Pollination management

From Wikipedia, the free encyclopedia

This article is missing citations or needs footnotes. Please help add inline citations to guard against copyright violations and factual inaccuracies. *(December 2007)*

Pollination Management is the label for horticultural practices that accomplish or enhance pollination of a crop, to improve yield or quality, by understanding of the particular crop's pollination needs, and by knowledgeable management of pollenizers, pollinators, and pollination conditions.

Honey bee on domestic plum blossom
Honey bees are especially[citation needed] well adapted to collecting and moving pollen,thus are the most commonly used pollinators. Note the light brown pollen in the pollen basket.

Contents[hide]

Pollinator decline

Placing honey bees for pumpkin pollination Mohawk Valley, NY

Main article: Pollinator decline

With the decline of both wild and domestic pollinator populations, pollination management is becoming an increasingly important part of horticulture. Factors that cause the loss of pollinators include pesticide misuse, unprofitability of beekeeping for honey, rapid transfer of pests and diseases to new areas of the globe, urban/suburban development, changing crop patterns, clearcut logging (particularly when mixed forests are replaced by monoculture pine), clearing of hedgerows and other wild areas, loss of nectar corridors for migratory pollinators, and human paranoia of stinging insects (killer bee hype).

[edit]

In 1989, following Hurricane Hugo, massive aerial applications for mosquitoes were done in South Carolina. The following year, watermelon growers who did not place beehives in the fields, observed the fruit begin to develop, then abort, or develop into small deformed fruit. There were entire fields that never yielded a single usable melon. Some growers went out of business; others began to

Date pollinator up an 'Abid Rahim' palm tree

seriously manage pollination. Since beekeepers were also heavily damaged by the mosquito spraying, the supply of bees for pollination was critically short for several years.

Importance of pollination management [edit]

The increasing size of fields and orchards (monoculture) increase the importance of pollination management. Monoculture can cause a brief period when pollinators have more food resources than they can use, while other periods of the year can bring starvation or pesticide contamination of food sources. Most pollinator species rely on a steady nectar source and pollen source throughout the growing season to build up their numbers.

Crops that traditionally have had managed pollination include apple, almonds, pears, some plum and cherry varieties, blueberries, cranberries, cucumbers, cantaloupe, watermelon, alfalfa seeds, onion seeds, and many others. Some crops that have traditionally depended entirely on chance pollination by wild pollinators need pollination management nowadays to make a profitable crop.

Some crops, especially when planted in a monoculture situation, require a very high level of pollinators to produce economically viable crops. This may be because of lack of attractiveness of the blossoms, or from trying to pollinate with an alternative when the native pollinator is extinct or rare. These include crops such as alfalfa, cranberries, and kiwifruit. This technique is known as saturation pollination. In many such cases, various native bees are vastly more efficient at pollination (e.g., with blueberries[1]), but the inefficiency of the honey bees is compensated for by using large numbers of hives, the total number of foragers thereby far exceeding the local abundance of native pollinators. In a very few cases, it has been possible to develop commercially viable pollination techniques that use the more efficient pollinators, rather than continued reliance on honey bees, as in the management of the alfalfa leafcutter bee.

Number of hives needed per acre (4,000 m²) of crop pollination [edit]

Common name	number of hives per acre
Alfalfa	1, (3-5) [2]
Almonds	2-3
Apples (normal size)	1
Apples (semi dwarf)	2
Apples (dwarf)	3
Apricots	1
Blueberries	3-4
Borage	0.6 - 1.0 [3]
Buckwheat	0.5 - 1 [3]
Canola	1
Canola (hybrid)	2.0 -2.5 [3]

Placing honey bees for pumpkin pollination in Mohawk Valley, NY

Cantaloupes	2-4, (average 2.4) [4]
Clovers	1 - 2 [3]
Cranberries	3
Cucumbers	1-2, (average 2.1) [4]
Ginseng	1
Muskmelon	1-3 [5] (7.5 hives per hectare) [6]
Nectarines	1
Peaches	1
Pears	1
Plums	1
Pumpkins	1
Raspberries	0.7 - 1.3 [3]
Squash	1-3 [7]
Strawberries	1 - 3.5 [3]
Sunflower	1
Trefoil	0.6 - 1.5 [3]
Watermelon	1-3, (average 1.3} [4]
Zucchini	1

[8]

It is estimated that about one hive per acre will sufficiently pollinate watermelons. In the 1950s when the woods were full of wild bee trees, and beehives were normally kept on most South Carolina farms, a farmer who grew ten acres (40,000 m²) of watermelons would be a large grower and probably had all the pollination needed. But today's grower may grow 200 acres (800,000 m²), and, if lucky, there might be one bee tree left within range. The only option in the current economy is to bring beehives to the field during blossom time.

[9]

See also: List of crop plants pollinated by bees

Types of pollinators [edit]

Organisms that are currently being used as pollinators in managed pollination are honey bees, bumblebees, alfalfa leafcutter bees, and orchard mason bees. Other species are expected to be added to this list as this field develops. Humans also can be pollinators, as the gardener who hand pollinates her squash blossoms, or the Middle Eastern farmer, who climbs his date palms to pollinate them.

The Cooperative extension service recommends one honey bee hive per acre (4,000 m² per hive) for standard watermelon varieties to meet this crop's pollination needs. In the past, when fields were small, pollination was accomplished by a mix of bees kept on farms, bumblebees, carpenter bees, feral honey bees in hollow trees and other insects. Today, with melons planted in large tracts, the grower may no longer have hives on the farm; he may have poisoned many of the pollinators by spraying blooming cotton; he may have logged off the woods, removing hollow trees that provided homes for bees, and pushed out the hedgerows that were home for solitary native bees and other pollinating insects.

Planning for improved pollination [edit]

Before pollination needs were understood, orchardists often planted entire blocks of apples of a single variety. Because apples are self sterile, and different members of a single variety are genetic clones (equivalent to a single plant), this is not a good idea. Growers now supply pollenizers, by planting crab apples interspersed in the rows, or by grafting crab apple limbs on some trees. Pollenizers can also be supplied by putting drum bouquets of crab apples or a compatible apple variety in the orchard blocks.

The field of pollination management cannot be placed wholly within any other field, because it bridges several fields. It draws from horticulture, apiculture, zoology (especially entomology), ecology, and botany.

US migratory commercial beekeeper moving spring bees from South Carolina to Maine for blueberry pollination

External links

[edit]

- Insect Pollination Of Cultivated Crop Plants S.E. McGregor, USDA, 1976
- Raising awareness among Canadians about plant pollinators and the importance of monitoring and conserving them J. A. Dyer, Seeds of Diversity Canada, Feb. 2006

References

[edit]

1. ^ Javorek SK, Mackenzie KE, Vander Kloet SP (2002) Comparative pollination effectiveness among bees (Hymenoptera: Apoidea) on Lowbush Blueberry (Ericaceae: *Vaccinium angustifolium*). Annals of the Entomological Society of America 95: 345–351
2. ^ POLLINATION BY HONEY BEES
3. ^ ***a b c d e f g*** Custom Pollination with Honey Bees in Manitoba
4. ^ ***a b c*** Pollination Requirements of Vine Crops, Malcolm T. Sanford, Extension Apiculturist University of Florida, 1995
5. ^ Vegetable Grower's Handbook Texas Agricultural Extension Services
6. ^ Bee pollination benefits for rockmelon crops Department of Agriculture and Food , Western Australia
7. ^ Chapter IV
8. ^ Ontario Beekeepers' Association
9. ^ Delaplaine et al. 1994, Bee pollination of Georgia crop plants. *CES Bulletin 1106*

Categories: Agriculture | Beekeeping | Crops | Pollination

Mid-Atlantic Apicultural Research & Extension Consortium

Delaware, Maryland, New Jersey, Pennsylvania, West Virginia and the USDA cooperating

MAAREC Publication 5.4
February 2000

POLLINATION CONTRACTS

It is highly desirable for beekeepers and growers to have a written agreement when honey bee colonies are being rented for pollination services. Such a contract will help to prevent misunderstandings and thus insure better pollination service. Key points that should be included in the contract are:

- Date of movement of bees into the crop, or the time relative to a certain condition of bloom, and the date on which bees are to be removed
- Location of crop
- Number and strength of colonies
- Pattern of colony placement
- Rental fee and the date(s) on which it is payable
- Grower agrees not to apply bee-toxic pesticides while bees are in the crop, but if necessary to do so, the beekeeper will be given 48 hours notice
- Grower agrees to warn beekeeper of other spraying in the area
- Grower agrees to reimburse the beekeeper for any additional movement of colonies in, out, or around the crop
- Grower will provide right of entry to beekeeper for management of bees.

MAAREC, the Mid-Atlantic Apiculture Research and Extension Consortium, is an official activity of fiveland grant universities and the U. S. Department of Agriculture. The following are cooperating members:

University of Delaware
Newark, Delaware

University of Maryland
College Park, Maryland

The Pennsylvania State University
University Park, Pennsylvania

Rutgers University
New Brunswick, New Jersey

West Virginia University
Morgantown, West Virginia

USDA/ARS
Bee Research Lab
Beltsville, Maryland

Requests for information or publications should be sent to: MAAREC, 501 ASI Building, University Park, PA 16802 Phone: (814) 865-1896 Fax: (814) 865-3048 Web site: http://MAAREC.cas.psu.edu
This publication is available in alternative media on request.

* * * * *

Participants in MAAREC also include state beekeeper associations, and State Departments of Agriculture from Delaware, Maryland, New Jersey, Pennsylvania and West Virginia.

MAREC Publication 5.4. Author: Maryann Frazier, The Pennsylvania State University

Visit the MAAREC Website at: http://MAAREC.cas.psu.edu

POLLINATION AGREEMENT

This agreement is made_______________ between ________________________________,
(month/day/year) (grower's name)

and ___________________________________ .
(beekeeper's name)

l. TERM OF AGREEMENT. The term of this agreement shall be for the ____________ growing season.
(year)

2. RESPONSIBILITIES OF THE BEEKEEPER:

a. The beekeeper shall supply the grower with __________ hives (colonies) of
(number)

honey bees to be delivered to the ________________________ as follows:
(orchard, field, etc.)

(Fill in the appropriate line or lines and cross out those that do not apply)

Approximate date of introduction __________________

Number of days after written notice from the grower ______________ .

Time in relation to the following amount of bloom ____

____

DESCRIPTION OF LOCATION(S):____

____

____

(For additional space attach a separate sheet dated and signed by both parties)

The beekeeper shall locate said bees in accordance with directions of the grower, or, if none are given, according to his judgment in providing the maximum pollination coverage.

b. The beekeeper agrees to provide colonies of the following <u>minimum</u> standards:

Disease-free colonies with a laying queen as evidenced by brood

______ frames with brood

______ frames covered with adult bees

______ pounds of honey stores or other food

______ story hives

The beekeeper agrees to open and demonstrate the strength of colonies randomly selected by the grower.

c. The beekeeper agrees to maintain the bees in proper pollinating condition by judicious inspection and supering or honey removal as needed.

d. The beekeeper agrees to leave the bees on the crop until:

(Fill in the appropriate line or lines and cross out those that do not apply)

Approximate date of removal ___________. Number of days of written notice from grower. ________________

Time in relation to amount of crop bloom ____

Other ____

3. RESPONSIBILITIES FOR THE GROWER:

a. The grower agrees to provide a suitable place to locate the hives. The site must be accessible to a truck and/or other vehicles used in handling and servicing the colonies. The grower shall allow the beekeeper entry on the premises whenever necessary to service the bees, and the grower assumes full responsibility for all loss and damage to his fields or crops resulting from the use of trucks or other vehicles in handling and servicing such colonies of honey bees.

b. The grower agrees not to apply pesticides toxic to bees to the crop while the bees are being used as pollinators nor immediately prior to their movement into the field or orchard if the residue would endanger the colonies.

c. The following pesticides, other agricultural chemicals and methods of application are mutually agreed to be suitable while the bees are on the crop: ____

____

____

d. The grower also agrees to properly dispose of all pesticide solutions in such a manner that bees will not be able to contact the material while searching for a water source.

e. The grower agrees to give the beekeeper a 48 hour notice if hazardous materials not listed on this contract need to be applied. The cost of moving the bees away from and back to the crop to prevent damage from toxic materials shall be borne by the grower.

f. The grower agrees to pay for _______ (number) colonies of bees at the rate of $_______ (amount) per colony. Payment shall be made to the beekeeper as follows: $_______ (amount) per colony on delivery and the balance on or before _______________ (date) of said year. Additional moves or settings shall require $_______ (amount) per hive per move.

g. The grower agrees to provide adequate watering facilities for the bees if none are available within one-half mile of each colony used in pollinating the crop.

Signed: Date: ________________________________

______________________________	______________________________
Grower	Beekeeper
Address ______________________	Address ______________________
______________________________	______________________________
Phone Number _________________	Phone Number _________________

POLLINATION CONTRACTS AND EVALUATING HONEY BEE COLONY STRENGTH

Marla Spivak
Department of Entomology
University of Minnesota

When cranberry growers rent honey bee colonies for pollination, it is important that the grower and the beekeeper have a clear understanding of each other's expectations. The information here is to be used a guide to help growers understand what beekeepers expect and need. The word "guide" is key here: growers will need to tailor these recommendations for their particular circumstances and for those of the beekeeper.

Most growers will want to rent from 1-3 colonies of honey bees per acre of cranberries. The more honey bees the better, although over 3 colonies per acre is not necessary. Without honey bees, growers will still get a crop of cranberries, but having lots of bees available will definitely increase yield, fruit size and quality.

The grower should establish a working relationship with a reliable beekeeper. How do you know if a beekeeper is reliable? If a beekeeper is willing to negotiate and sign a pollination contract, it is a good first indication that the person is trustworthy. A sample pollination contract can be found on the next page. Basically, the grower and beekeeper need to agree on how many colonies will be rented, and what the rental fee will be. They need to agree on when the bees will be brought into the cranberry plantations, where they will be located, and when they will be removed. And they need to agree on pesticide use, and who is responsible for vandalism and stinging incidents.

Here is an example of how rental fees are determined for almond pollination in California. Many almond growers determine the fee by the strength of the colonies upon arrival. An independent person (not the grower or the beekeeper) sets up the pollination contract, and inspects 10% of the beekeeper's colonies to evaluate colony strength. In most cases, the grower pays for the services of this independent contractor. Colonies must be of minimum strength, which for almonds is 6-8 frames of bees (this minimum will be higher for cranberries, see below). The grower will pay the beekeeper $6.50 to $7.00 per frame of bees, with a cap at 10 frames of bees. Sometimes the grower will pay a flat fee of $55 or $60 per hive, but will require that the colonies have a minimum of 8 frames of bees. If they have less, the weak colonies must be removed or replaced. If they have more (on average), the grower may increase the pay.

In some cases, the grower pays the beekeeper half of a pre-determined rental fee on arrival of the bees. The grower and beekeeper then each pay half of the cost to bring an independent person in to evaluate colony strength. If the colonies are all of a minimum strength, the beekeeper gets his money back, and the grower pays the remainder of the set fee. In California, beekeepers have learned which growers do not give their money back, and these growers now have a hard time finding reliable beekeepers for pollination.

Almonds bloom in February, at a time when bee colonies are not as strong as later in the season. Research has shown that a colony with 6-10 frames of bees is sufficient for almond pollination, and stronger colonies do not increase efficiency.

Cranberries bloom in mid to late June. This is the time of year when honey bee colonies are very strong and have sufficient bees of foraging age to collect honey. It is also the time of year when clover and other flowers are in bloom, which are much more attractive to bees than cranberries, and produce much more honey. To move their bees into cranberries for pollination, the beekeeper must be paid enough to compensate the beekeepers for the loss of honey production. Otherwise, the grower will likely end up with hive boxes containing colonies that too weak to provide adequate pollination. In May and June, beekeepers can split their strong colonies, keeping the strongest units for honey production and renting the weakest one for pollination. If growers want strong colonies for pollination, they must be willing to pay for them. How much? The price should be negotiated with the beekeeper, and may vary depending on honey prices. Most experienced beekeepers know how much honey they produce during the 3 week period when they would bring in bees for pollination, and also know how much their bees will produce from the cranberries, so can give the grower an honest estimate of the difference. Another thing to consider is where the cranberry property is located. If the property is surrounded by open fields, the bees will tend to forage on both the cranberries and on surrounding clover and wildflowers in the area. Pollination efficiency may go down, so more colonies may be needed per acre (2-3 per acre), but the beekeeper will not lose too much of a honey crop, so the negotiated price may be less. If the property is surrounded by woods, the bees will tend to forage more on the cranberries, fewer colonies may be needed (1-2 per acre), but the rental fee may be higher because the beekeeper will lose more honey.

How strong should a colony be? A colony should contain *a minimum* of 9-10 frames of bees, and a maximum of 15-16, although a colony with 9-10 frames of bees is sufficient. To be more specific, one deep hive box (brood chamber) contains 9-10 frames. Most colonies are kept in 2 deep hive bodies, with honey supers (less deep boxes) on top. A good frame of bees is *covered* with bees, both sides, top to bottom. If there are 10 frames of bees, there should be 6-8 frames of brood of all ages (eggs, larvae, and pupae). If there are 16 frames of bees, there will be 10-13 frames of brood. There should be a laying queen, noted by the presence of eggs in the combs. Lots of brood in the colony, especially larvae which require constant feeding, stimulates bees to collect pollen – this is an important thing for a grower to know.

Another important point is that the colonies should have empty supers where they can store honey. If the supers are full when they arrive, the bees will have no place to store honey and may swarm. Empty supers stimulate the bees to collect honey – another important fact for growers.

