUPERING

With a good queen present, brood rearing usually proceeds as rapidly as the workers are able to care for the brood. The queen adds one comb after another to those on which she has brood until every comb in the hive body is filled with brood or stores or both. Sometimes during a heavy honey flow, one or more combs of honey may separate the brood nest from empty combs beyond. The queen may then refuse to cross over the combs of honey to the empty combs and her egg laying is retarded. In that event the combs should be rearranged so that the empty combs are next to the brood nest or, if the weather is quite warm so there is no danger of chilling the brood, interspersed among the combs already containing brood. The spreading of combs of brood is sometimes practiced even when combs of honey do not restrict egg laying, but great care should be taken to avoid chilling the brood.

Supering Time Important

Before the first hive body is filled, the first super should be given. A certain amount of experience is necessary to be able to judge just the right time for giving supers. One must take into account not only the condition of the colony but also the season and the probabilities of honey flow. In general, it may be said that the first super should not be given until the colony has occupied all the first story and has become crowded enough so that it will welcome additional room, but before it has become crowded to the extent that brood rearing or nectar storage has been curtailed or a tendency to swarm has started to develop because of lack of room.

Bees sometimes hesitate to go up into supers, particularly if they are filled with frames of foundation instead of drawn combs. This hesitancy may be overcome by exchanging a few of the super frames with frames containing some honey and brood. In the case of comb-honey production, or when an extracting frame of a different depth from the brood frame is used, a few bait combs partially filled with honey may be placed in the super for this purpose. Scratching the surface of

such combs to expose liquid honey makes them more attractive to the bees.

The second super is frequently placed below the first, and the third below the second, to induce the bees to occupy them more readily, but this entails much heavy lifting and extra time. More and more beekeepers are using the system known as top supering, in which each successive super is placed on top of the last one. This system is not so applicable to comb-honey production in which the supers containing the earliest-gathered honey are usually kept on top to prevent the honey from becoming travel stained.

VENTILATION

In the early spring the hive entrance should be contracted to a width of only an inch or two in order to conserve heat for brood rearing. As the colony becomes stronger and the weather warmer, the entrance is enlarged until it is open the full width of the hive. As supers are added and the colony becomes populous, more ventilation is needed to prevent the bees from loafing and clustering over the front of the hive. The additional ventilation may be provided by raising the front of the hive by means of a small block, thereby allowing the air to come in along the sides of the bottom board, and also by staggering the supers, slipping the first one forward slightly, the second one back, the third one forward, to allow currents of air to pass through the hive. During a dearth of nectar this cannot be done because of the tendency of the bees to rob.

ROBBING

When the weather is warm and no nectar is available, bees from some of the strong colonies may enter the hives of the weaker ones, steal honey, and carry it back to their own hives. Once robbing gets well started it is difficult to control, and the weak colonies may be robbed out completely and killed. When a robber colony has finished with one hive, it will search the apiary until another colony is found too weak to defend itself.

It is much easier to prevent bees from starting to rob than it is to stop them once they have started. Keep all colonies strong so they are able to defend themselves against robbers, and contract the entrances during a period of dearth of nectar flow. Do not work a yard during a dearth and do not expose any honey or sugar sirup in or near the yard at such times.

If in spite of all precautions robbing starts in a yard, the colony that is being attacked may have its entrance blocked completely for a short time until the robbing tendency is past. If necessary, the weak colony may be moved to the location of a strong one, and the strong one which is able to defend itself placed where the weak one was. Sometimes the use of carbolic acid or other repellant substance smeared around the entrance and along the cracks between the supers and along the edges of the top and bottom board of the attacked hive will help temporarily. It may be necessary also to close the hive of the robber colony for a time. It sometimes helps to exchange the location of the robbing colony with that of the colony being attacked.

QUEEN EXCLUDERS

Beekeepers are divided on the question of the value of queen excluders. Opinion ranges all the way from that of the man who states that he wouldn't think of keeping bees without an excluder for every hive to the man who wouldn't have one on his place.

Excluders are necessary in some systems of management particularly when

one wishes to keep extracting combs separate from brood combs, where one uses a two-queen system, and in certain systems of swarm control, queen rearing, and queen introduction. It is well for the beginner to operate a few colonies with excluders and a few without to become familiar with their use. He can then decide for himself whether it is necessary or advisable to use them under the conditions in his locality and with his particular system of management.