In sum, strong colonies with good, laying queens and room to store honey will be the best pollinators of cranberries. After 2-3 weeks in the cranberry fields, the beekeeper will want to move the bees to a different location where they can build back up and produce more honey.

Main points:

1. Growers and Beekeepers should have signed pollination contracts. Handshakes and gentlemen agreements don't ensure payment or responsibility.

2. The bee colonies should have a minimum of 9-10 frames of bees. They should have a minimum of 6 frames of brood and should all have laying queens. They should also have at least 1 empty honey super on arrival.
3. At least 10% of the colonies should be inspected, preferably by an independent person, for strength (frames of bees).
4. The rental fee should consider the minimum and maximum the grower will pay per frame of bees or per colony, the current price of honey, and how much honey crop the beekeeper would lose by putting *strong* colonies in the cranberries. (Note: a beekeeper will not lose any honey crop from weak colonies because weak colonies neither pollinate nor make honey!)
5. The contract should stipulate when the bees should be brought into the cranberry fields, and when they should be removed. It is best to have the bees brought in during very early bloom to ensure they first flowers they find are the cranberries in front of their 'noses', which will help ensure they keep on foraging on the cranberries.
6. The contract should also stipulate that the grower will NOT use toxic insecticides on the cranberries or surrounding edges during the rental period, except with the understanding and consent of the beekeeper.
7. The grower should assume liability for vandalism while the bees are on his property, and for stinging incidents. Foraging bees rarely sting unprovoked, but the colonies can stage a good defense if need be.

Questions? Feel free to contact me:
Marla Spivak
spiva001@umn.edu
(612) 624-4798

Pollination Agreement

Date____________________________ For Season _____________________

The Beekeeper

Name____

Address____

Phone Number ____

The Grower

Name ____

Address____

Phone Number ____

No. of colonies ordered ____

Rental Fee for Grade A colonies _______________________________________

Rental Fee for Grade B colonies _______________________________________

Compensation for Additional Movement
Of bees or other Extras ____

Total Rental Fee ____

Name of Crop ____

Location of Crop ____

Distribution Pattern of Colonies shall be _________________________________

The Grower Agrees:

1. To give _______ days notice to bring colonies into crop
2. To give _______ days notice to take colonies out of the crop
3. To pay one-half the agree total fee when the bees are delivered
4. To pay in full within ______ days after the delivery date
5. To pay one percent a month interest on amount unpaid after the due date.
6. To use no toxic pesticides in the crop during the rental period, except with the understanding and consent of the beekeeper, and to warn the beekeeper if neighbors use toxic sprays
7. To provide an uncontaminated water supply
8. To assume liability for livestock damage or vandalism
9. To assume public liability of stinging while the bees are located in the crop.

The Beekeeper Agrees:

1. To open and demonstrate the strength of colonies randomly as selected by the grower.
2. To leave the bees in the crop for a period necessary for effective pollination, estimated to be approximately _____ days with a maximum period of ______ days, after which time the bees will be removed or a new contract negotiated.
3. To ensure that colonies are properly located and will remain in good condition while pollinating the crop.

Signed **Date** ________________________

______________________________________ ______________________________

Grower **Beekeeper**

Maximizing Honey Production with Effective Spring Management

Written by Carl Wenning, Heart of Illinois Beekeepers' Association, and based upon
the comments of George W. Imirie, Maryland Master Beekeeper.*
Gleaned from an 1999 ABF Presentation in Nashville, TN

It is a well known fact that it requires about 42 days from the deposit of a fertilized egg by a honey bee queen to the point where a worker bee becomes a forger. Worker bee brood spend 3 days as eggs, 5.5 days as larvae, and 12.5 days as pupae before they emerge from the cell. For the next 21 days the average new bee works within the hive feeding larvae, cleaning cells, packing pollen, processing nectar, guarding the hive entrance, and so on. Only after these 42 days have elapsed do honey bees begin their foraging work. If nectar flow first occurs in, say, early-April, then brood production needs to begin at least six weeks before that -- by late February -- if there is to be the required number of foraging bees to bring in the nectar for maximized honey production. It is also a well-known fact that a colony of 60,000 bees will significantly out produce two colonies of 30,000 bees. This is due to the fact that the first 15,000 or so bees in a hive are required to service the queen, to nurse brood, and to perform the chores of housekeeping. With twice the number of colonies, there are twice the number of nurse bees. So, with one colony there are only 15,000 nurse bees (25% of total population), whereas with two colonies there are 30,000 bees (50% of the total population) tied up with nursing duties. With one hive there are 45,000 bees foraging; with two hives there are only 30,000 bees foraging. Which situation will yield more honey is clear. With this in mind, how can one maximize honey production? It's simple. Build up large colonies, but build them up in advance of the main nectar flow -- not on it!

Feed nectar and pollen substitutes early. The influx of nectar and pollen stimulate the workers to begin feeding the queen excessively which, in turn, promotes egg laying. Feeding 1:1 sugar water serves as a nectar substitute. Pollen substitute can be purchased commercially (Imirie suggests *BeePro,* and none other) and may be fed as patties placed upon the top bars. The powder of the substitute may be mixed either with 1:1 sugar water or with high fructose corn syrup. Liquid vegetable oils may be incorporated to keep the pollen substitute from drying out.

Work to avoid swarming. As noted above, one key to maximizing honey production is to have large colony populations. It is therefore imperative to control swarming. Swarming management includes reversal of hive bodies, timely supering, and keeping young queens. These practices have been described elsewhere. (See, especially, *Controlling Swarming: A Guide for Experienced Beekeepers* written by Carl Wenning and available from the author.) Requeen only during the fall if possible, around the time of Labor Day. By replacing a queen during the spring build up for the main nectar flow, the egg laying and brood rearing processes will be interrupted. This will, in turn, reduce the colony population and, consequently, the honey production.

Super early and to excess. Unripe honey, which contains a large percentage of water, requires much more space than it will occupy after it has been processed into ripe honey. If you suspect that your bees will produce three supers full of honey, then provide them five supers to store and convert nectar. Put your supers on by tax day -- April 15th. Put all your supers on at once to encourage nectar collection and to dissuade the bees from swarming. Early supering implies that you need to get <u>required</u> medications in and then <u>out at least 30 days prior to supering for honey.</u>

Install Imirie shims. An Imirie shim is inserted between every two supers, and is included at the top as well. These shims -- nothing more than a wooden frame of a queen excluder with the wire rack removed and a notch cut in one side -- are designed to provided openings for the foraging bees, and to reduce entrance way congestion without cutting holes into the wood of the supers and hive body. (The openings also allow for better ventilation.) A queen excluder (George is "a strong believer" in queen excluders) is positioned under the lowest super to keep the queen from laying eggs in the bridge comb that may be drawn out in the area of the shims. (Bridge comb is much less likely IF there is adequate supering.) As bees return to the hive with nectar, there is no reason why they should have to fight their way through the brood chamber to turn over their nectar load to the house bees. This only adds to the congestion of the brood chamber. Let those bees bringing in the pollen for brood production use the main entrance way. Reducing the congestion of the brood chamber will help to keep the swarming urge at a minimum.

Use captured swarms to draw out foundation. Never put undrawn foundation in a hive used for honey production. Bees won't draw out comb unless there is an immediate need, and if they are in need of a place to store nectar, drawing out comb will be a real impediment to honey production. Drawing comb consumes inordinate amounts of time and honey (bees consume about 8 lbs. of honey to produce 1 lb. of wax), and slows down honey production. Use captured swarms that have the propensity for drawing out foundation quickly to create storage cells. After the comb is drawn, kill the old queen found in the swarm and replace it with a new queen, or else join the bees with another colony using the paper method. Without a doubt, the beekeeper's most valuable asset is plenty of drawn comb.

Put one hive in your apiary on a scale -- permanently. Watch for the first signs of nectar flow. An increase in weight of 15-20 pounds per day is a much better indicator of the beginning of the nectar flow than flowers on trees, bushes, and plants. Learn to distinguish swarm season from nectar season. Bees behave differently during these two times; they have different "modes." Bees are most likely to swarm immediately before the main nectar flow. Once the nectar flow commences, bees are much less likely to swarm. Bees have different behaviors during these times, and beekeepers must work the bees differently.

In the end, the goal of spring management is to help the bees do what they naturally want to do. They have a propensity for hoarding honey that can be taken advantage of if you learn to understand the bee. You'll really have to learn to think like a bee if you expect to maximize your honey production. As George Imirie says, you need to change from a beeHAVER to a beeKEEPER in order to optimize honey production. Of course, you will have no control over the weather and nectar sources, but these too can and do affect honey production.

George W. Imirie has been keeping bees since 1933. During this time he has managed to achieve an average of 132 pounds per colony per year. This is rather amazing in light of the fact that the nectar flow in Maryland rarely exceeds six weeks in length!

---

* The above thoughts are based upon my recollection of Mr. Imirie's presentation, and my own understanding of beekeeping and its practices. If I have misrepresented Mr. Imirie's thoughts, it is only through my own fault. I accept full responsibility for any misrepresentation of facts and inaccuracies in the expression of Mr. Imirie's thoughts.

Amanda M. Ellis

Bee Diseases / Pests

(This information is from the U. S. Environmental Protection Agency http://www.epa.gov/opp00001/factsheets/ipm.htm)

1. **What is IPM?**

   Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

   The IPM approach can be applied to both agricultural and non-agricultural settings, such as the home, garden, and workplace. IPM takes advantage of all appropriate pest management options including, but not limited to, the judicious use of pesticides. In contrast, *organic* food production applies many of the same concepts as IPM but limits the use of pesticides to those that are produced from natural sources, as opposed to synthetic chemicals.

2. **How do IPM programs work?**

   IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach. The four steps include:

   - **Set Action Thresholds**

     Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

   - **Monitor and Identify Pests**

     Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used.

- **Prevention**

  As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment.

- **Control**

  Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less *risky* pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

(This information is from the University of Georgia Honey Bee Lab website at http://www.ent.uga.edu/bees/ with some additional updates.)

Varroa Mites (*Varroa destructor*):

Varroa mites are external, obligate parasites of worker and drone honey bees. **Varroa** mites are visible with the naked eye and look somewhat like a tick. They feed on the hemolymph of adult bees and the developing brood. The reproduction cycle of the mite takes place inside the cells. Female mites (foundresses) enter the brood cells of last stage worker or drone larvae just prior to the cells being capped. There she will deposit five to six eggs over a period of time while feeding on the brood. The first egg laid will be unfertilized and develop into a male. The subsequent eggs will be fertilized and develop into females. The eggs hatch and the young mites begin to feed on the developing pupa. It is normal for mating to occur between siblings. The adult female mites along with the original female mite(s) leave the cell when the bee emerges. The female mites will enter another cell or attach themselves to an adult bee to feed. **Varroa** mites are transported from colony to colony by drifting or robbing bees.

Varroa destructor is a common mite found on *Apis cerana*, the Asian honey bee on which it does not cause serious damage like it does on *Apis mellifera*. These mites were accidentally introduced into the United States in the mid 1980s. Before this time, honey bees were found coast to coast across the United States. Now only an estimated 2% of the feral honey bee population remains, and even this derives annually from honey bee swarms from beekeeping operations. Practically speaking, the wild honey bees have become extinct in the United States due to infestation of the **Varroa** mite.

Visible symptoms of **Varroa** mite damage can be evident on newly-emerged bees which is due to the mite feeding on the immatures within the cell or viruses that are associated with varroa. The newly-emerged bees may be smaller than normal, have crumpled or disjointed wings, and shortened abdomens. The lifespan of the newly emerged bee is also reduced. Severe infestations of **Varroa** mites within the cell (5 or more foundresses) can cause death to the pupa. Other symptoms of mite infestation are rapid colony decline, reduced adult bee population, evacuation of the hive by crawling bees, queen supersedure, spotty brood, and abnormal brood with symptoms resembling **European foulbrood** and **sacbrood** disease.

Infested colonies will die within 1 to 2 years if the beekeeper does not take necessary actions against **Varroa** mites. If upon initial examination of your colony you do not see visible mites, use a capping scratcher on drone brood to see if **Varroa** are inside cells. **Varroa** mites prefer drone brood over worker or queen. If mites are detected you may need to treat in order to save your colony. At this time there are a few chemical treatments available for **Varroa** mite control in the US: Check Mite+ strips (active ingredient coumaphos), Apistan (active ingredient fluvalinate), ApiGuard or ApiLifeVar (active ingredient thymol), and MiteAway II (active ingredient formic acid). Always follow manufacturer's instructions when using chemicals. Also, never treat during a nectar flow because the chemicals can contaminate the honey, and never leave strips or applicators in hives after the recommended time because this encourages resistance. In recent years, mite resistance to Apistan and CheckMite+ strips has become a problem throughout the world. Therefore, rotating chemicals, delaying treatment and using cultural controls are recommended to manage mites in a more sustainable manner.

Delaying treatment can be accomplished if you monitor the level of **Varroa** infestation in your colonies. Treatment is justified only when the economic threshold is achieved. Economic thresholds are defined as the pest level that justifies treatment in order to prevent the pest from reaching damaging levels. For the southeast Piedmont region, the economic threshold has been determined to be:

mite populations: 3172-4261
ether roll levels: 15-38
overnight sticky sheets: 59-187

Ether rolls are easy to do and require little work. Take a quart jar and fill with about 300 bees (1.5 inches of bees). Then spray some ether engine starter fluid into the quart jar and replace the lid. Shake the jar for 30 seconds. The mites will dislodge from the bees and stick to the sides of the jar. Count the number of mites and compare them to the numbers above. A similar method (and easier alternative) to ether rolls are powdered sugar shakes. It requires a jar with 8-mesh hardware cloth lid. Fill the jar with about 300 bees and 2 tablespoons of powdered sugar. Allow the bees to move around the sugar and shake the jar (**not** upside down) for about one minute. Turn the jar upside down and shake the sugar onto a clean, white surface. Count the number of mites and use the recommendations for ether roll levels. Return the bees back to their colony. If the numbers are at or above the economic threshold, you should treat your colony. If the numbers are below then you can wait. Overnight sticky sheets can also be executed with little effort. Various beekeeping equipment vendors sell sticky sheets. Place these into your colony and the next day (18-24 hours) remove them and count the number of mites. It's best to keep screens in the colonies for 3 days, count mites, and calculate an average mites per day. If the mite number exceeds those above it is time to treat.

Cultural methods for **Varroa** mite control include using drone comb or bottom screens to trap **Varroa** mites. **Varroa** mites prefer drone brood. Using a few frames of drone comb per colony draws mites into the cells which are then capped by the worker bees, trapping the mites within. The frames are removed and put into the freezer 24-48 hours to kill the mites.

Bottom screens are also an effective control method. They are basically a wood-bound screen (8-mesh hardware cloth) that is placed underneath the brood chamber. The mites fall through the screen onto the bottom board or ground. The mites are thus separated from the bees and eventually die. It should be stressed that these two treatments alone will not rid your colonies of all **Varroa** mites and should be used as a means to delay the economic threshold and the need for a chemical application. Hopefully in the future, genetic bee stocks resistant to **Varroa** mites will become more available to beekeepers.

Tracheal Mites (*Acarapis woodi*):

Tracheal mites were first detected in the United States in 1984 and have since caused the loss of tens of thousands of colonies and millions of dollars. **Tracheal** mites infest the tracheal system of the adult honey bee. Levels are highest during the winter and spring. Mites prefer adult bees less than four days old. Once they are on the bee, mites are attracted to carbon dioxide emissions and enter the spiracles located on the thorax which lead to the tracheal system. They puncture the wall of the trachea and suck the hemolymph of the bee. **Tracheal** mites live, breed and lay eggs in the tracheal system. The adults and eggs plug the tubes of the trachea which impairs oxygen exchange. They also spread secondary diseases and pathogens since they puncture the trachea in order to feed. Individual bees die due to the disruption to respiration, damage to the tracheae, microorganisms entering the hemolymph, and from the loss of hemolymph. Honey production may be reduced when over 30 percent of the population is infested with **tracheal** mites. Also, the likelihood of winter survival decreases with increasing infestation of the mite. Mites are transmitted from bee to bee within a colony and to other colonies by robbing or drifting bees.

Infested bees will be seen leaving the colony and crawling on the grass just outside the hive. They will crawl up the blades of grass or the hive, fall back down and try again. The wings may be disjointed and the bees unable to fly. The abdomens may be swollen. In late stages of infestation, bees will abscond from the hive. If you are unsure if you have **tracheal** mites, send a sample of bees in alcohol to your local county extension agent for verification.

One method for controlling **tracheal** mites is the use of menthol, available from most bee supply companies. The temperature must be above 60° F in order for the menthol to work. The bees breath in the vapor which, it is believed, desiccates the mites. Menthol must be removed during a nectar flow in order to not contaminate honey.

Another less caustic treatment for **tracheal** mites is an oil extender patty (also referred to as "grease patties". It consists of two parts sugar to one part vegetable shortening. Make a small patty about four inches in diameter and sandwich it between wax paper. Cut the wax paper around the edges so the bees have access to the patty. Center the oil patty on top of the frames within the hive body. The bees will be attracted to the sugar and obtain oil on their bodies. The oil acts as a chemical cloak and the tracheal mites are unable to identify suitable bee hosts. The oil patties are acceptable for prolonged treatment since the oil will not contaminate honey supplies.

Wax moth (*Galleria mellonella*):

The greater wax moth (*Galleria mellonella*) is the most serious and destructive insect pest of unprotected honey bee comb in warmer regions. Wax moths primarily infest stored equipment but will invade colonies whose worker bee population has been weakened by disease, queenlessness, failing queens, pesticide kills or starvation. However, many people outside of the beekeeping industry consider wax moths a beneficial insect because the larval stages are used as fish bait and for feeding insects in zoos.