Many questions in regard to the operation of a beekeeping business, such as choice of type of equipment, arrangement of honey houses, routine operations, and colony management, are highly controversial. This is because of wide variations in conditions in different parts of the country and because the personal factor enters strongly into the many phases of management of a business so highly individualistic as beekeeping. The beginner should study thoroughly the conditions in his locality that have a bearing upon beekeeping management. The success of any system of management must depend on a knowledge of the fundamentals of the biology and the behavior of the bee, and the beginner should also study the experiences of other beekeepers.

COLONY RECORDS

Keeping an individual record of each colony is one of the best ways for the beginner to learn the effects of the various factors that influence colony development. Such records should not only be kept, but studied and compared from season to season and correlated with such factors as times of honey flows, times of installing packages, requeening, and major manipulations which affect the colony. If possible, at least one colony should be kept on scales, and a daily record of weights kept to learn when the honey flows start and stop. At the same time observations should be made in the field to determine the sources of nectar and pollen. The commercial beekeeper cannot keep individual records on all his colonies, but he can and should keep individual yard records and will find it to his advantage to keep at least one colony on scales.

SWARMING

Many systems of swarm prevention and swarm control have been devised and advocated, some good and some bad, some good under certain conditions and not under others. The beekeeper will find as he attempts to follow any of these systems and to solve the problem with his own bees under his own conditions that an understanding of the significance of swarming in the biology of the bee will be a help.

Swarming may be considered as a provision of nature for the preservation of the species; the instinct to swarm is therefore inherent within the bee. It is the normal method of colony reproduction. The honeybee is a social insect and the colony may be considered as a complete organism made up of many individual bees; queen, workers, and drones. No one of them is complete in itself since none can exist any great length of time and live a normal life except as it is associated with others to form a colony, just as individual cells of the body cannot exist any length of time except as they are associated with other cells to form a complete whole. The honeybee, therefore, has two kinds of reproduction, individual reproduction from eggs and colony reproduction by the casting of swarms.

When bees were still in a wild state and not in any way controlled by man, the number of colonies was maintained by swarming. There is always a small proportion of colonies that becomes hopelessly queenless because of something happening to virgins on their mating flight, or because of other inter-

FIG. 5. SWARMING SHOULD BE ELIMINATED

ferences with the normal course of events. Had it not been for swarming, the species would probably have become extinct. Since man has found it profitable to use the honeybee for his purposes and has devised methods for making colony increase that are far better from his standpoint than allowing bees to swarm, the swarming instinct which was necessary to the very existence of the species, and therefore one of the most deep-seated of all its instincts, has become, from man's point of view, not only unnecessary but undesirable. Man tries in every way possible, therefore, to eliminate the tendency of this instinct to manifest itself. Failing that, he has to devise manipulations that will to as great an extent as possible overcome it and prevent its interference with his plans.

The honeybee is not domesticated as are our domesticated animals which have been molded both physically and psychologically by breeding to conform as far as possible to a preconceived pattern that suits man's purpose. The honeybee is still essentially a wild animal and man has been able to utilize it, not by changing it to the extent he has changed domesticated plants and animals, but by intensively studying its biology, its instincts, its behavior, its possibilities, and its limitations under all conditions, and making his own activities in operating bees conform to what his studies tell him provides the most perfect conditions for the bees themselves.

An obvious method of attack on the swarming problem would be to attempt to eliminate the swarming tendency by selective breeding since some strains of bees have less tendency to swarm than others, just as the plant breeder has eliminated the tendency and even the ability of some plants to reproduce by seeds.

Some progress has been made by beekeepers in breeding for nonswarming tendency and for other desirable qualities and physical characteristics by selection of breeding stock. Progress has been limited because mating could not be controlled in the honeybee since mating takes place only outside, at a considerable distance from the hive, and beyond the immediate control of man. Methods of controlled mating which promise to be a great help in breeding toward a specific pattern of honeybee have recently been developed. However, the techniques are so far adapted only to the laboratory and require fairly expensive equipment and the skill of a trained worker. At best only partial success has as yet been attained. The techniques have been improved and somewhat simplified lately, but their requirements are still such as

to make the method impractical for the average queen breeder.