Newly hatched larvae are white but successive instars are medium to dark gray on the top with creamy white undersides. The larval head capsule is brown. Wax moth larvae prefer dark combs because they contain a variety of nutrients such as entrapped pollen and larval skins. The larvae grow rapidly and will migrate toward the edges of the frames or corners of the supers to spin a cocoon and pupate.

Damage occurs as the larvae burrow into the comb feeding on the wax, larval skins, pollen and honey. As the larvae chew through the comb they spin a silk lined tunnel through the cell walls and over the face of the comb. These silk threads can tether emerging bees by their abdomens to their cells and they die of starvation because they are unable to escape from their cell. This phenomenon is termed galleriasis. In severe infestations, the wax comb, wooden frames, and sides of the hive bodies can be heavily damaged.

The most effective method for preventing wax moth damage in hives occupied by bees is to maintain strong colonies. The bees will remove the moth larvae and repair the damage as it occurs. Stored equipment can be protected against wax moths by fumigating it with paradichlorobenzene crystals or by stacking honey supers in a criss-cross fashion in open sheds. The penetrating air and daylight discourage colonization by moths. Some beekeepers store supers in enclosed barns with a lighted bug-zapper running constantly to kill emerging adult moths. This practice can eventually eradicate moths from the room.

Small Hive Beetle (*Aethina tumida*)

Adults and larvae of the small hive beetle are found in active bee hives and stored bee equipment where they feed on honey and pollen. Adults are broad, flattened beetles about 5.7 mm (¼ inch) long, 3.2 mm wide and dark brown to nearly black in color. Adults are red just after pupation and soon thereafter become blackish. They move rapidly across comb and are difficult to pick up. The larvae are elongate, whitish grubs with rows of small spines along the back. Larvae look superficially like wax moth larvae, but the legs of beetle larvae are larger, more pronounced, and restricted to near the head. Beetle larvae do not spin webs or cocoons in the bee hive but rather pupate in the soil outside the hive. Pupae are whitish brown. The small hive beetle is native to southern Africa where it requires 38-81 days to develop from egg to adult, and five generations per year are possible. The first record of this beetle in the western hemisphere was determined from a commercial apiary in Florida in May 1998. Beetle specimens were found from bee hives near Atlanta, Georgia in June 1998 and confirmed as *A. tumida* on July 13, 1998.

In Africa the small hive beetle behaves as a scavenger of weakened colonies much like the greater wax moth, and it is relegated to secondary pest status. But that has not been the experience of Florida beekeepers in whose apiaries the beetles have caused considerable damage and colony loss. Beetle larvae tunnel through combs, killing bee brood and ruining combs. Larvae can heavily damage delicate, newly drawn-out comb; however, old sturdy brood comb seems to withstand heavy larval infestation without disintegrating. Bees in Florida have been found to abandon combs and entire colonies once they are infested. Beetles defecate in honey and cause it to ferment, producing a frothy mess in supers and honey houses. Honey thus contaminated is no longer salable, and moreover it is unpalatable to bees and cannot even be used as bee feed. Florida observers report that the fermented honey smells like rotting oranges. In heavily-infested operations in Florida larvae by the thousands have been observed crawling out of colony entrances or across honey house floors in an effort to reach soil to dig in and complete their development.

It is cause for concern that the beetle's behavior in Florida has been much more virulent than that reported from Africa. Such is often the case with pest organisms when they are imported to new locations without their natural assembly of diseases, predators, and parasites that keep their populations in check.

If *A. tumida* is suspected or detected, the following precautions are suggested:

1. Be clean around the honey house. Do not leave filled supers standing long before extraction. Do not leave cappings exposed for long periods. Beetles can build up rapidly in stored honey, especially away from protective bees.
2. Do not stack or store infested supers onto strong colonies.
3. Be aware that supering colonies, making splits, exchanging combs, or use of Porter bee escapes can spread the beetles or provide room for beetles to become established away from the cluster of protective bees.
4. Monitor colonies for hygienic behavior; ie., the ability to actively rid themselves of both larval and adult *A. tumida*. Propagate those queen lines found to be beetle-resistant.
5. Experiment with trapping or cultural control measures. It may be possible to trap beetle larvae as they attempt to reach soil and pupate. Moving colonies may be advisable to keep a beetle population from building up in any particular apiary. The ability of beetles to complete development may vary according to different soil conditions and beekeepers may find some locations naturally less prone to beetle infestation. Fire ants may be a beneficial insect in this context if they are found to prey on pupating beetles.
6. Bees will normally not clean up equipment or supers full of beetle-fermented honey. However, bees may finish the job if the beekeeper first washes out as much honey as possible with a high-pressure water hose
7. Treat soil in front of affected hives with GardStar™ soil insecticide or similar approved product.
8. Treat colonies with CheckMite+ bee hive pest control strip according to label instructions.

American Foulbrood:

AFB is the most serious bacterial disease of honey bee brood and is caused by the bacterium *Paenibacillus larvae*. The disease is transferred and initiated only by the spore stage of the bacterium. The reason this disease is so serious is that the spores can remain viable and last indefinitely on beekeeping equipment. It is extremely contagious and spreads easily via contaminated equipment, hive tools, and beekeeper's hands. A beekeeper's best way to manage **AFB** is to avoid it.

Normal healthy larvae are glistening white, but AFB-infected brood turn chocolate-brown and melt into a gooey mass on the floor of the cell. They may exhibit a syndrome called 'pupal tongue' where the tongue protrudes to the top of the cell. As the disease progresses, colonies may also display a pepper box symptom where the cappings are perforated and sunken into the cell. When the larvae are brown and have not formed a hardened scale, the symptom of ropiness can be demonstrated. To do this, poke a stick into this mass, macerate it and withdraw it from the cell. If AFB is present the contents will rope out up to one inch. This is the most definitive field test for AFB. As the dead larva dries, it becomes a black scale that adheres tightly to the cell floor. These scales are difficult to remove and remain a site for constant re-infection. A single scale can contain one billion spores, and it takes as few as 35 spores to trigger the disease. These scales are difficult to see and can easily be missed when purchasing used equipment. Colonies with high levels of AFB will have a foul odor similar to a chicken house. As more and more brood becomes infected and dies, the colony dwindles and eventually collapses.

One has an advantage if the beekeeper can purchase brand new hive equipment, install package bees, and maintain them perpetually in isolation from other apiaries. This, however, is not always practical or realistic. It always makes good sense to practice sanitation practices such as washing hands and hive tools between apiaries, avoiding used hive equipment of unknown or suspicious history, and avoiding feeding bees honey from unknown sources.

It is possible to breed for bees that are genetically resistant to **AFB** and other diseases. One of the most important characteristics in bees is the so-called hygienic behavior, the ability to detect and remove from the colony abnormal cells of brood. Hygienic queens are available from nationally-advertised queen breeders. See advertisements listed in *American Bee Journal* [www.dadant.com], *Bee Culture* [www.airoot.com], and *Speedy Bee* [www.abfnet.org].

Another tactic for preventing **AFB** and a similar disease, European foulbrood, is biennial treatments of the veterinary antibiotic Terramycin. It is fed as a mixture in either powdered sugar, sugar syrup, or in vegetable oil extender patties. For Georgia, Terramycin treatments are recommended for September and again in February. It is important to never feed Terramycin within four weeks of a nectar flow to avoid contaminating honey for human consumption.

There has been recent evidence in this country for bacterial resistance to Terramycin. One of the suspected causes for this development is the sharp increase in use by beekeepers of the medicated vegetable oil extender patty. Bees do not always consume the patties rapidly which leads to a situation in which antibiotic lingers in the hive for weeks or even months. Resistance was not a problem in this country prior to the widespread use of extender patties in the 1990s. For these reasons it is recommended that Georgia beekeepers remove all uneaten portions of medicated extender patties after patties have been in the hive for one month. Another antibiotic, Tylosin (brand name Tylan), is also available for use but one must follow the directions and measurements closely when mixing and applying to colonies.

AFB is regulated by the Georgia Department of Agriculture, and infected colonies are normally burned by state inspectors [link: bsmith@agr.state.ga.us]. As state budgets allow, beekeepers may be indemnified for these losses. The spores of the **AFB** bacterium are extremely persistent in contaminated comb and hive parts. Although resistant bee colonies may clean up visible signs of infestation, it is more typical for **AFB** to be incurable and essentially doom the colony. Beekeepers should never maintain a hospital yard in which they group **AFB** colonies together in isolation. Such yards simply serve as reservoirs of disease that will serve to contaminate apiaries for miles around. It is equally inadvisable to treat infected colonies with Terramycin. The antibiotic will simply obscure visible signs of the disease, but the symptoms will rapidly recur once the antibiotic is removed.

European Foulbrood:

EFB is a bacterial disease of honey bee brood. It is generally considered less virulent than American foulbrood and colonies sometimes recover from infection. Its field symptoms are easily confused with those of **AFB**, but there are important differences. Instead of being a healthy pearly white, larvae with **EFB** appear off-white, progressing to brown, and are twisted in various positions in the cell. Larvae with **EFB** usually die before they are capped whereas larvae with **AFB** die after they are capped.

The sanitation precautions recommended in the section on **AFB** apply also to **EFB**. Likewise, bee stocks selected for hygienic behavior can be expected to minimize outbreaks of **EFB**. The disease sometimes goes away on its own at the onset of a strong nectar flow. The beekeeper may be able to control the disease by simulating a nectar flow (by feeding sugar syrup) and by requeening the colony.

Preventive biennial treatments with Terramycin (or Tylosin) antibiotic, as recommended in the section on **AFB**, will also prevent **EFB**. As with **AFB**, it is important to consider antibiotic treatments as a *preventive* measure, not a cure. Terramycin treatments in **EFB**-infected colonies may actually be counterproductive because the medication permits those infected larvae to survive which would otherwise perish. These survivors then persist in the colony as a source of contamination. If the infected larvae are instead permitted to die, the house bees eject them from the hive and with them goes the source of infection. The bacterium does not form long-lived spores that persist on hive surfaces.

Chalkbrood:

Chalkbrood is a disease of bee brood caused by a fungus, *Ascosphaera apis*, which was discovered in the United States in 1968. The larvae must ingest the spores of the fungus in order for the infection to occur. It only infects larvae that are three to four days old. There are no chemical treatments for this disease. Instead, it can be controlled by bee breeding and good management. The infected larvae are quickly covered by the white cotton-like mycelium of the fungus which eventually fills the entire cell. The white/grey mass soon hardens, forming a hard, shrunken mummy which is easily removed from the cell. The larva in the cell will resemble a chunk of chalk, hence, the name of the disease **chalkbrood**.

Bee stocks selected for hygienic behavior can be expected to minimize outbreaks of this disease. Hygienic queens are available from nationally-advertised queen breeders. See advertisements listed in *American Bee Journal* [www.dadant.com], *Bee Culture* [www.airoot.com], and *Speedy Bee* [www.abfnet.org]. Another way to minimize the disease is to maintain a warm, dry hive interior. Hives that are drafty, damp, lying in low spots, or heavily overgrown with vegetation are susceptible to **chalkbrood** disease. Hives should lean forward slightly so that rain water runs out the entrance instead of accumulating inside. If a hive is moist, prop the lid to air out the interior. Old equipment should be replaced or repaired if it has large gaping holes that permit entry of moisture and drafts.

Some operations have recurring problems with the disease that are not easily traced to season or management practices. This may suggest a genetic susceptibility in the bee stock. It also suggests that old combs may harbor spores of the disease that persist to trigger the disease season after season. Research suggests that old combs should be replaced periodically to improve brood production.

Nosema

Nosema is caused by the microsporidian *Nosema apis* (and the newly identified *Nosema cerana*), a small, unicellular organism that is unique to honey bees; it is the most widespread of the adult honey bee diseases. **Nosema** infects the epithelial cells of the honey bee ventriculus thereby causing dysentery. Queens, drones and workers are all susceptible to **Nosema**. The spore from the parasite must be ingested by the bee in order for infection to occur. The spore germinates in the midgut, penetrating the cell lining as it multiplies, reducing the life span of the honey bee. **Nosema** spores are spread to other colony members through fecal matter. Colonies in northern climates are more seriously affected than colonies in the south because of the increased amount of time bees are confined in the hive. **Nosema**, if left untreated, can cause queen supersedure, winter kills, reduced honey yields and dwindling populations. It is more common during times of confinement like winter and spring.

Symptoms of **Nosema** are vague and difficult to field diagnose. If you believe your colonies are infected with **Nosema**, send a sample of your bees in alcohol to your local county agent for verification.

The symptoms include: slow spring build-up (best indicator), disjointed wings, distended bloated abdomen, a lot of yellow streaks on the outside of colony and crawling bees outside of the hive. These symptoms may also be associated with tracheal mites.

Do not overlook this disease just because it is not common in the south. Prevention is the best way to keep your bees free of disease. Some good beekeeping practices are to avoid placing hives in low spots and to provide ample ventilation. Treat with antibiotic Fumidil-B® (fumagillin) according to the manufacturer's instructions.

Sacbrood

Viruses are pieces of genetic material that parasitize a host cell, making the cell produce more viruses. No vaccines or medications are available for any of the honey bee viruses. Therefore, good sanitation practices are the key to prevention. Comb replacement and requeening are the best practical responses to a virus infection.

Beekeepers rarely consider **sacbrood** a serious threat; however recent estimates suggest that one larva killed by the **sacbrood** virus contains enough virus to kill over one million larvae.

More research needs to be conducted on the **sacbrood** virus since it is unknown how the virus is actually transmitted to the larvae in nature, why severe outbreaks occur only during the build-up season, or how the virus persists from year to year.

Symptoms of **sacbrood** are partially uncapped cells scattered about the frame or capped cells that remain sealed after others have emerged. Diseased individuals inside cells will have characteristically darkened heads which curl upward. The dead prepupa resembles a slipper inside the cell. Diseased prepupae fail to pupate and turn from pearl white to pale yellow to light brown and finally, dark brown. The skin is flaccid and the body watery. The dark brown individual becomes a wrinkled, brittle scale that is easily removed from the cells (unlike **AFB**).

Hairless Black Bee Syndrome (or Chronic Bee Paralysis)

Chronic bee paralysis is the only viral disease of adult bees that has a clearly defined symptom: an abnormal trembling motion of the wings and body. Other symptoms are the bees' inability to fly which forces them to crawl on the ground and up the stems of grass in front of the hive. The abdomens will be bloated and the wings will be partially spread or dislocated. Bees afflicted with the virus will appear shiny and greasy because of the lack of hair which should not be confused with robbing bees. Also, adult bees are chewed by other bees and harassed by guard bees at the entrance to the hive (again may be confused with signs of robbing). Adult bees die within a few days of the onset of symptoms. The virus is spread from bee to bee by unusually prolonged bodily contact or rubbing which causes many hairs or bristles to break exposing live tissue. Bees do not transmit sufficient virus to cause paralysis by food exchange because many millions of virus particles are required to cause paralysis when given to a bee in food. Bees vary genetically in susceptibility; therefore requeening is a good practice if symptoms appear.

Other Problems:

Queenlessness can occur in many ways, but once a colony becomes queenless the reaction of the colony is predictable. The colony will become agitated and most of the activities of the hive are disrupted. When the beekeeper opens the hive, many bees will fan, much like when you see scenting bees (secretion of Nasonov pheromone and its dispersion by wing fanning). There may also be a loud roar from the bees. Usually within a few hours of being queenless, the bees will begin to construct emergency queen cells from existing cells containing worker larvae less than four days old. Nurse bees will supply the cell with large amounts of royal jelly to divert the development of the worker larva into a queen.

Usually the queen cell is constructed in time to permit requeening. If not, the colony becomes hopelessly queenless and will eventually die unless a new queen is added to rejuvenate the colony. During the time between queenlessness and complete colony collapse, workers will begin to lay eggs inside the cells. At first glance one would think there is a queen in the colony, but with a closer look, it is obviously laying workers. Workers have the ability to lay unfertilized eggs when their ovaries are stimulated.

Worker ovary development is normally suppressed by the queen's presence, but if the queen is killed or if she is old and not producing adequate amounts of pheromone then the workers begin to produce queen cells or lay eggs. Differences between worker and queen eggs are undetectable to the naked eye. Laying workers are usually revealed by the manner in which they deposit their eggs. A queen will lay a single egg cemented to the base of the cell in a cohesive pattern. A worker will lay numerous eggs in all areas of the cell and the pattern will be spotty. Occasionally worker bees will lay at least a few eggs in a queenright colony but this usually not a problem. Re-queening a laying worker colony can be difficult because laying workers rarely accept a new queen. Vigilance by the beekeeper and prompt queen replacement are the solutions to this problem.

Spotty brood can be a symptom of diseases like AFB or EFB or it can be a sign of a failing queen, queenlessness, varroa mites, or inbreeding. When examining a frame of brood, one should see cells with all stages of eggs and brood. There should be a continuous pattern of brood. Unacceptable patterns will have numerous cells unoccupied throughout the comb. The solution for spotty brood is to check for disease or other disorders and then re-queen.

Starvation is one of the leading causes of colony collapse over winter; however, starvation can occur at any time. Colonies can perish from starvation if they go into the winter period with inadequate honey supplies or if the cluster becomes separated from the honey. Symptoms of starvation are numerous dead bees between the combs and on the floor, many positioned head first in a cell.