As in any other living organism, a colony of bees passes through a normal life cycle. Starting with infancy, represented by a newly cast swarm or by a colony established with package bees or with a nucleus, it passes through the rapidly growing period of youth, represented by the build-up period of the colony through spring and early summer, and finally reaches maturity, represented by the production of a surplus of drones and virgins. As the climax of the reproductive cycle it gives forth offspring, represented by the swarm or swarms that are cast. Temporarily exhausted from the reproductive process it has passed through the colony then starts in at the beginning of the cycle again with a newly mated queen.

Nature aims to guarantee the continued existence of the species and does this by concentrating the energies and activities of the colony toward this one supreme purpose, making everything else subservient to this, including the gathering of sufficient food reserves. Man reverses the relative importance of the two processes and attempts to eliminate or suppress the colony (not the individual) reproductive instincts, shunting the stream of energy thereby conserved into another channel, the storage instinct, so he may obtain larger crops of honey. The measure of any attempt to solve the swarming problem is the degree of efficiency with which this is accomplished.

Certain conditions, some of them under the control of man, tend to hasten a colony's attainment of maturity, such as unfavorable conditions owing to excessive heat, lack of ventilation, and crowded conditions in the brood nest. The presence of many queen cells and drones, while being a result of development toward maturity, apparently accelerates still further development toward what the beekeeper calls swarming fever.

External factors which have a bearing on the development of the swarming tendency differ greatly in different parts of the country, from year to year, under different systems of management, and according to whether one is producing comb or extracted honey. Swarm control is much more difficult in the former than in the latter because a more crowded colony condition is necessary to produce the finest comb honey. Local weather conditions are sometimes an important factor, as when several days of rain keep all the field force of a strong colony shut in during the peak of emergence of young bees, thereby causing a badly congested condition.

If a colony reaches its maturity at a time when there is little or no honey flow, there is no outlet for its storage instinct. As a consequence its energies tend to concentrate on the swarming instinct. When a good honey flow starts before the colony reaches its peak, its energies are at once given a free outlet through the channel of the storage instinct and it becomes much easier for the beekeeper to check swarming. Most observant beekeepers have noted instances in which colonies that had begun preparations for swarming during a period of dearth turned about and tore down all queen cells shortly after a good honey flow had started, and this without any preventive manipulations being applied. For maximum honey production, it is important to have the colony "hit the honey flow just right" as the beekeeper expresses it, that is, to have the colony still on the upward curve of its natural expansion when the major honey flow begins so that to the momentum of this unchecked colony growth is added the stimulus of incoming nectar. This combination provides optimum conditions for maximum honey production.

Keeping in mind the basic causes and biological principles involved in swarming, the following measures may be taken in planning one's beekeeping management:

1. Attempt to secure or develop a strain of bees that does not swarm readily. 2. Keep colonies headed with young queens. 3. Have a large enough single-brood chamber or a double-brood chamber so the queen is never restricted in her egg laying. 4. Provide sufficient ventilation. 5. Use full sheets of foundation to cut down to a minimum the number of drones reared. 6. If necessary, spread the brood using additional supers, in order to prevent too great a congestion when large numbers of hatching bees emerge over a brief period. 7. Choose suitable apiary sites which do not become too hot because of lack of air movement, and keep them free from tall weeds and grass. 8. Make records of the various honey flows and plan the management so the colony does not reach its peak of development before the major flow starts.

Prompt action is necessary if in spite of all precautions, or because conditions have prevented one from taking precautions, a colony has built queen cells and otherwise has progressed so far in its preparations that it has the swarming fever. This means that the queen has greatly retarded or even stopped her egg laying, and that a large proportion of field bees are loafing in the hive instead of gathering nectar, pollen, or water, or scouting for new pastures. Many procedures have been suggested for swarm prevention under these conditions. All are based on altering the conditions in the hive so as to require the colony to reorganize itself and its activities. This changes its energies from swarm preparation to other work or as the beekeeper expressively puts it, "drives swarming out of their heads."

Sometimes such a mild measure as cutting out queen cells and giving more room is all that is necessary. One must make sure that every queen cell is removed. When more drastic measures are needed, brood may be removed and placed in a super above an excluder or given to other colonies, filling the space left vacant in the brood chamber with empty combs or with frames of foundation.