It is important to periodically check your colonies to ensure they have proper supplies of honey. Lifting colonies from the rear is a quick method for determining quantities of honey stores. If the colony is light, mix a heavy 2:1 (sugar:water) syrup and feed them with internal division board feeders, inverted plastic pails on top of the cluster or hive-top feeders. Do not rely on Boardman entrance feeders in cold weather since the bees are unable to leave the cluster in order to feed. Recommendations for food needs will vary by region, but for southern regions, a single hive colony will need at least one medium super of honey. That will equal a minimum of 60 pounds of honey or syrup.

Colony survival over winter is more likely if proper fall management strategies are followed. These include a strong viable queen, adequate supply of honey and pollen, colonies maintained in a disease-free condition, and well-constructed hives protected from extreme climatic conditions.

13 Bee Pests and Diseases

Diseases of Adults

Nosema Disease

Nosema, the most common disease of adult bees, is caused by the microscopic protozoan *Nosema apis* Zander. This is a spore-forming organism that invades the digestive cell layer of the midgut. Up to 30 million spores can be found in a single bee one and a half weeks after initial infection. Now found worldwide, wherever bees have been introduced, it is a serious problem in temperate climates. The disease is most prevalent in the spring, especially after winter weather has confined bees to their hive. Nosema greatly reduces the life span of all castes of adult bees, reduces honey yields, and is a factor in the supersedure of package bee (and other purchased) queens, further delaying the growth of a colony.

The spores are viable for up to one year in the bee's fecal material and are found outside the colony environment, especially at drinking areas commonly used by bees. The disease is spread at these water holes, by drifting and robbing bees, and from feces on frames and combs. Package queens or caged queens may have nosema and should be treated when installed. Some effects of severe nosema are:

- Reduced longevity of workers (by 50 percent).
- Reduced honey yield (by 40 percent).
- Queen supersedure, as egg-laying ability in queen is adversely affected.
- Hypopharyngeal (food) glands of workers are affected, and poor brood-rearing ability will result because the nurse bees are unable to produce enough brood food.
- Hormonal development is disrupted, causing bees to age faster and forage earlier in life than normal.
- Secretion of digestive enzymes is disrupted, causing bees to starve to death.

Although bees with the disease display no specific symptoms, listed below are some signs that could *also* be associated with pesticide poisoning, mite infestation, or mite-associated pathogens. If most of these symptoms are observed in the spring of the year, after winter confinement, however, nosema should be suspected:

- Bees are unable to fly or can fly only short distances.
- Bees are seen trembling and quivering; colony is restless.
- Feces found on combs, top bars, bottom boards, and outside walls of hive; also correlated with dysentery or diarrhea (see "Dysentery," below).
- Bees are seen crawling aimlessly on the bottom board, near the entrance, or on the ground; some drag along as if their legs are paralyzed.
- Wings are positioned at various angles from body, or bee is said to be *K-winged*—that is, wings are not folded in the normal position over abdomen but with the hindwing held in front of the forewing.
- Abdomen distended (swollen).

The only way to diagnose nosema disease is to dissect the bee and look for spores. A field test, which is not very reliable but good in a pinch, is to pull apart a bee until the viscera are visible. If the midgut (ventriculus) is swollen and a dull grayish white, and the circular constrictions of the gut (similar to constrictions on an earthworm's body) are no longer evident (normal gut color is brownish red or yellowish, with many circular constrictions), then nosema is the culprit (see the illustration on nosema).

If you place the midgut on a microscope slide and crush it, nosema spores, if present, will be evident at about 40×. They are small, smooth, ovoid bodies, much smaller than pollen grains.

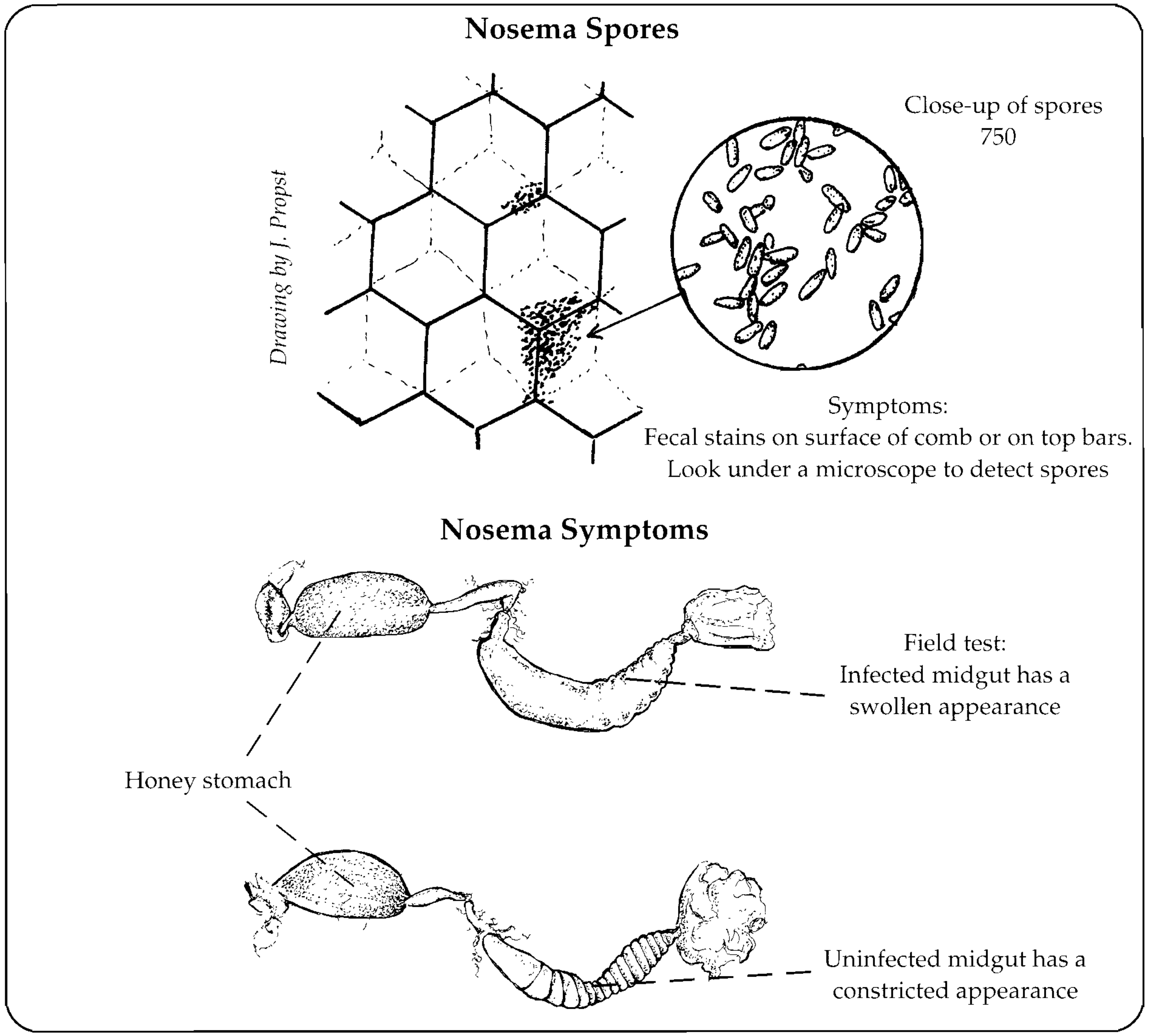
Nosema can be a serious disease if not checked. Because it is often confused with symptoms of other diseases, amoeba, or mite predation, diagnosis is important in order to treat for nosema properly (see "Diseases and Pests" in the References).

TREATMENT FOR NOSEMA

Good management practices and feeding the antibiotic *fumagillin* (isolated from the fungus *Apergillus fumigatus* and sold as Fumidil-B and under other brand names) as a preventive measure help control the disease and ensure healthy colonies. To control the disease and prevent it from spreading:

- Provide fresh, clean water; individually feed each colony water via Boardman feeders.
- Provide a young queen.
- Locate hives at sunny sites, sheltered from piercing winds but with good air drainage.
- Maintain adequate stores of pollen, honey, or cured sugar syrup; if stores are short, bees should be fed a heavy, medicated syrup in early fall and protein supplements.
- Keep only clean combs; sterilize or dispose of those that are soiled with fecal material.
- Provide upper hive entrance during winter to improve hive ventilation.

Combs with nosema spores should be sterilized, especially if you are going to reuse frames from dead colonies. If you do not disinfect the frames, you spread the disease. Heat equipment to 120°F (49°C) for 24 hours; combs should be free of honey and pollen and temperatures should not get above 120°F or the wax will melt. Or you can also fumigate supers.



To fumigate combs:

Step 1. Place a hive body on a board or upturned outer cover.

Step 2. Soak a pad of cotton or rags in ¼ pint (118 ml) 80 percent acetic acid (available from photographic supply houses as glacial acetic acid); place pad on top bars of combs.

Step 3. Add hive bodies above the first one, placing a soaked pad on the top bars of each super in the stack. Close off the entrance, or treat the bottom board separately.

Step 4. Make the stack airtight by sealing adjacent hive bodies with masking tape and place inner and outer covers on top with a pad of acid in between.

Step 5. One week later, disassemble the stack and air out combs for two days.

Another approach is to replace old, fecal-stained, and dark combs with new foundation. A good rule of thumb is to replace frames when you can no longer see through them when held up to the sun, on a rotation cycle of every four to five years. In other words, as you go through your hives in the spring, pull out the older combs and replace them with new foundation.

The drug used to control nosema disease is bicyclohexyl-ammonium fumagillin, sold as Nosem-X or Fumidil-B. It must be fed mixed in syrup (not in powdered or patty form); it is sold by suppliers of bee equipment. This material is viable for two years, which can be extended if unopened bottles are stored in the freezer. Research has shown that spring feeding of fumagillin to established colonies can increase honey production by about 58 percent.

To dissolve the powder thoroughly, first mix it with warm water in a small jar, let stand for 5 minutes, then shake until foamy. Alternatively, you can thoroughly mix the powder with some sugar, then add it into the warm water.

The medication is fed in the formulation of 75–100 mg fumagillin per gallon of sugar syrup:

- Add 2 teaspoons to 4 ounces (½ cup) of warm water 95°F (35°C) and mix this into 2 gallons of 2:1 (sugar : water) syrup. This feeds ONE COLONY, delivering the correct amount of the medication. Proper dosage, especially for bees confined for long periods of time, is 2 gallons medicated syrup per hive. In the spring, a 1-gallon feeding is enough; use 2 gallons in the fall.
- For six packages, use the 0.5-gram bottle of fumagillin per 6 gallons of 2:1 syrup; 44 pounds of sugar in 2¾ gallons of water makes 6 gallons of 2:1 sugar syrup.
- Use the 9.5-gram bottle of fumagillin to make up 100–120 gallons of medicated syrup for feeding 100–120 package colonies in the spring or 50–60

colonies in the fall; 371 pounds of sugar in 23 gallons of water yields 50 gallons of 2:1 syrup.

Note: Always follow label directions when medicating bees.

Amoeba

Amoebae are in the kingdom Protista, which includes mostly single-celled eukaryotes (such as the protozoa, slime molds, algae, and the Sarcodina, or amoebae). The amoeba that affects honey bees is called *Malpighamoeba mellificae* Prell, which forms resistant spores called *cysts*.

A single bee can have a half-million cysts within three weeks of initial infection. Cysts are ingested by bees from infected food or water or from other contaminated material. Once ingested, the cysts migrate to the Malpighian tubules (the kidneys of bees), where they germinate within 24 hours. Within two to four weeks, new cysts are formed, pass into the intestines, and are voided with the feces.

Once the infection is under way, the bee's abdomen becomes distended, and the tubules cease functioning. The tubules take on a glossy appearance when filled with the spherical cysts, which measure 5–8 micrometers (μm) across; nosema spores are oval, measure 4–6 μm long by 2–4 μm wide, and are not in the Malpighian tubules.

Amoeba are found mostly in bees infected with nosema disease, and the cysts are often seen under the microscope in fecal material along with nosema spores. Although mostly present in workers, queens can be affected as well.

There are no clear symptoms other than dwindling colony populations, as bees die away from the colony. The effect of heavy infestation results in reduced honey yield and the impaired functioning of the tubules. Development time of the cysts is slowed in temperatures of about 68°F (20°C) or lower but increases as the temperature in the broodnest increases to 86°F (30°C). Therefore, the spring is the time when amoebae infections are most severe, peaking in May in the Northern Hemisphere.

The only control is hygienic conditions in the apiary and at the water source, and decontamination of frames or replacement of equipment; fumagillin has no effect. Some reports indicate that requeening has been a successful strategy for saving an infested colony.

Dysentery

Dysentery is not caused by a microorganism and is not a disease at all but primarily the result of poor food and long periods of confinement. In general, dysentery is caused by:

- Fermented stores
- Diluted syrup fed in fall
- Syrup with impurities such as those found in raw or brown sugar
- Dampness
- Long periods of confinement
- Too much moisture in the hive
- Poor drainage
- Honeydew in stores

SYMPTOMS

The symptoms of dysentery are similar to those of other diseases of adult bees:

- Sluggish bees
- Swollen abdomens
- Hive stained with yellow to brownish fecal material

The only way to treat dysentery is to:

- Provide a winter exit, so bees can take cleansing flights on warm winter days instead of defecating inside the hive.
- Provide good winter stores, with low water content (properly cured honey and sugar syrup).
- Feed thick syrup (2:1) in the fall, if bees need more stores going into winter.
- Medicate (as for nosema) as a preventive measure to help control the diarrhea.

Septicemia

Septicemia is caused by several different bacteria found in the hemolymph (blood) of bees, the most common of which is *Pseudomonas aspiseptica*. Although septicemia rarely if ever debilitates bee colonies, it can be recognized by these symptoms:

- Dying bees are sluggish, and hemolymph turns white instead of clear.
- Dead bees decay rapidly.
- Dead bees become dismembered when touched, as the muscle tissue degenerates.
- Dead bees have putrid odor.

Bees come into contact with the bacteria in soil, water, and infected bees by way of their breathing tubes (tracheae). It is still not clearly understood how the disease is transmitted or how to treat it, but some success has been found by requeening colonies and placing hives in locations that are sunny and dry and have good air drainage.

Other minor diseases are not mentioned here; many beekeepers never see these in their bees. For a complete look at all the diseases of bees, see "Diseases and Pests" in the References.

The Pesticide Problem

Farmers apply chemicals to protect their crop investment; most of these—fungicides and herbicides—do NOT harm honey bees. Because bees are insects, they are, however, killed by *insecticides*. The term *pesticide* is used to include all types of chemicals put on plants to control any pest, fungus, weed, or insect.

Problems related to honey bees and pesticide usage arise when insect pests threaten the crops that bees are working and growers use insecticides to protect their crops from such pests.

Bees are exposed to insecticides in several ways:

- Inadvertent but direct application on flying bees—bees may die in the field or after they return to the hive.
- Contact with recently applied insecticides—depending on the formulation, bees may die in the field or return and die in the hive.
- Consumption of contaminated water, nectar, or pollen—field bees, hive bees, and larvae will die inside the hive.
- Misapplication of material, including direct application to nontarget plants, as well as drift from treated areas and the use of inappropriate chemicals or application methods will kill field bees, hive bees, and larvae.

It is important to know the characteristics of insecticide-treated bees, because they can be easily confused with other disease symptoms. In general, you will notice:

- A sudden reduction in the number (thousands of bees) in a previously strong colony in the middle of the summer season.
- Excessive numbers of dying and dead bees, within 24 hours, in front of the hive, on the bottom board, or on top bars.
- Dying larvae crawling out of cells.
- A break in the brood-rearing cycle; disorganization of colony routine.
- Inappropriate queen supersedure.
- Within four to eight weeks, brood will either become chilled because of the lack of workers or will die from diseases or poisoned pollen.

Several types of insecticides exist, each affecting bees in a different way. The kinds of insecticides in general use today include these groups:

- Organophosphates
- Chlorinated hydrocarbons
- Carbamates
- Dinitrophenyls
- Botanicals
- Pathogens
- Pyrethroids

The symptoms for bee poisoning by these chemicals are summarized in chapter 26 of E. L. Atkins, *The Hive and the Honey Bee* (Hamilton, Ill.: Dadant and Sons, 1992), to which you should refer for more complete information.

In general, the most deadly insecticides with which you will probably come in contact are microencapsulated methyl parathion, carbaryl (Sevin), and Furadan. These are very toxic to bees and should be avoided.

Pathogen insecticides (compounds that cause diseases), unless specific for hymenopterous insects, are *not* toxic to bees, but you will see their names in conjunction with controlling many lepidopteran insects (such as the wax moth or gypsy moth). The most common pathogens are:

- Bacteria: *Bacillus thuringiensis* (Dipel, Biotrol, Thuricide).
- Virus: *Trichoplusia polyhedrosis* (Polyhedrosis virus).

What You Can Do

To reduce the chances of colony exposure to insecticides, you can take the following steps:

1. Carefully select the location of your apiary.
   - Locate and meet farmers, landowners, or land renters within a three-mile radius of your apiary.
   - Contact beekeepers in the area to learn about past problems.
   - Check plat, county, or aerial photo maps to assess apiary location in relation to areas that may be sprayed (parks, orchards, residences).
   - Become familiar with the crops grown, production methods, rotation practices, and past insect problems in your area.
   - Be aware of planting, blooming, and harvest dates of target crops.
2. Assess your chosen apiary site; weigh the potential for these chemical dangers:
   - Spray drift from nearby treated areas.
   - Frequency of sprays during the season.
   - Cyclic or unexpected outbreaks of insect pests (such as gypsy moths or mosquitoes).
   - Need for sprays during blooming period of target crop.
   - Application methods used (air or ground, low-volume, ultra-low-volume, standard, or electrostatic equipment).
3. Become familiar with:
   - The identification of crop pests in your area.
   - Pest population levels that require spray treatments (economic threshold).
   - The types of insecticides used locally, as well as their common names and formulations.
   - Registration procedures for apiary sites, so applicators can locate hives.
4. Know formulations of insecticides: Formulations with the designations WP (wettable powder), EC (emulsifiable concentrate), MC (microencapsulated), and D (dust) will kill bees on contact and, when they dry on the plant, may be picked up by bee feet or body hairs. Insecticides in these forms may also be mixed with pollen or in water puddles near sprayed areas. Addition of stickers or spreaders may significantly reduce problems caused by these formulations, by making pesticides less accessible to bees (i.e., sticking to plants).
5. Determine:
   - Local weed and wildflower blooming periods; learn to identify local honey plants.
   - Where bees are foraging at any particular time (by marking bees).
   - Where bees will forage next (sequence of blooming plants).
   - What time of day bees are on particular target crops.