If the colony has reached its peak early enough in the season, it may even be divided and each half provided with a queen. Swarm control and increase are thus effected by the same operation.

If a first or prime swarm issues and is caught, it may be established as a new colony and operated as such or later combined with the parent colony, depending upon the plans of the beekeeper and the further possibilities of the season. When combining, be sure that no queen cells or virgins remain in the parent colony, otherwise swarms headed by virgins may issue. If the prime swarm is not reunited with the parent colony, the latter must be given a queen, or left with one virgin or queen cell to prevent its becoming hopelessly queenless.

With swarming controlled and with ample room provided for the developing colony and for the storage and ripening of nectar, the size of the crop will depend upon the possibilities of the location and upon weather conditions.

CARE OF HONEY CROP

It is important that the honey be well ripened before it is removed from the hive. In comb honey it is desirable that almost every cell be filled and capped and that at most only a few cells next to the outside edges remain uncapped. In extracted honey a larger number of cells may still be uncapped

when the honey is removed but the greater the proportion of capped honey, the higher the quality of the product will be. Even in the case of extracted honey at least three fourths of the cells on both sides of the comb should be capped; if a condition of high humidity prevails, even more should be capped, otherwise the honey will contain too high a moisture content, will be too thin, and will be more liable to fermentation.

The preparation of the honey for market depends on the form in which it is to be marketed and the plan followed in selling. It is of fundamental importance that in every part of the operation all utensils, containers, and everything coming in contact with the honey be kept clean. The honey house should be kept as neat and sanitary as a modern creamery or cannery or any other place where food products are prepared.

Liquid honey should be strained to remove all foreign materials and particles of wax. It should be allowed to remain in a settling tank until perfectly clear before it is put into final containers. If it is desired to keep the honey in a liquid condition as long as possible, it may be heated to 160° F. for a few minutes to kill any yeasts that may be present and to liquefy any crystals, and the temperature then lowered rapidly in order not to darken the color nor impair the flavor as the delicate aromas are easily driven off by heat. Care should be taken not to heat any portion of the honey much above 160° F. In general, it is well to avoid the use of heat as much as possible and where it is necessary, as in liquefying crystallized honey or in clarifying or sterilizing to prevent fermentation, to apply by means of a water bath.

Not only should the honey itself be put into perfect condition before marketing but the containers, whether of glass or tin, should be clean and neat with attractive labels. The retail pack-

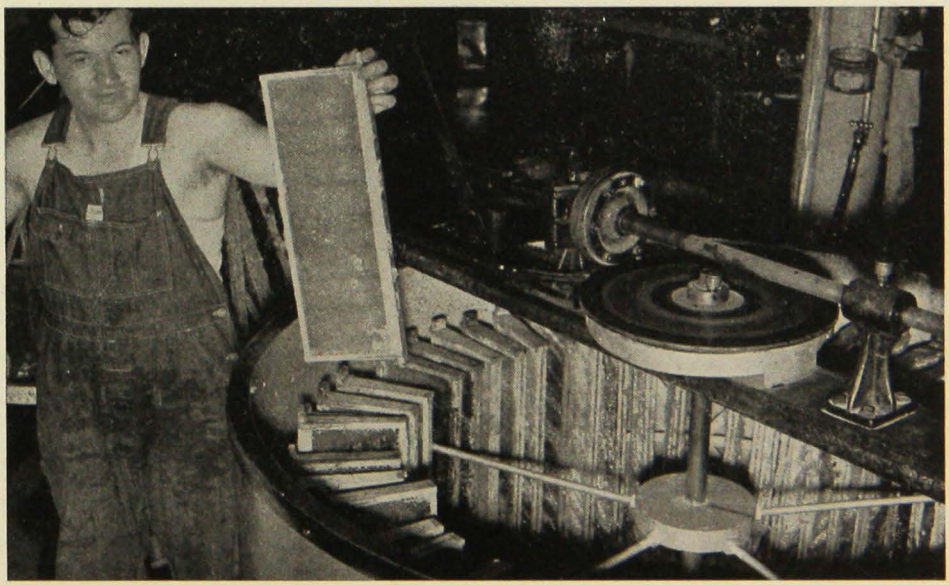

FIG. 6. EXTRACTING THE HONEY CROP

age must be one that appeals to the eye of the consumer before it can compete successfully with other food products.

FALL MANAGEMENT

As cool weather approaches, the hive entrances should be contracted to conserve the heat in the hive and the energy of the bees, as the energy conserved during the fall and winter makes the bees just so much younger physiologically, and so much longer lived in the spring. Some of the chief requisites for good wintering of bees must be provided in late summer and early fall; a young queen, plenty of young bees, and an abundance of stores of pollen and well ripened honey of good quality. The amount of honey to be left on the hive when removing the crop depends on the probabilities of a fall and an early spring flow.

For convenience in discussing winter food requirements, the period for which stores must be provided may be divided into three parts: first, from the end of the surplus flow to the beginning of the wintering period; second, the period of cold weather during which the bees are in their winter cluster most, if not all, of the time; third, the early spring period up to the time when the colonies are able to gather sufficient stores for maintenance.

These three periods are extremely variable depending on the season and the locality. In the latitude of St. Paul, the winter period usually extends from early November to early April. Likewise, the consumption of stores during the first and third periods varies widely depending on whether there is a dearth of nectar or a good flow and on how weather conditions affect the bees directly. We have had variations for each of the three periods in consumption of stores from less than 10 to more than 30 pounds in the apiary at University Farm. It is therefore impractical to state a definite amount of stores that should be left in the hive as a reserve for the period between the end of the surplus flow of one year and the beginning of the flow the following season. Like many other matters in beekeeping, it is an individual problem for specific locations which each beekeeper must work out.

For the average, a surplus of from 50 to 60 pounds at the end of the surplus flow is usually safe, but the beekeeper must keep in mind the possible need of feeding later. Where fall feeding is necessary to provide an adequate supply of stores, or to replace stores of inferior quality for the winter period, the sugar sirup should be made by mixing about two and a half parts of white granulated sugar to one of water. The sugar should be completely dissolved and it is well to have the sirup warm when placed on the hive. To retard granulation, a teaspoonful of tartaric acid may be added for each 20 pounds of the solution while it is being heated. The sugar in the solution must not be scorched as this would kill the bees.

WINTER PROTECTION

In addition to having the colony in perfect condition and supplied with plenty of stores, some protection from air currents and low temperatures must be given. This may be provided either by placing the colonies in a well-insulated basement or cellar, or by enclosing the hives in the yards with some waterproof material that will give insulation and wind protection.

Cellar Wintering

The cellar or basement should be large enough to allow about fifteen cubic feet for each colony. It should be dark, fairly dry, as free as possible from noise or any source of disturb-

ance, and should be provided with some ventilation. The insulation should be sufficient to keep the temperature fairly constant at about 40° to 43° F. There is more danger from temperatures above this range than from below it, as the higher temperatures cause the bees to become more active, restless, consume more stores, use up more energy, become liable to dysentery, and come through the winter in a greatly weakened condition.

The bees should be placed in the cellar as soon as possible after the last good flight weather has passed. They should be taken out of the cellar about the time the willows and soft maples bloom. For the latitude of St. Paul these dates will be in early November and early April.

When the hives are taken into the cellar the entrance blocks should be removed, leaving the full depth entrance entirely free. These blocks should be replaced when the hives are put out on their summer locations. It is better to take the bees out in the evening of a cool, cloudy day. If they are brought out in the middle of a bright warm day, there is apt to be much drifting.

Outside Wintering

Assuming the colony to be in perfect condition, the most important factor for good outside wintering is a location well protected from the wind. Various types of insulating materials and various methods of using them have given good results. Wooden packing cases, enclosing one, two, or four colonies, with space to provide about four inches of packing material under the hives, around the sides, and over the tops are used successfully. For packing one may use whatever insulating material is most readily available. Sawdust and planer shavings have a high insulating value. Clover chaff and flax straw are good, and even forest leaves, rye, or wheat straw may be used, although the insulating value of the last is poor. A tunnel must be provided through the packing material from the hive entrance to the outside.

A type of protection less expensive than the wooden case may be provided

FIG. 7. MINNESOTA WINTERS DEMAND GOOD PROTECTION FOR BEE COLONIES

by using a tarred, asphalted, or other waterproof paper to enclose the packing materials which may be any of those mentioned above or some commercial insulation material that may be stored from year to year when not in use. When using waterproof paper, packs of two, four, and eight colonies are common, and even whole rows of hives are sometimes wrapped in one pack. There is more tendency for robbing and drifting when colonies are packed in rows; when packing four or eight in a group this danger may be avoided by having some of the colonies face different directions.