6. Anticipate:
   - Changes in cropping practices.
   - Scheduled and unscheduled sprays.
   - Crop blooming periods and sequences.

Finally, when it happens, know whom to contact and what to do if bee kills are evident. Have handy the phone number and address of the local apiary inspector. Find out what legal recourse you have and how and where to take samples for analysis. In most cases, if your bees are not registered, you will have no recourse. Remember, many times your problem may lie *not* with a farmer spraying but with a neighborhood homeowner killing those "pesky" insects on the backyard rose bush or dandelions in the lawn.

Protecting Bees from Pesticides

Here are some general protective measures you can take before spraying occurs; use one or a combination of several methods:

- Make sure the applicators (local or contracted) know you and your apiary locations (supply maps).
- Check your county extension office for information on protection programs in your area.
- Make routine contacts with landowners, renters, applicators, and county agents for updates on pest problems.
- Post your name, address, and home and work phone numbers (or a neighbor's number so you can be contacted immediately) conspicuously near apiaries.
- Paint hive tops with a light color for easy aerial identification.

When spraying is imminent, here are some quick methods to use to protect your bees:

- Reduce hive entrance.
- Gorge hive with sugar syrup by pouring it directly on top of the frames (bees will stop foraging to help clean it up); pour in about one quart twice a day for one day before a spray and once a day for two or three days following a spray.
- If practical (you have only a few colonies), close the entrances with a screen to confine bees and place a screened cover on top, covered with a wet cloth or burlap. Keep this wet, especially if the weather is hot, with a sprinkler or watering can, for *at least* 24 hours. This is a dangerous step to take, because even with wet burlap, hives could overheat and the bees could die very quickly.
- Screen entrances with 8-mesh hardware cloth, and screen the top (cover top with a wet cloth).
- Activate pollen traps to collect contaminated pollen (destroy this pollen).
- Supplement feed colonies with syrup, water, and clean pollen patties during *and* after spray period.

If you have time and it is practical, the best protection method of all is to move your hives at least two miles from their previous location and target area. This method is the most expensive but also the most successful.

Once a kill has been experienced, you must immediately help those colonies that have been affected. After all, if it is early enough, they may still yield a surplus of honey or at least store enough for winter. Here are some things to do:

- Combine weakened colonies to increase populations.
- Requeen when necessary rather than waste time by letting bees rear new queens.
- Destroy contaminated stores, combs, or equipment; supply new equipment and clean combs or foundation.
- Feed syrup, pollen, or pollen substitutes to maintain the colony and stimulate brood rearing.

All beekeepers should strive to cooperate with neighboring growers for their mutual benefit. But the ultimate responsibility for a colony's protection rests with you the beekeeper, not the farmer, landowner, or applicator. You need to make the site selections as safe as possible and be alert to the expected problems while anticipating the unexpected. Utilize the numerous resources available to help you and your bees.

Such sources of information are:

- State and county extension offices (extension entomologists, agronomists, and horticulturists, as well as publications on crops, insect identification, insecticide lists, and formulations).
- State apiary inspector (for registering your apiary sites).
- Regional, state, and local beekeeping organizations.
- Libraries or city and state agencies, for maps and other references.

Brood Diseases

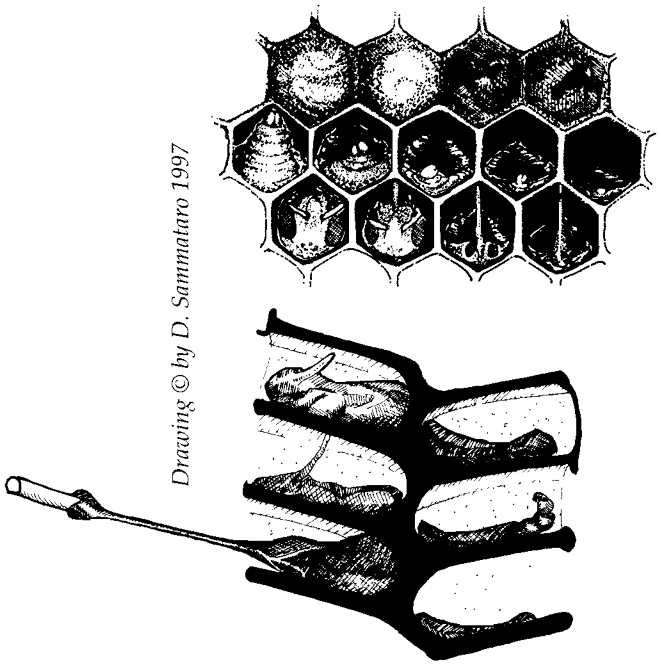
Brood diseases can be devastating to both novice and commercial beekeepers. Recognition of healthy and diseased brood is an important part of colony management, and awareness of how these diseases are carried may prevent a serious outbreak.

Disease carriers include:

- Beekeepers, by moving between diseased and clean colonies and not cleaning hive tools, gloves, or other beewear and equipment.
- Brood frames that are interchanged within or between apiaries.
- Old, diseased equipment or frames that are bought and interchanged or mixed with clean colonies.
- Honey, either fed directly or robbed by bees.
- Pollen sold commercially.
- Package bees or queens.
- Swarms.

Bee diseases are not mutually exclusive. A colony could have nosema and both foulbrood diseases at the same time (as well as mites)! Some conditions,

American Foulbrood Disease



Symptoms:
Cappings are sunken, brood appears dark brown and "melted" down, and pupal tongue sticks up

Test:
See if the contents of the cells are sticky and will extend at least an inch when drawn out

such as chilled brood, could look like diseased comb. Careful attention to the symptoms and the condition, history, and mite levels of the colony is necessary to differentiate the two.

American Foulbrood Disease

American foulbrood disease (AFB) is caused by the bacterium *Bacillus larvae,* which exists in both a spore and a vegetative stage. The disease is transmitted by the spore, and the infected brood is killed by the vegetative stage, when the spore germinates in larval guts. This is the most destructive of the brood diseases and is the reason that apiary inspection laws were first passed.

Once the vegetative stages appear in a colony, the disease is spread rapidly, and the colony weakens; in most cases, the colony will eventually die unless it is resistant to AFB. Spores can live in hive products (such as honey, wax, and propolis) for up to 69 YEARS. The LD_{50} of AFB (i.e., the amount of AFB needed to kill 50 percent of the bees) is just 35 spores fed to each one-day-old larva. Larvae affected are often older and therefore capped over and not immediately visible. Once AFB has progressed, old, diseased larvae, uncapped by the bees, are seen as black scales with their tongues stuck out.

SYMPTOMS

The symptoms of AFB are varied and could be confused with other disease or mite symptoms: make sure you learn to recognize this disease. Look for the following:

- Brood pattern is irregular rather than compact.
- Healthy larvae are glistening, white color; diseased ones lose this appearance and turn from light brown to dark brown. Larvae die upright, not twisted, in cells.
- Since the death of larvae and pupae often occurs after their cells are capped, the cappings become concave and some will be punctured by bees attempting to remove the dead brood (see the illustration on AFB).
- Surface of cappings will be moist or wet rather than dry.
- Larvae long dead develop the consistency of glue and are difficult for bees to remove.
- Eventually dead larvae dry out; the dried remains, or *scales,* adhere tightly to the bottom, back, and side walls of the cell.
- Some dead pupae, shrunken into scales, may have tongues that protrude at a right angle to the cell wall or are straight up. This may be the only recognizable characteristic.
- Unpleasant odor can permeate apiary if many colonies died over winter.

Any smelly hive, especially if winter-killed, should be suspect. If you look at the brood frames in good light, you should be able to see the protruding tongues.

AFB is transmitted from hive to hive in these ways:

- Beekeepers use disease-infested equipment, tools, or bee suits.
- Frames that contain diseased larvae and spores are moved to clean colonies.
- Bacteria are present in honey or pollen cells that were not cleared of scale. These spores are passed on to larvae by nurse bees feeding them.
- Cleaning bees spread bacteria throughout hive when attempting to remove dead brood or scales.

- Diseased robber bees enter an uninfected colony, or bees rob a diseased colony.
- Bees drift from diseased to clean colonies.
- Swarms have AFB.

If a colony is suspected of being infected with AFB, follow these steps as soon as possible:

Step 1. Reduce entrance to minimize robbing.

Step 2. Distinguish it from the rest by color or symbol, to reduce drifting.

Step 3. Begin medication (chemotherapeutic) program immediately, treating all the colonies in the apiary (see "Foulbrood Disease Chemotherapy," below).

Call your state bee inspector for advice and to confirm diagnosis. If unavailable, send a sample of the diseased brood and comb, one free of honey and about 4 or 5 square inches in area. Cut the sample out of the frame and wrap it in NEWSPAPER so it will not get moldy; do not use any other kind of wrapping. On a separate piece of paper, write your name and address and place this paper and the sample(s) in a sturdy wooden or cardboard box and mail to your state bee lab or to one of the national bee labs operated by the USDA (see "Bee Laboratories" in the References). Under separate cover, send a letter stating that you are sending samples, the problem you are having with the colony, and the following information:

- Name and address of beekeeper.
- Name and address of sender (if different from beekeeper).
- Location of samples and source.
- Number of samples sent (each labeled, numbered, and placed in a package); indicate if the samples are from the same or different apiaries.

TESTING FOR AFB

Use the "ropiness test," described in the next paragraph, on larvae that have been dead for about three weeks. Because it is difficult to determine how long a larva has been dead, randomly test between 5 and 10 cells from several frames. An accurate way of determining how long a larva has been dead is by checking for the presence or absence of its body segments or constrictions (similar to the constrictions on an earthworm). If they are absent, the larva has been dead for at least three weeks.

Insert a match, grass stem, or twig into suspect cells, stir the dead larval material, then slowly withdraw the testing stick. If a portion of the decaying larva clings to the twig and can be drawn out about 1 inch (2.5 cm) or more while adhering to the other end of the cell, its death was probably due to AFB. Be sure to burn the test stick. Scrub your smoker and hive tools with a soapy steel wool pad, and wash your hands, gloves, and bee suit thoroughly in soapy water with bleach.

TREATMENT BY BURNING HIVES

Before the availability of chemotherapy and ethylene oxide gas or gamma chambers, the only acceptable method of dealing with colonies infected with AFB was to destroy them by burning. Two methods of treating diseased hives, burning and fumigation, are discussed here.

In the first method, you burn all wooden parts, wax, bees, and honey:

Step 1. Kill all adult bees by spraying all frames at night with an insecticide (such as Resmethrin or Sevin) or with a 3–4 percent solution of soapy water (1 cup of liquid detergent per gallon of water is enough).

Step 2. To save the bees, you can shake them out of the hive into a super filled with foundation frames; feed bees on medicated syrup. This method is not advisable, because many bees will drift to other colonies, spreading the disease.

Step 3. Remove the entire hive *intact* to a field in which a pit has been dug that is at least 18 inches (45 cm) deep and contains a hot-burning fire. If you must carry the hive furniture separately, place each super on burlap or cardboard to keep dead bees and diseased honey from spreading the spores in the existing apiary.

Step 4. Burn all brood, honey, bees, and wax in the pit. You can support the hive bodies with large tree limbs placed across the pit. Make sure all is consumed and turns to ash. You can save dry wax (to be sent to a rendering plant), as long as it is securely closed against robbing bees.

Step 5. Cover ashes and pit with fresh dirt.

You can save newer hive bodies, if they are not too coated with wax and propolis (which are loaded with AFB spores). Invert, so rim edges are down, and stack hive bodies from three to four high. Then, to sterilize supers:

- Fill the inside of the stack of supers with newspaper and ignite it; when the insides of the hive bodies are scorched, extinguish the fire.
- You can also paint the insides with kerosene and light it by igniting the newspapers; this is a more thorough way to sterilize hive equipment.
- A propane torch may be used for the tops and bottom boards as well as for hive bodies. Wood should be lightly browned and all edges, corners, and seams given special attention. Scrape edges and inside thoroughly.

Before burning or using chemotherapy on bees with AFB, check with your state's bee inspector to be sure the procedure is legal and to determine the amount and kind of medication that is required.

TREATMENT BY FUMIGATION CHAMBERS

After killing the bees, place hive bodies, covers, and bottom boards in a fumigation chamber, such as an ethylene oxide gas chamber. You can use heat sterilization as well, such as a boiling paraffin bath (see Appendix D). Radiation with gamma rays will also decontaminate empty combs and equipment, but gamma radiation chambers are not commonly available. These special chambers can decontaminate empty combs and equipment by killing the disease spores and allowing you to reuse the equipment.

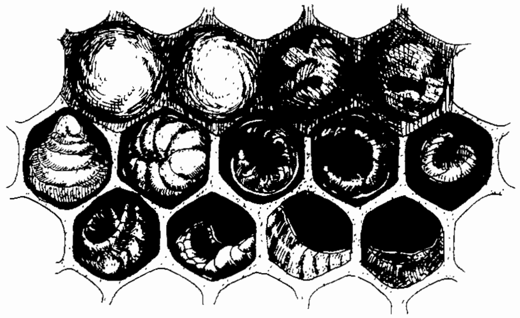
Many states no longer have ethylene chambers (at this writing), because the chemical is no longer available. Check with your local bee inspectors or state agriculture extension offices for licensed operators or for more information on radiation chambers in your area.

European Foulbrood

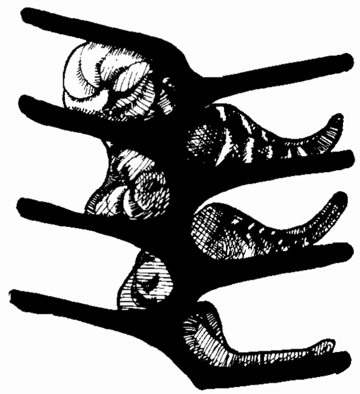
European foulbrood (EFB) is caused by the spore-forming bacterium now called *Melissococcus pluton* (formerly known as *Streptococcus pluton* and *Bacillus pluton*), although other bacteria may also infect larvae at the same time, producing similar symptoms. EFB is commonly found in weak colonies, such as those used for pollination.

The disease is usually prevalent in the spring, slowing the growth of the colony. Larvae more than 48 hours old are at greatest risk, and thus those that die are usually *not* capped but are visible in the bottom of the cells. The bacterium is found in feces, in wax debris, and on the sides of cells of infected larvae. Not as serious as American foulbrood, EFB should be treated with drugs, and the colony should be requeened or strengthened with additional bees or both.

European Foulbrood Disease



Symptoms:
Bacteria infects younger, uncapped larvae, turning them brown



Drawing © by D. Sammataro 1997

Test:
Larvae are twisted in the cells, no pupal tongue is evident, no "foul" smell is present, and the ropiness test does not apply

SYMPTOMS

The symptoms of a colony infected with EFB are different from those for AFB. Learn to recognize these:

- Larvae die in coiled, twisted, or irregular positions in their cells (see the illustration on EFB).
- Since most larvae die young, their cells are uncapped, and you can see the discolored larvae clearly.
- Larvae color may change from pearly white to light cream, then from brown to grayish brown, darkening as the dead larvae dry up. Normal, healthy larvae stay a pearly white color.
- Dry scales—the remainder of the larvae—are easily removed from their cells, unlike AFB scales, which are difficult to remove, so ropiness test will not work.
- Some larvae die in capped cells, scattered over the brood comb; cappings may be discolored, concave, and punctured.
- A sour odor may be present.
- Drone and queen larvae are also affected.

European foulbrood is transmitted from colony to colony in these ways:

- Cells in which larvae hatch may contain bacteria.
- Bacteria are present in honey or pollen or both and are passed on to larvae by nurse bees feeding them.
- As scales are removed by cleaning bees, bacteria are spread throughout the colony.
- Diseased robber bees enter a clean hive.
- Contaminated equipment is used.
- Bees from diseased hives drift to clean hives.

Bees seriously infested with varroa mites may have EFB-like symptoms; if there is any question, send a sample to the Beltsville Bee Lab via the method previously described in the section on AFB testing. Read about varroa mites and bee parasitic mite syndrome below, this chapter.

To control EFB:

- Requeen the colony, to break the brood cycle; this allows the bees to clean out dead and infected larvae.
- Use chemotherapeutic agents to treat the disease (see "Foulbrood Disease Chemotherapy," below).
- Feed with clean syrup and pollen supplement or substitute, not with pollen you purchased, as it could contain EFB spores or other disease organisms.
- Restrict drifting between colonies by relocating or redistributing hives (see the illustration on p. 38).
- Carefully inspect brood in frames before exchanging equipment.

Foulbrood Disease Chemotherapy

Drugs can be given to bees for both AFB and EFB once the disease has been diagnosed or as a preventive measure. The antibiotic drugs will not cure the disease; they prevent the spores from germinating, allowing the bees to clear out diseased brood. The antibiotic must be present while the larvae are being fed to prevent the spores from germinating inside healthy larvae. Use antibiotics only in connection with good management practices of normal colony hygiene and in maintaining healthy bees.