Beekeepers sometimes simply wrap their colonies with one or two thicknesses of a waterproof paper. This gives little insulation but does give good wind protection.

Winter Entrances

In outdoor wintering, bottom entrances sometimes become clogged. For this reason, top entrances or, in cases where bees are wintered in two-story hives, middle entrances between the two stories may be used. The entrances need not be more than from 2 to 4 inches in width.

Both cellar and outside wintering are successfully practiced by Minnesota beekeepers in all parts of the state. There are advantages and disadvantages to both types, and factors of locality and management will govern the choice. But in every case one of the most important factors is the condition of the colony, and that is a result of management long before winter comes on. One advantage of outside wintering is that the protection may be given much earlier in the fall and continued much later in the spring, covering two periods that are sometimes very critical for the bees.

SPRING WORK WITH OVERWINTERED COLONIES

When the first flying weather occurs in late winter or early spring, a careful examination should be made to locate any dead or weak colonies. Hives containing dead colonies should be closed and removed at once to a bee-tight building, cleaned of all dead bees, and the combs carefully examined for any evidence of disease. Weak colonies should have their entrances contracted to a very small opening to conserve heat and prevent robbing. All colonies must be checked for stores, and feed given to any that need it.

As soon as the weather is sufficiently warm, an examination must be made to locate any queenless colonies and to determine whether any of the queens present are failing. If necessary, queens should be ordered from the South for replacement. At this time of year, the colony should not be opened more than is absolutely necessary, and when opened should be closed as quickly as possible to avoid chilling the bees and brood. As soon as brood rearing is well under way and conditions are suitable, an inspection of all colonies for disease should be made.

All the bottom boards should be cleared of dead bees and any other material that may have accumulated during the winter. This can be done with little trouble by having one extra bottom board placed under hive No. 1. The bottom board belonging to hive No. 1 is then cleaned and placed under hive No. 2, continuing until all are cleaned.

Spring Dwindling

During early spring the observant beekeeper will notice that the colony population decreases, sometimes very

rapidly. This is because many of the old bees that had just enough vitality to come through the winter die after their first few flights. This decrease in bee population is referred to as spring dwindling.

The rapidity and extent of this spring decrease in population depends on such factors as the condition of the colony in the fall, the quality of the winter stores, the amount of protection during the winter, weather conditions, and management during the spring. Sometimes it indicates the presence of an adult disease. Losses from spring dwindling frequently more than double the actual winter loss. In reality they should be counted as winter loss. The reduction in colony population continues until the daily rate of emerging bees equals the daily death rate of the old bees.

A yard of overwintered colonies is likely to show every gradation from colonies that are dead or have only a few live bees to those that are unusually strong. The beekeeper's job is to equalize these and to bring all colonies to the proper strength, so they will develop to the right condition by the beginning of the major honey flow.

The exact steps to be taken depend on conditions and the average strength of the yard. It may mean the equalizing of bees, brood and stores, requeening, the adding of package bees, or feeding. This is sometimes the most disagreeable and most discouraging period for the beekeeper, and the work requires judgment that can be attained only by several years of experience. The amount of attention necessary at this time depends to a great extent upon the thoroughness with which the colonies were prepared during the previous summer and fall and the protection provided during the winter.

Once the colonies have all been brought to proper strength, requeened if necessary, and left with sufficient stores, the management during the rest of the season will be the same as for colonies developed from package bees.

BEE DISEASES

The disease of bees may be divided into two classes according to whether they affect adult bees or the brood. There are very few reports of serious trouble from diseases of adult bees in Minnesota.

Adult Diseases

DYSENTERY.—Dysentery is a condition that often accompanies poor wintering rather than a disease caused by a specific organism, although it may also be associated with Nosema. Bees affected with dysentery have their rectums greatly distended with watery contents and are forced to void their feces in or near the hive, instead of in flight as they do normally. Too high a water content in the winter food, poor-quality stores, and poor protection bring about this condition.

ISLE OF WIGHT.—The Isle of Wight or Acarine disease is caused by a tiny mite which gets into the thoracic trachea of the adult bee. Fortunately it does not occur in this country, and we have a quarantine law forbidding the importation of bees from other countries except Canada which is also free from it.

PARALYSIS.—Paralysis is a disease which causes the bees to become weak, sluggish, dark-colored, shiny, and to have a trembling motion. The affected bees usually crawl or are carried out of the hive by the other bees and die. If the disease persists, the colony should be requeened.

NOSEMA.—Nosema is caused by a one-celled animal parasite, *Nosema apis*, in the digestive tract. Bees af-

fected by it have a tendency to run about outside the hive, and many of them lose their wings. It is more evident in early spring and disappears with warm weather. There are some indications that it may be more prevalent and cause more loss than is generally supposed.

SEPTICEMIA.—Septicemia is a bacterial disease affecting the blood of the adult bee. The symptoms are somewhat the same as those of paralysis. The legs and wings of the dead bees drop off easily and fall apart at the joints. It is more prevalent in moist shady locations.

Brood Diseases

Three of the four brood diseases of bees, sac brood, European foul brood, para foul brood, and American foul brood, which are present this country, occur in Minnesota. Only the last one, however, is so serious as to be of great economic importance.

SAC BROOD.—Sac brood is caused by a filtrable virus and is widespread but seldom causes serious loss. The affected larva dies after it has become full grown but before the cell is capped, and it turns a yellow-brown color. The skin becomes tough and the body contents become watery. The scale formed when the larva dies is brown in color. There is no characteristic odor associated with this disease. Neither the dead larva nor the scale formed from it stick to the walls of the cell as in the case of American foul brood, but may easily be removed with a match or toothpick. Because of this a good colony will usually clean out all scales and dead larvae and the disease will disappear. If it does not, the colony should be strengthened with bees and brood from another hive and then requeened.

EUROPEAN FOUL BROOD.—European foul brood is caused by *Bacillus pluton.* The larva dies when it is quite small and is still curled up on the bottom of the cell. It turns a grayish-yellow color and gives off a slightly sour odor. The larva and the scale formed from it may easily be removed. This disease is not of common occurrence in Minnesota and seldom causes serious loss. If it persists, the colony should be requeened with a young queen of Italian, Carniolan, or Caucasian stock.

AMERICAN FOUL BROOD.—American foul brood is a bacterial disease which attacks the honeybee larva. It is the most serious disease with which beekeepers in this country have to contend. The causative organism, *Bacillus larvae,* is a spore-forming bacillus which is taken in with larval food in the spore stage. In the alimentary canal it changes to the vegetative form, multiplies rapidly, and attacks the walls of the digestive tract. It causes death in the late larval or in the pupal stage of the bee, generally after the cell has been capped.

The dead larva or pupa turns a brown color and lies lengthwise along the lower cell wall. The cell cappings become sunken, discolored, and many of them are punctured, giving the comb a characteristic appearance. When the cells are opened, an occasional one may disclose the shrunken pupa in the lower part of the cell with its extended tongue sticking to the top wall. If a match or toothpick is inserted into the decayed body, the contents are shown to have a sticky, glue-like consistency and ropes or strings out when the stick is withdrawn. A characteristic, disagreeable odor is given off which has been compared with the odor of burned glue. As the decayed mass dries, it shrinks into a small, dark-brown scale which sticks to the bottom wall of the cell so tightly that it cannot be removed without tearing away part of the wall. In inspecting for disease, the combs should be held at an angle

so the light shines down to the bottom of the cells.

American foul brood is spread by infected food. The most dangerous source is contaminated bee equipment and honey from a badly diseased colony. It is one of the greatest hazards, if not the greatest, that beekeepers have to face. It has caused losses in this country amounting to millions of dollars and has put thousands of beekeepers out of business. It is such a threat to the success of any beekeeping undertaking that no one should think of going into the business without making himself thoroughly familiar with it and with the problems of its control.

Most of the states have laws and regulations having to do with the control and eradication of the disease and a state bee inspector whose duty it is to administer the law. However, no state has sufficient funds to inspect all its colonies. Each beekeeper must learn to be his own inspector, and he should know how to avoid doing anything that would expose his bees to the disease and what steps to take if any of his colonies should become infected. The following suggestions are therefore offered as guides.