The antibiotic Terramycin (TM) is the only one registered in the United States (with the Environmental Protection Agency (EPA) by Pfizer) for treating AFB and EFB. If stored in a dry, dark refrigerator or in a freezer, an unopened TM packet can last several years past its expiration date. Drugs used as a preventive measure should be applied in the spring and fall, not during a honeyflow. If drugs are used during a honeyflow, the honey must not be used for human consumption. There are three methods approved for feeding medication to bees: in syrup, dry, or in an oil extender patty.

Terramycin soluble powder (or TSP), whose generic name is oxytetracycline hydrochloride (TM-HCl), is sold as an animal formula soluble powder at farm and bee supply stores. It comes in 6.4-ounce packets (2½ packets is equivalent to 1 pound), which contain 10 grams of active ingredient (or 25 grams per pound of product and therefore known as TM-25). This material is very fragile and can absorb water from the air, breaking down the components.

Terramycin is also sold bulk as TM-50D and TM-100D (in 50-pound bags). How much to feed is related to how much active ingredient is present per pound of material. To give each colony the proper dosage, follow label directions carefully, or you may not be giving enough medication to treat the disease.

However the medication is fed, you must stop feeding TM **45 days** (not 30 days, as the old label says) before you put on your honey supers.

Here are the new (revised in 1997) label directions for feeding Terramycin:

Dust or Powder. Use powdered instead of granulated sugar to make it easier to mix the antibiotic in with the sugar. The basic mixture is 1 teaspoon TM-25 in 2 tablespoons of powdered sugar; feed this

Guide for Treating Many Colonies with Terramycin-25

Number of packets (6.4 oz.) TM-25 soluble powder	Amount of sugar needed	Number of colonies fed (1 oz. per colony)
Dusting		
1 teaspoon	2 tablespoons powdered	1 (equals 200 mg)
1 packet	2 lbs. 12 oz.	50
2 packets	5 lbs. 7 oz.	100
4 packets	10 lbs. 14 oz.	200
Feed 200 mg or 2 tablespoons per colony three times at three- to five-day intervals		
Syrup (2:1 ratio of granulated sugar to water)		
1 teaspoon	1 quart syrup	1 (equals 200 mg)
1 packet	50 quarts (12.5 gallons) syrup	50
2 packets	100 quarts (25 gallons) syrup	100
Feed 1 quart three times at three- to five-day intervals; must drink all the syrup		

Extender Patty	**Shortening**	**Granulated sugar**	
4 teaspoons	1/4 cup	1/4 cup rounded	1 complete dosage
1 packet	1 lb.	3 lbs.	14 (1/3 pound patty each)
3 packets	3 lbs.	9 lbs.	40

mixture of 1 ounce (2 tablespoons) to each colony three times at three- to five-day intervals. See the table on treating many colonies with TM-25. The total dosage per treated colony must equal 600 mg of oxytetracycline HCl (Terramycin).

When dusting, make sure to sprinkle the sugar mixture onto the *end* of the top bars of each colony; do not dust directly on top of brood frames containing uncapped larvae, because Terramycin is toxic to them. Repeat two more times at three- to five-day intervals to give the bees the required amount of medication. The medication is bitter and some bees will not take it; they will even propolize around it. If this is the case, try another method of feeding the antibiotic.

Stop all treatment SIX weeks before a main honeyflow. Because this form of TM (soluble powder) will absorb water from the air, make a new batch each year from an unopened or new packet. Store your mixture in an airtight container in a dark, cool place when not in use.

Syrup or Bulk Feeding. This method of feeding TM is not recommended because the drug loses viability in syrup after one week. Feed freshly made TM syrup if treating a swarm by spraying bees directly. You can feed a diseased colony with the syrup as long as the bees are VERY hungry and will take the syrup quickly. You can also spray diseased bees repeatedly, until they eat the required amount. DO NOT FEED DURING A HONEYFLOW.

Mix 1 teaspoon TM-25 for each quart (0.95 liter) of a syrup made in a 1:1 ratio of white granulated sugar to water. To dissolve the sugar, use very hot water and stir vigorously; once cooled, add the TM. Feed 1 quart three different times (three- to five-day intervals between feedings), making it fresh each time.

Extender Patty. The patty is the most stable form of TM and can last six to eight weeks. It is usually fed to bees over the winter months, and its oil base can help keep tracheal mite levels from increasing. For mixing, use 4 teaspoons of TM-25 in a patty made of ¼ cup vegetable shortening and ¼ cup, rounded, of white granulated sugar. This is the proper dosage for one colony, as it contains the needed amount of TM. Refer to the table for treating many colonies with TM-25.

Fungal Diseases

Chalkbrood

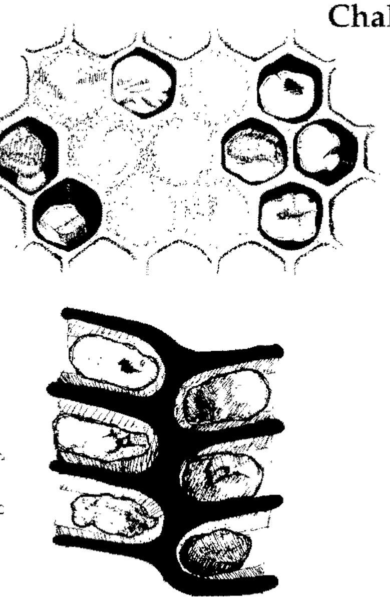
Although common in Europe for decades, chalkbrood was first reported in the United States in 1968 and has since spread throughout the country. It is caused by the fungus *Ascosphaera apis* (Maassen ex Claussen) and, although it may reduce honey production, usually will not destroy a colony. Some genetic lines, especially inbred bees, are more susceptible than others, so one control may be to requeen a diseased colony with a new strain of bees.

As a symptom, look for chalky white, mummified larvae in the cells or on the bottom board. The infected larvae are usually removed from their cells by nurse bees. Dried mummies will eventually turn dark gray to black. All these colors of mummies can be found in brood frames and on the bottom board (see the illustration on chalkbrood).

The most susceptible larvae are four days old and those larvae that are chilled, especially drone larvae. The spores of the fungus are resistant to degradation and can be viable for 15 years; spores are transmitted from bee to bee during food exchange, to or from queen bees, and by drifting bees. Contaminated combs and tools will also carry the disease. This fungus is transmitted throughout an apiary by:

- Wind
- Soil
- Nectar, pollen, and water

Chalkbrood Disease



Symptoms:
Fungus infects young larvae, which appear chalky white in the cells, but turn gray and eventually black

Mummified larvae may resemble pollen packed in cells, but bees pull out these mummies, which will be clearly visible on the bottom board

Drawing © by D. Sammataro 1997

- Drifting bees or diseased robber bees
- An infected queen
- Equipment

While chalkbrood is not normally a serious disease, in severe cases bee numbers can be reduced and honey crops lost. There is no chemical registered for use against this disease, but you can try the following:

- Move hives to sunny location.
- Remove infected combs and burn them.
- Add bees to strengthen the weakened, diseased colony.
- Requeen with hygienic stock.
- Feed syrup and protein supplements to keep the colony strong and healthy (see "Diseases and Pests" in the References).

Stonebrood

Another fungal disease, stonebrood, is caused by several species of *Aspergillus*, a common soil inhabitant. It is a rare disease not often seen by beekeepers and is frequently confused with chalkbrood. The only reliable way to differentiate the two is by laboratory cultivation of the fungal spores.

Viral Diseases of Bees

There are 18 known viruses that cause disease in bees. Different from bacteria, viruses are fragments of DNA or RNA (nucleic acids in a protein coat) that have become detached from the genomes (chromosomes) of bacteria. They are considered nonliving organisms because they lack all the necessary features that would allow them to reproduce on their own. They can reproduce only by altering the DNA of living host cells to manufacture more virus. Therefore, antibiotics, which kill bacterial organisms, do NOT work on viral diseases. Many virus-prone bees may have genetic predisposition to viral infection. Thus the only reliable way to control such diseases is to requeen the colony with nonsusceptible stock.

All bee viruses are probably in or on bees or in the hive in some latent form. Many of them can be activated once they find an entry into the bee's body, via the tracheae or by injury, breaking off hairs or feeding wounds caused by mites. One of the effects of mite predation is the appearance of otherwise benign viruses. As of 1997, six different viruses have been linked with mite infestation.

Sacbrood Virus

Sacbrood is a disease caused by a filterable virus and may be present in conjunction with other brood diseases. This disease is NOT one associated with bee mites but may be carried genetically by inbred bee lines.

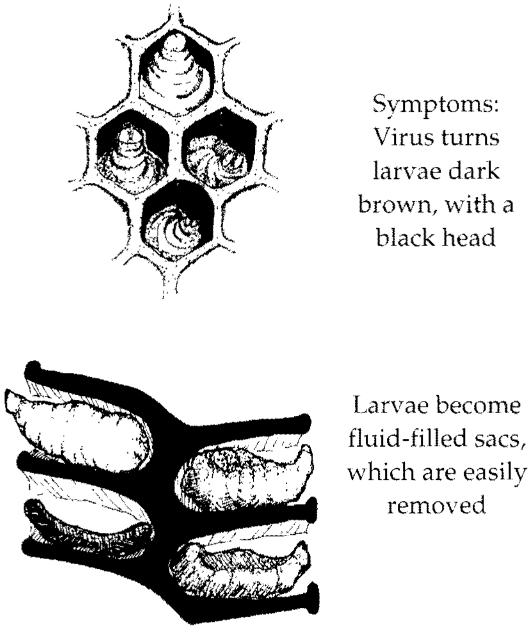
SYMPTOMS

The symptoms for sacbrood are as follows (see also the illustration on sacbrood):

- Larvae are darkened from white to yellow; eventually they turn dark brown.
- Larvae have dark head regions.
- Black-headed larvae are bent toward cell center.
- Larvae fail to pupate and die with heads stretched out.
- Diseased larvae are easily removed in liquid-filled sacs.
- Scales (when sacs are old and dried down) are dry, brittle, and easily removed.

Sometimes bees remove these diseased larvae quickly, but if any question exists as to the identification of diseased brood, call your state bee inspector or send a sample to the state or federal bee labs (see "American Foulbrood Disease," above). Because sacbrood is a viral disease, medication is ineffective; requeening the colony may remedy the situation.

Sacbrood Disease



Drawing © by D. Sammataro 1997

The recently identified black queen cell virus may be associated with nosema disease and is found in commercial queen-rearing operations. The dead queen larvae or prepupae sealed in the queen cells turn the wax walls brown black. The larvae inside the cells are yellow, with a sacbroodlike covering. This virus may be controlled with fumagillin.

Viral Diseases Associated with Bee Mites

Acute bee paralysis (ABP) is common in a noninfective form in seemingly healthy bees, but when present in varroa-infested colonies, this virus kills both adult bees and brood. The presence of the mite intensifies this disease because feeding wounds made by the mites on the bees allow the virus access to otherwise healthy bees, enabling the virus to multiply to lethal levels. When activated in adult bees, it is transmitted to the larvae via the food from nurse bees. It is thought to be the major cause of midsummer bee mortality when varroa populations are high. Originally from the Asian honey bee (*Apis cerana*), ABP is also found in bees without varroa mites. Several strains of the virus exist.

Closely related to ABP, the Kashmir bee virus (KBV) is found in a latent form in bees and pupae. It appears to be activated from a benign to a lethal state when varroa mites feed on bees. Once introduced into bee hemolymph, it can cause mortality within three days. KBV may be associated with other bee pathogens, such as nosema, but this link is still uncertain.

Chronic paralysis virus (CPV) was one of the first viruses to be isolated. Symptoms are very similar to those of colonies suffering from tracheal mites (see below), and this virus may have been the cause of the Isle of Wight disease outbreak in the 1920s. Many of the symptoms are similar to those used to diagnose nosema, amoeba, or the presence of tracheal mites. CPV has two forms, or syndromes: Type I syndrome is recognized by trembling bees that crawl on the ground with dislocated wings (K-wing) and swollen abdomens; it can be associated with dysentery, mite infestation, and other diseases. Type II is also called hairless black syndrome because the bees lose their hair, appear shiny black or greasy, and can't fly but tremble and crawl about. The virus can enter a wound as small as a broken hair, and if bee food (syrup or pollen patties) contains contaminated hairs, the bees will get the virus. Inbred bee races that are susceptible to CPV have also been identified. If your bees come down with viral diseases, switch queen breeders and rear your own queens from different lines.

Other mite-associated viruses are cloudy wing virus, slow paralysis virus, and deformed wing virus. This last virus, usually found in varroa-infested colonies, causes the wings of young bees and pupae to become deformed, an effect often thought to be caused by mite feeding. Mite feeding does cause other bee deformities, however. Many of these viruses went undetected before the introduction of parasitic mites, especially varroa. The best way to control mite-induced diseases is to control the mites.

Mites

Two parasitic mites introduced into the United States in the late 1980s have changed beekeeping practices forever. The result has been the loss of bees (between 25 and 80 percent of bee colonies) and the decline in the number of beekeepers (up to 25 percent) nationwide, as well as the increase in costs to rear healthy bees and to lease colonies for pollination, with an accompanying rise in the price of honey. Parasitic mites currently found only in Asia and other countries have equally devastating potential. We must be careful not to introduce them elsewhere (see the information on other parasitic mites).

Tracheal Mites (Acarine Disease)

Tracheal mites, the causative agent for acarine disease, came into the United States via Mexico in 1984. From its first report, the mite has now been spread by migratory beekeepers and packages into northern states and Canada. Many colonies have died since this mite was introduced, causing losses in the hundreds of millions of dollars as a result of dead bees, honey not produced, and loss of pollination services (see "Mites" in the References). Distribution of the tracheal mite is now worldwide, except in Australia, New Zealand, and Hawaii. Originally found in Europe, its true origin is not known.

The small mite (*Acarapis woodi* [Rennie]) lives inside the thoracic tracheae (breathing organs) of adult bees. A mated female emerges from an old host bee and, by crawling up on the bee's hair, quests to find a newly emerged (callow) bee (see the illustration of the questing mite). Once the mite finds a suitable host, she enters the trachea by means of the spiracle opening and can lay about one egg per day for 8 to 12 days. After the eggs hatch, the immature mites, or larvae, live as parasites inside all castes of adult bees, feeding on bee hemolymph by piercing the walls of the tracheal tubes (see the illustration of stages of tracheal mites). New mites emerge in 11–12 days, if males, or 14–15 days, if females (see the figure on the life cycle). Mites can cause severe bee losses, some-

Other Parasitic Bee Mites (not yet in the Americas)

Euvarroa sp.

- Natural host is *Apis florea.*
- Range is Southeast Asia, Thailand, India, and Sri Lanka.
- Life cycle is similar to varroa, but they live only in drone brood.
- Smaller in size than varroa.

Tropilaelaps clareae

- Natural host is *Apis dorsata.*
- Range is Southeast Asia, Philippines, India, China, and Afghanistan.
- Appearance is elongate and large; color is reddish-brown.
- Males and females are equally large.
- Life cycle is similar to varroa, but brood is essential for survival.
- Larva is mobile and feeds actively.
- These mites do not feed on adults.
- These are a very serious pest in the tropics, but not so much of one in temperate climates.

Questing Female Tracheal Mite

Drawing © by D. Sammataro 1997

times weakening or destroying entire colonies, usually in regions where cold climates confine bees for several months. Tracheal mites cause fewer problems to colonies in warmer regions.

COLLECTING BEES TO TEST FOR TRACHEAL MITES

External signs of tracheal mites are unreliable but include dwindling populations of bees, weak bees crawling on the ground with K-wings, and abandoned hives in the spring with plenty of honey stores. To determine if you have mites, you MUST dissect bees or have them dissected by someone else. If you suspect that your apiary is infested with this mite and an inspector is unable to visit your yard, collect bees to check for mites, using this procedure:

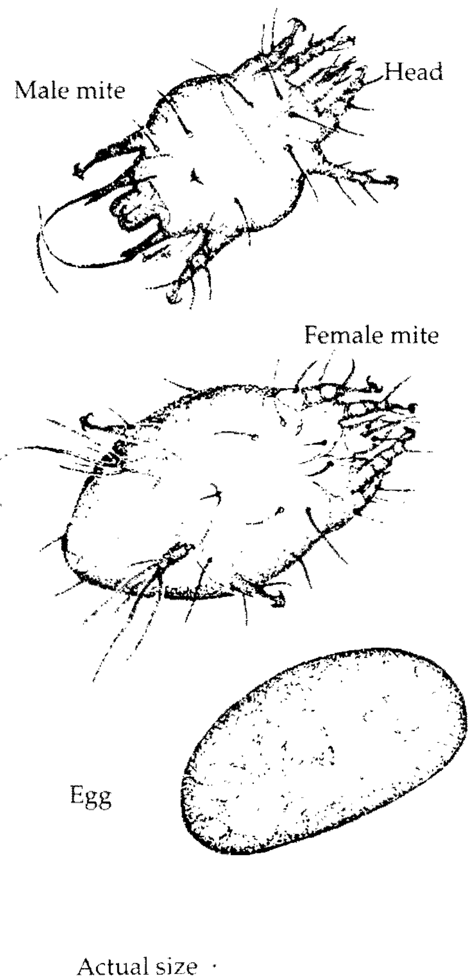
Step 1. Sample at least 50 percent of the colonies in the apiary.

Step 2. Collect only "old" bees; they are most likely to have an infestation and are the easiest to diagnose. Old bees can usually be found on the inner cover, at the entrance, or out foraging, not near the broodnest.