1. Never buy bees in hives, or used bee equipment, or use bee equipment belonging to others unless you know such bees and equipment are free from disease.

2. When starting with bees try to determine whether there is any source of infection, either diseased bees or unused or discarded bee equipment, within bee flight of your location. Bees will fly several miles, and old combs may harbor the disease for many years.

3. Never feed honey to bees unless you know it was produced in disease-free colonies.

4. Inspect your colonies regularly, and acquire the habit of examining brood combs critically whenever working with your colonies.

5. Learn the distinguishing characteristics of the three brood diseases found in Minnesota, and learn to distinguish diseased brood from brood that may have died from starvation, chilling, or arsenical poisoning.

6. If in doubt, send a sample of the dead brood to the State Entomologist, University Farm, St. Paul, or call your local deputy bee inspector.

7. If you have reason to fear there may be some infection in your colonies which has not yet developed to a point where it can be detected, do not transfer combs from one colony to another in feeding, equalizing, or making increase. Be particularly careful to guard against robbing. Do not expose any honey or used equipment.

8. If a case of American foul brood appears in your yard, dispose of the diseased colony, even though only a few affected cells are found. Watch carefully other colonies near the location from which the diseased colony was removed as drifting bees may have carried the infection to them. Dispose of diseased colonies in accordance with the instructions given below which are sent out by Professor A. G. Ruggles, State Entomologist, to all deputy inspectors.

ERADICATION OF AMERICAN FOUL BROOD

When bees are found to be infected with American foul brood, immediate action is necessary. The safest and in the end the cheapest means of stamping out the disease is to burn the infected colony. Other methods, such as shaking, treating with formaldehyde, and treating with chlorine, have been tried but are not advised and are never

recommended. The method recommended by the U. S. Department of Agriculture and all of the states where inspection is rigidly carried on may be summarized as follows:

A. Kill the bees of the diseased colony.

1. Leave the colony undisturbed for at least one-half hour just before the bees are killed. This allows the bees to return which were disturbed in the inspection of the colony. Spread a tablespoon of calcium cyanide dust on a sheet of stiff paper or cardboard and slide it in the entrance of the hive. The entrance should be left open a few minutes to allow field bees to return. The hydrocyanic gas which is given off is one of the deadliest poisons known, and great care should be taken in handling it. It should be kept under lock and key and the container tightly closed to avoid escape of the gas. *Never leave can in the car with the lid off.*

2. In cases of emergency when calcium cyanide is not available, gasoline may be used in killing the colony; however, it is a poor substitute. When all bees are in the hive the entrance should be closed and the hive made bee tight. The hive cover is lifted gently so as not to disturb the bees, a pint or more of gasoline is quickly poured over the tops of the frames, and the hive again closed before any bees escape. *The usual precautions about having no fire near must, of course, be taken.*

B. Burn all the bees and combs immediately.

1. Before the bees are killed select a place not likely to be plowed or disturbed where a pit 18 inches deep is dug, large enough to hold all the materials to be burned.

2. Hives containing the dead bees should be carried near to the pit intact and placed on paper or burlap to catch any bits of comb and dead bees that may be dropped. These dead bees are also thrown into the pit and burned.

3. Kindle a fire, make it as hot as possible, and use several strong cross members of wood or metal to support the combs and allow plenty of draft underneath. Feed the bees and combs to the fire as fast as conditions permit.

4. When everything is completely burned, rake all scraps and dead bees into the pit and fill it in.

C. Disinfect the empty hives.

1. Sprinkle the inside surfaces of the bodies with kerosene, stack them seven or eight high in the form of a chimney, allow ventilation and a little fuel at the bottom, and ignite the fuel. The bodies need not be scraped; they should be stack with rabbets downward. As soon as the inner surfaces are scorched, cover the stack with a board to smother the fire. Wash the outside and edges of the bodies with soap and water. A blow torch is useful in scorching the covers and bottoms and may also be used for the hive bodies.

Or 2. Thoroughly scrape the hive bodies, bottoms, and covers. Catch all scrapings on paper and burn. The hives should then be completely immersed in lye solution (10 gallons of water per pound of lye) and boiled for 15 minutes.

UNIVERSITY FARM, ST. PAUL, MINNESOTA

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