Step 3. Place the collected bees in a 70 percent ethyl alcohol or isopropyl (rubbing) alcohol solution, or freeze them in a glass vial, or plastic jar or bag.

Step 4. Send or deliver these specimens to the state bee inspector, the state entomologist, the Beltsville Bee lab, or a private lab, with the following information: your name, address; location of apiary tested (state, county, township); number of colonies in the apiary; and source of bees (e.g., packages from dealer X).

Stages of Tracheal Mites



Drawing © by D. Sammataro 1997

If sending them through the mail, use bees stored in alcohol. A positive diagnosis of the tracheal mite by gross examination of the colony or as a result of seeing bees walking around on the ground is not reliable. Some of the visible symptoms are the same as those of viral or other diseases and may not necessarily be due to the mite.

DISSECTING BEES

Patience and practice are the most important requirements for a successful dissection. A dissecting microscope (at least 40 to 60×) and a pair of fine jeweler's forceps are also needed. Practice on old summer drones first; they are easy to hold, and their tracheal tubes are larger. If requeening a colony, check your old queen, for she can infest a colony too. Finally, collect some old summer or early spring bees and dissect them. Here's how:

Step 1. Soften a frozen bee by holding it in your hand for a few minutes. If the bee was stored in ethanol, it is already soft enough, but the tissues will be darkened.

Step 2. Place the bee on its back, and pin it through the thorax, between the second and third pairs of legs, onto a piece of corkboard or a beeswax-filled jar lid, or petri dish. You may also hold the bee in your fingers, once you have become accomplished at this procedure.

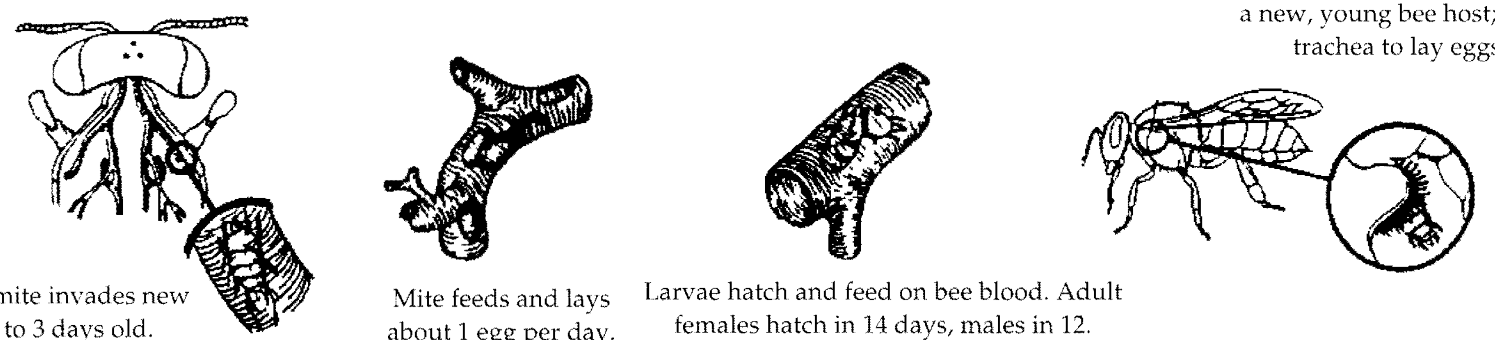
LIFE CYCLE CHART

Tracheal mite (*Acarapis woodi* [R.])

Chart © by D. Sammataro 1997

AGE OF BEE | 1 to 3 days old | 3 days | 8 days | 12 days

Daughter mites exit old bee, quest on bee hairs, and transfer to a new, young bee host; enter trachea to lay eggs.



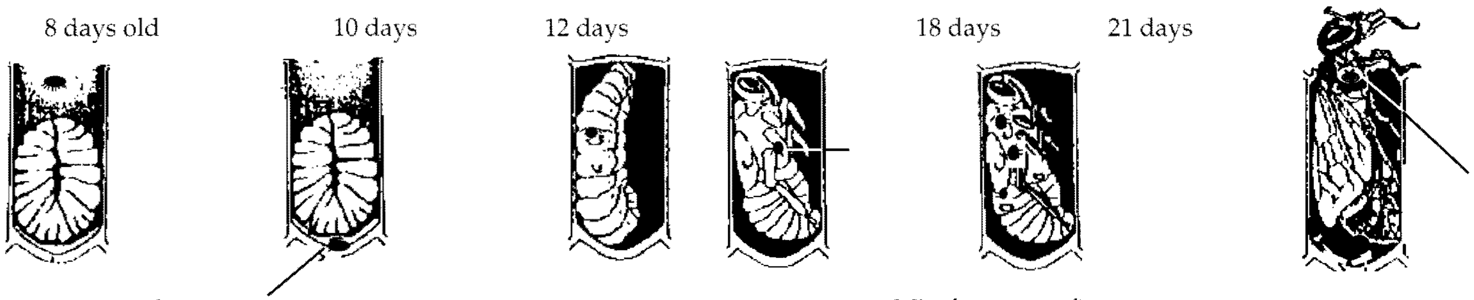
Female mite invades new bee 1 to 3 days old.

Mite feeds and lays about 1 egg per day.

Larvae hatch and feed on bee blood. Adult females hatch in 14 days, males in 12. Mating occurs in the trachea.

Varroa mite (*Varroa jacobsoni* Oud.)

AGE OF BEE | 8 days old | 10 days | 12 days | 18 days | 21 days



Female mite, attracted to the brood pheromones, invades larva before it is capped. Mite will invade drone brood first.

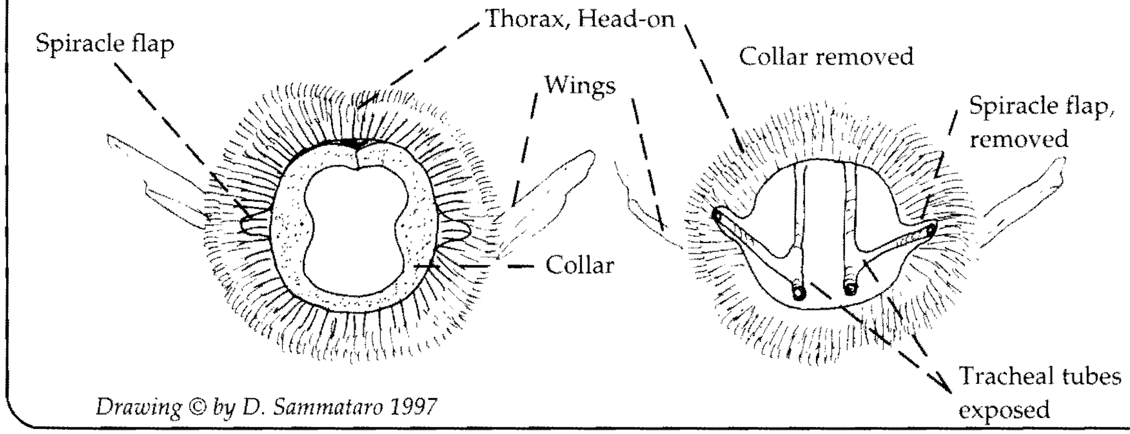
Female foundress mite hides in the bee brood food until cell is capped over.

When bee larva has spun its cocoon, the foundress mite feeds on its blood and begins to lay eggs.

Mite lays up to five eggs, which damage developing bee by feeding on it, allowing pathogens to enter. Mating occurs inside the cell.

Daughter mites exit as injured bee emerges; mites disperse to nurse bees and invade new larvae. Male mite usually dies in the cell.

Dissecting Bees for Tracheal Mites



Drawing © by D. Sammataro 1997

Step 3. While looking under the microscope, take off the head, and pull and remove the collar surrounding the thoracic opening with the forceps (see the illustration on dissecting bees).

Step 4. The thoracic tracheal tubes will be exposed when this covering is removed. In a healthy bee, they look like pearly white dryer hoses.

Step 5. If mites are present, the trachea will have shadows or be spotted—the spots being all ages of mites. In severe infestations, the tube can be completely brown or black.

Step 6. Darkened tracheae will be visible to the naked eye, whereas healthy trachea will be white and shiny. You can use this method to detect heavy infestations (in the spring and fall) but not light ones, such as in the summer.

CONTROLLING TRACHEAL MITES

Chemical. Menthol, from the plant *Mentha arvensis*, is sold in crystal form (98 percent active ingredient) at many bee supply stores, and each two-story colony takes 1.8 ounces (one 50-gram packet) of these crystals. The problem with menthol is that it is temperature dependent. Menthol vapors will sometimes make bees leave the hive if the outside temperature is too hot. Conversely, the crystals will be ineffective if the outside temperature is too cold, because not enough vapor would be released. The packet should remain in the colony for at least two weeks. Remove all menthol at least one month before the surplus honeyflow, to keep honey from becoming contaminated. As for all treatments, follow label directions.

An alternate method is to use vegetable oil patties; a vegetable shortening and sugar patty kept in the colony all the time seems to protect against these mites. Some research shows that TM extender patties (those containing the antibiotic) could also be beneficial to bees by helping them overcome mite-vectored pathogens, but these patties should be placed only on overwintering colonies; see the chart on making oil or TM patties (p. 133).

Place one ¼-pound oil/sugar patty, about the size of your hand, on the top bars at the center of the broodnest. The bees at most risk are the young nurse bees, found in the broodnest. The patty should last about one month; after that, replace it with another oil patty. If some colonies appear to remove the patty much more quickly, they may be displaying hygienic behavior; try rearing queens from these colonies. Because young bees are continually emerging, it is important to have the patty present in the colony for an extended time. The best time to treat is when mite levels are climbing—fall and early spring (see the figure on the sequence of treatment times.).

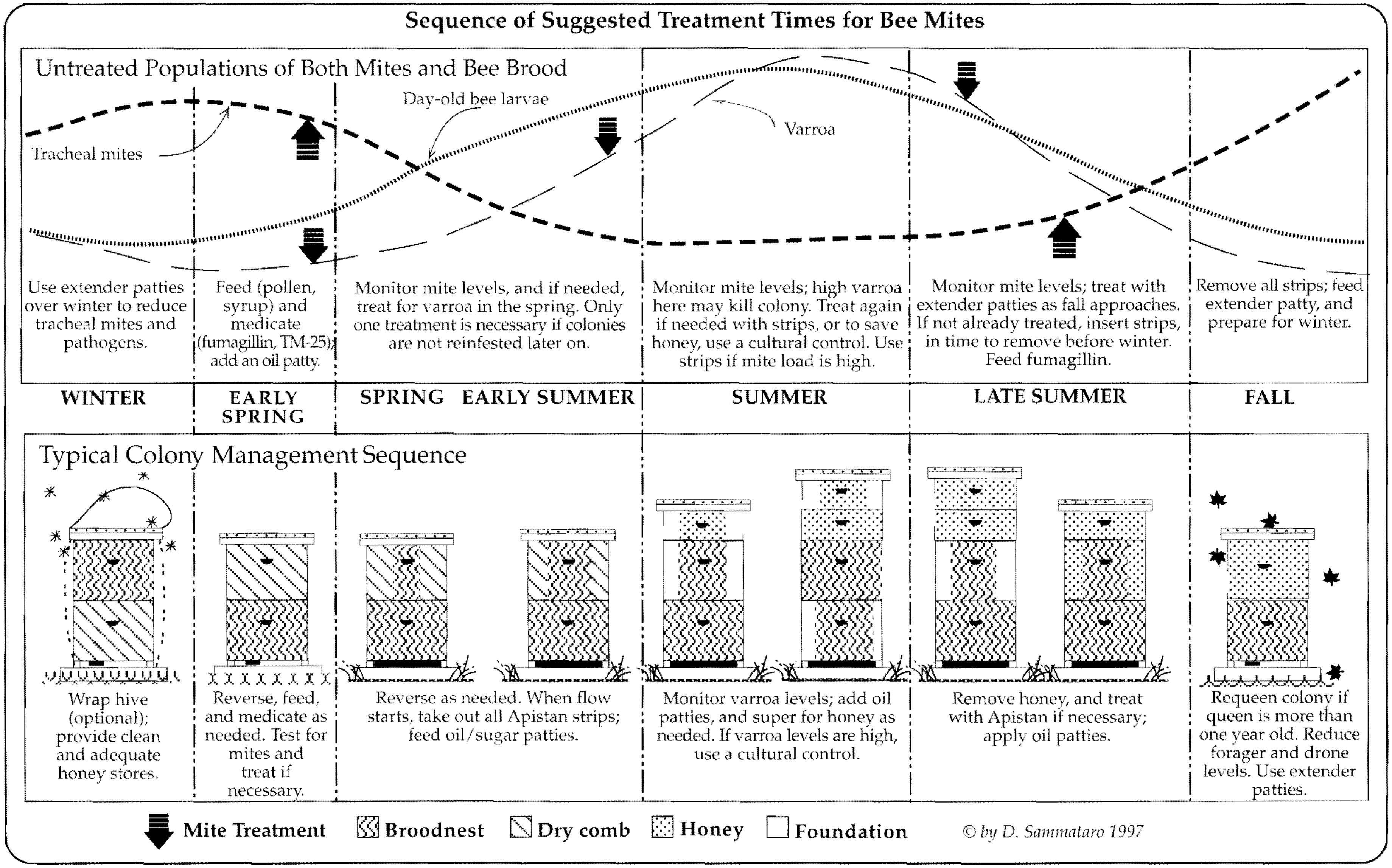
Cultural Practices to Reduce Tracheal Mites. Used with menthol or oil patties, some of these techniques seem to help reduce the number of tracheal mites in a colony:

- Requeen with resistant bee stock (e.g., Buckfast)
- Reduce numbers of foragers and drones in the fall (they are heavily infested) by moving hives and destroying field force with soapy water.
- Place TM extender patties on colonies in fall and spring; keep oil-only patties on during summer.
- If the colony is highly infested, split the colony, kill older foragers, requeen, and treat with menthol crystals or oil patties.
- Keep bees healthy with plenty of pollen and honey stores, and provide food supplements if needed.

Varroa Mite

First discovered in Java and described in 1904, the varroa mite (*Varroa jacobsoni* Oudemans) was originally confined to Asia on *Apis cerana*, the Asian honey bee. As a result of moving mite-infested bees, varroa has spread worldwide since the late 1950s, except to Australia, New Zealand, and Hawaii.

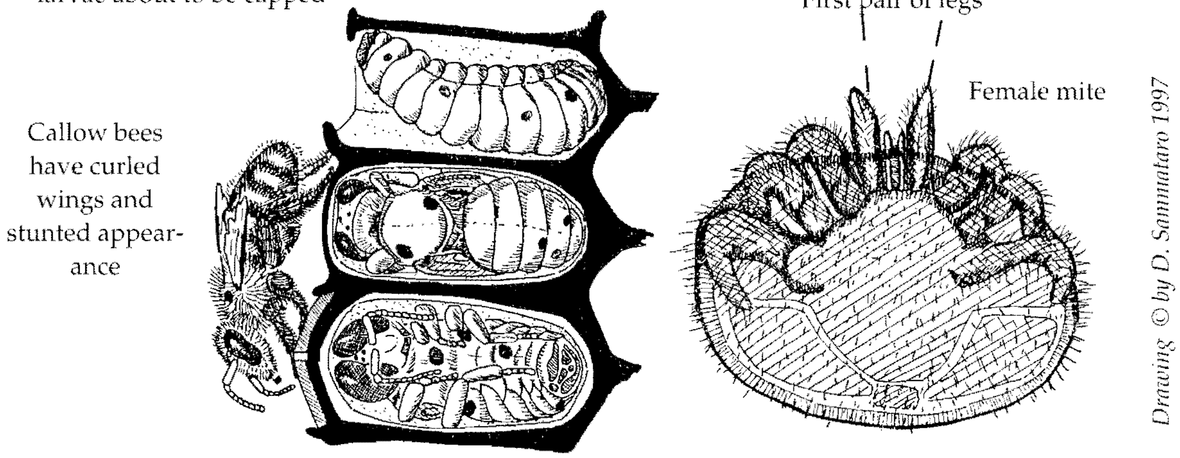
In 1986, varroa was first reported in the United States and is now one of the major killers of bee colonies. Adult female mites attach themselves to adult bees and are thus inadvertently carried to other, uninfested colonies or apiaries. The movement of the African bees north from Central America, as well as the practice of shipping bees in the mail, has accelerated the mite's spread throughout the United States. The website http://www.snre.umich.edu/~sarhaus/image/animap2.gif has an animated map of varroa's spread.



Only adult female mites are found on adult bees, where they feed on bee hemolymph by piercing the soft tissues of bees between abdominal segments or behind the head. Adult mites are about the size of a large pinhead and can be seen, after close examination, with the unaided eye (see the illustration of the varroa mite).

Varroa must complete its life cycle on bee brood. Females are attracted to the odor of the drone brood pheromone—but they will also invade worker brood if there is not enough drone—and enter prepupae as the cells are about to be capped.

Varroa Mite



There the mites hide at the bottom of the cell and emerge from the jelly after the cell is capped. The mite will lay her eggs on the pupa, and young mites (nymphs) feed on the hemolymph of the forming bee. Daughter mites mate with their brother in the cell, after which the new females will emerge with the callow bee.

Most times the young bees, if not killed outright by the stress caused by feeding mites, are usually deformed by virus and soon die. The new females will live for a time outside on other bees (this is the phoretic state), until they invade new brood to repeat the cycle.

As of 1997, the only chemical control for varroa is Apistan strips, a plastic strip (like a flea collar) impregnated with the pesticide fluvalinate. Do not be tempted to use other materials; some chemicals can become incorporated into the honey and wax, making them unfit for human consumption or sale. Contaminants in wax will vaporize and become inhaled when burning beeswax candles.

SYMPTOMS

Symptoms of varroasis are many and can be confused with those of other diseases or situations, such as pesticide poisoning. Look for:

- Infested capped drone or worker brood; cappings can be punctured, as in foulbrood disease.
- Disfigured, stunted adult bees, with deformed legs or wings or both.
- Bees discarding larvae and pupae.
- Pale or dark reddish brown spots on otherwise white pupae.
- Spotty brood pattern and the presence of diseases.
- Uncapped cells.
- General malaise of a colony, with symptoms of multiple diseases (AFB, EFB, and sacbrood, to name a few).
- A dead colony in the early fall, right after honey has been harvested.

DETECTING VARROA MITES

There are three basic techniques you can use to detect varroa mites. It is important to be able to test your colonies periodically to determine which treatment you can use. Because Apistan strips cannot be used during the honeyflow, you may need to treat a colony using an alternate method to keep the mite levels low enough for the bees to collect honey.

Cappings Scratcher (with forklike tines).

Step 1. Pick a frame of drone brood or a large patch on several frames.

Step 2. Hold the fork parallel to the comb and insert the tines into the top third of the cappings.

Step 3. Pull the capped drone pupae straight up or lift up the handle end of the fork, leaving the tines on the comb, until the drone pupae are pulled out of their cells.

Step 4. Examine the pupae carefully. A heavy infestation is at least 2 mites per cell; a moderate level is 5 mites per 100 pupae. The mites are clearly visible: females are reddish brown and look like ticks on the white pupae. Immature mites are white or light brown.

Ether Roll.

Step 1. Collect approximately 100–300 bees in a wide-mouthed jar with a lid.

Step 2. Scrape bees (don't get the queen) into the jar; you can also modify a small car vacuum to collect bees.

Step 3. Knock bees to the bottom of the jar with a sharp blow; there should be about a 1-inch layer of bees on the bottom (see the illustration of testing for varroa).

Step 4. Remove lid, spray a 2-second burst of ether starter fluid into the jar, and replace the lid immediately. Alternatively, you can add enough 70 percent alcohol or soapy water to cover the bees.

Step 5. Agitate the jar for a minute to dislodge the mites from the bees, and then roll the jar for about

10 seconds; mites should stick to the sides of the jar. If soapy water or alcohol was used, shake the jar for about three minutes, and strain out bees using a coarse hardware cloth strainer. The mites will be in the liquid, which can later be strained through a coffee filter.

Smoke or Miticide Strips and a Sticky Board.

Step 1. Place a sticky board in the bottom of colony; you can make a board with cardboard or other stiff paper coated with Vaseline. Cut paper to fit on the bottom of the bottom board, and cover with a piece of 8-mesh hardware cloth stapled to a ¼-inch high wooden lath frame to keep bees off the board (see the illustration of testing).

Step 2. Smoke the colony with a smoker that contains 1 ounce of smoldering pipe tobacco.

Step 3. Puff bees 6–10 times; close up hive for 10–20 minutes.

Step 4. Pull out the sticky board and count mites.

You can also use miticide strips instead of smoke; insert one strip per five frames of bees for one to three days with the sticky board in place. Or, put in just the sticky board overnight to collect the natural downfall of mites. Generally, an overnight fall of over 50 mites may indicate time to treat all colonies.

These techniques will tell you, with some degree of accuracy, if you have varroa. The question is, do you treat if you see only 1 mite or if you count over 100 mites? This is a judgment call. If you see mites early in the spring, put in your strips for the recommended time. If you see mites during a honeyflow, when you cannot treat with the strips, try a few of the cultural controls to reduce the number of mites, then treat with strips later. Consult the figure in this chapter on the sequence of treatment times, and keep up with journal articles on the progress of mite control.

TREATMENT FOR VARROA

Miticide strips. Currently, there are two treatments to control varroa: Apistan strips and CheckMite+. Insert these strips according to label directions, when you have no honey supers on the colony. Here is how to use the strips:

- Read and understand label instructions before using any strips.
- Wear *new* chemical resistant gloves when handling strips.
- Use one strip per five frames of bees; this kills only varroa mites.
- Keep strips in the colony according to the label.
- Discard used strips; do not reuse.

Test your bees to see if you have mites. Use strips once in the spring and once in the fall if your bees are in a heavily infested area. Timing of treatment is very important; refer to the figure on the sequence of treatment times (p. 140).

Tobacco smoke (or wheat flour sprinkled on adult bees) knocks mites off bees, thus lowering their numbers. Use this if you have supered for honey. Smoke the colony heavily, or dust bees lightly with flour (being careful not to get flour into uncapped brood cells). Insert sticky boards to catch the mites. This is an emergency treatment only, for when you cannot use strips. Repeat in one week, because it will not affect mites in brood cells.

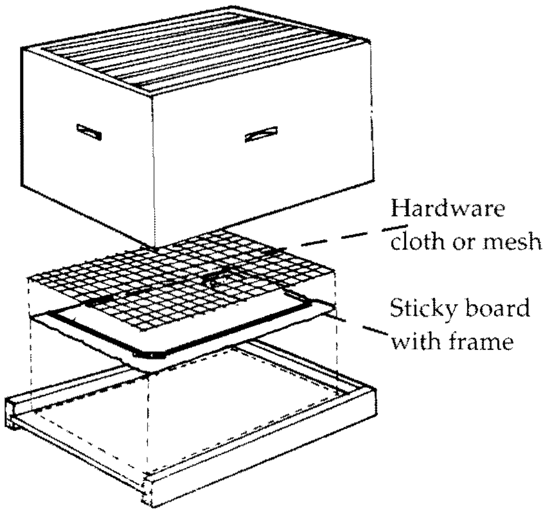
Formic acid. Formic acid is now available to use for mite control. Do not use the liquid form, as it is highly caustic and can burn. Use the slow-release gel packs, available from some suppliers. It acts as a fumigant, killing both types of parasitic mites. It is also toxic to bees if not applied correctly, and it is EXTREMELY CAUSTIC TO HUMANS.

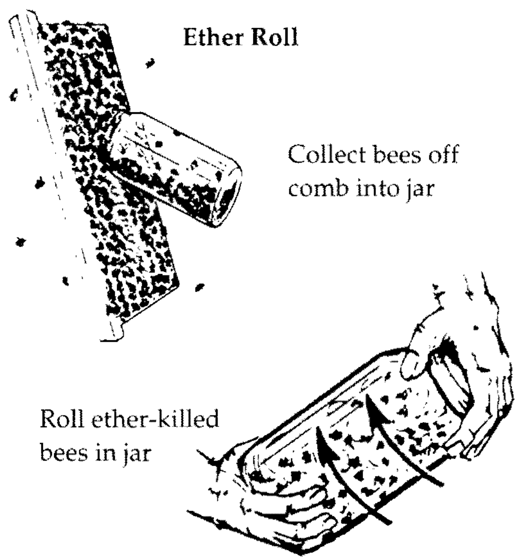
IPM Mite Management. An integrated pest management (IPM) program for mites and bees uses several control measures. They include:

- Restricting brood rearing by caging the queen and removing capped brood or requeening the colony with queen cells. This breaks the mite-brood cycle and allows the bees to clean out diseased brood.
- Trapping mites in drone brood and freezing the

Testing for Varroa

Sticky Board and Apistan Strips or Tobacco Smoke





Courtesy of M. Burgett and A. I. Root Co.

frames, which reduces the mite population temporarily and can be used successfully if a frame of drone foundation is inserted in each deep super once a month and removed.
- Scraping off mites by means of a pollen trap, or trapping mites on a sticky oil strip.
- Essential oils (botanical oils of essence), which are showing promise but are still in the experimental stage. Keep current with the bee journals for more information on new controls.

Bee Parasitic Mite Syndrome

First reported by European beekeepers whose colonies were stressed by varroa mites, bee parasitic mite syndrome (BPMS) was coined by researchers at the Beltsville Bee Lab in Maryland (see "Bee Laboratories" in the References) to explain why colonies infested with both varroa and tracheal mites were not thriving. BPMS may be connected to the vectoring of virus by both mites (such as acute bee paralysis virus). The symptoms of BPMS can be present at any time during the bee season and include:

- Varroa mites present in colony (tracheal mites may be present too).
- Crawling bees on ground, with deformed wings (Deformed Wing Virus).
- Queens superseded more than normal.
- Spotty brood pattern.
- Foulbrood and sacbrood symptoms present.
- Diseased brood in all life stages of bees.
- Lowered adult bee population.
- AFB symptoms present, but no ropiness, odor, or brittle scales.
- No predominant disease bacteria found.

Although not much is known about BPMS, these treatments have been effective:

- Feed colonies with TM in syrup; feed with fumagillin.
- Treat for varroa with miticide strips.
- Treat for tracheal mites with vegetable oil patties.
- Feed pollen supplements.
- Use resistant bee stock (e.g., Buckfast for tracheal). Hygienic behavior seems to be beneficial for varroa mite control, and some bees appear to pick off the mites. Select colonies that seem to have some tolerance for mites, and breed queens from them (see Chapter 10).

Integrated pest management (IPM) is a strategy whereby one uses multiple tactics such as requeening and chemical and soft controls to "manage" mites rather than eliminate them (an impossible task), provided they do not damage the hive. It is not possible to kill all mites in a hive and all mites in a region. The presence of some mites in the hive does not detract from hive health, provided the colony is strong and mite numbers do not get out of hand.

Major Insect Enemies

Small Hive Beetle (see page 148)

Wax Moth

First reported in the United States in 1806, this pest was probably introduced with imported bees. The female greater wax moth (*Galleria mellonella* L.) is from ½ to ¾ inch (1.3 to 1.9 cm) long, is gray brown (color varies somewhat), and holds her wings tentlike over her body instead of outstretched, as would a butterfly (see the illustration of a wax moth). The wax moth is thought to have evolved with honey bees from Asia and commonly inhabits nests of all honey bee species.

This moth deposits eggs in cracks between hive parts or in any other suitable place inside the hive. After hatching, the larvae are quite active, moving up to 10 feet in optimum conditions, to infest other hives, where they tunnel into the wax combs, hiding at the midrib to keep from being discovered by house bees. The dark wax of brood combs contains the shed exoskeletons of bee larvae and some pollen, both of which are highly attractive to wax moth larvae. The larvae can grow to 1 inch long (2.5 cm) in from 18 days to 3 months, depending on the temperature. As these larvae tunnel along, silk strands mark their trails through the combs (see the illustration). Before pupating, the larvae fasten themselves to the frames or inside walls, inner covers, or bottom boards of the hive and spin a large silk cocoon, sometimes damaging the hive by chewing into the wooden parts. Left untended, wax moths can destroy weak hives within one season. Symptoms of wax moth damage are:

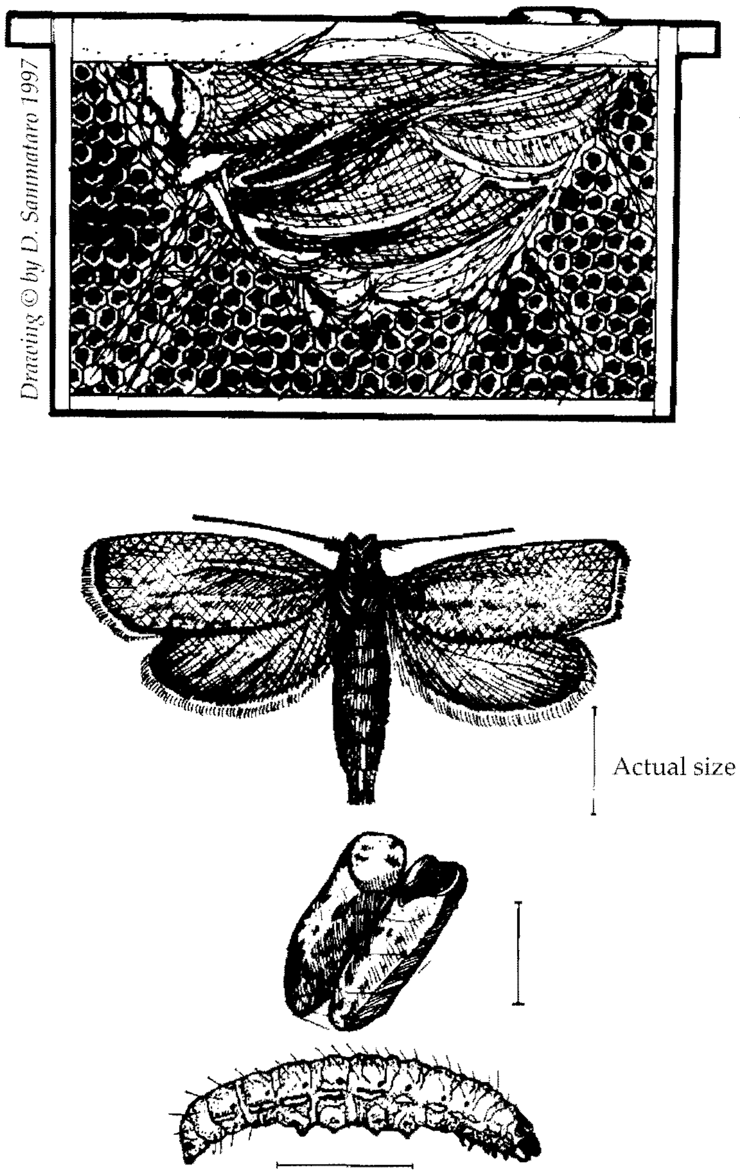
- Tunnels in combs.
- Silk trails, crisscrossing one another over combs.
- Small dark objects (excrement of wax moth larvae) in the silk trails in a hive.
- Silk cocoons attached to wooden parts.
- Destroyed comb; piles of debris on bottom board.

To control wax moths, use these methods:

- Maintain strong colonies (the best defense against wax moths).
- Store empty combs in cold places; cold temperatures will slow down the rate of growth and deter adult moths from laying their eggs.
- Freeze combs (like comb honey) at 20°F (−7°C) for 4½ hours; at 10°F (−12°C) for 3 hours; or at 5°F (−15°C) for 2 hours. If treating much comb honey, freeze for at least 24 hours.
- Store empty combs with moth crystals (Paradichlorobenzene, or PDB) when air temperature is above 60°F (16°C), but air out at least 24 hours before using.
- Fumigate dry combs with a mixture of 74 percent carbon dioxide (CO_2) and 21 percent nitrogen (N), at 50 percent relative humidity, at 100°F (38°C) for 4 hours; 115°F (46°C) for 80 minutes; or 120°F (49°C) for 40 minutes. Be careful, as beeswax melts at 148°F (64°C).

A cultural practice in the South is to let fire ants (*Solenopsis invicta* Bunen) kill wax moths, if combs are left near an active ant nest. But use caution, be-

Wax Moth



cause these ants also kill bee colonies and sting beekeepers.

Wax moths are naturally beneficial because they destroy diseased combs of feral colonies; they are also a valuable commodity, used as fish bait and pet food for reptiles and other exotic animals. They can be reared off beeswax, using baby cereal, glycerin, and honey and are often a secondary business to many beekeepers (see Appendix H).

The lesser wax moth (*Achroia grisella* Fabricius) does similar damage to wax comb. But unless the infestation is great, the damage is minor compared with that of the greater wax moth.

Africanized Bees

Recently, Africanized bees have become a serious pest in some areas of Texas, Arizona, and California. If you are living in an area that is subject to this invasion, make sure you can differentiate European honey bees (EHB) from the Africanized bees (AHB). In general, AHB are smaller than EHB, faster moving, more aggressive, and more apt to abscond and swarm (see Appendix G).

SOCIAL PARASITISM

Africanized honey bees have been reported to usurp a weak European colony, mating nuc, or colony recently stressed by beekeeper manipulation. A small cluster or swarm of AHB will land nearby, and the workers will enter the weaker colony, killing the resident queen. Once she is dead, the AHB queen will enter and resume her duties. Still being studied by researchers, such activity illustrates an important reason to keep good records of your queens, especially if you live in areas bordering those with AHBs; you will quickly be able to tell if your colonies have become Africanized.

Animal Pests

Skunks and Raccoons

Skunks (family Mustelidae), which includes weasels and badgers, and raccoons (family Procyonidae) are serious pests to bees, often visiting hives in the early evening as well as during the day. They can cause damage to both equipment and bees and dig up the beeyard looking for food to eat. By scratching at the entrance, skunks entice bees to come out of the hive, and as the bees crawl out, the skunk eats them. Skunks even teach their young that hives are a good place to get some tasty snacks, thus depleting hive populations drastically; your apiary could become decimated quickly if you do not take some countermeasures to protect colonies. Skunks also feed on bumble bee colonies. Raccoons often take and scatter anything loose in the apiary, including feeder jars and frames of brood or honey that have been left out. Some raccoons can lift off the covers of hives. Depending on the severity of winter in your area, these pests could be nearly a year-round problem.

In areas that have a lot of coyote and coatimondi (usually found in southwestern U.S. deserts), it has been reported that these creatures can get into beehives in search of liquid and food. In this case, heavy rocks placed on top of the hives deter such pests.

Signs of their visits are:

- Defensive bees.
- Grass near hive entrance is torn up.
- Scratch marks on the hive front or on earth at the hive entrance.
- Weak colonies for no other apparent reason.
- Scat and droppings near hives.
- Area near entrance is muddy after a rain.

Discouraging and eliminating these pests may be accomplished by:

- Using hive stands, at least 18 inches high, to keep bees out of reach (see "Hive Stands" in Chapter 4). This is the best and easiest way to eliminate skunk predation.
- Sprinkling rock salt crystals on the ground around the hive. Although this method may deter these pests until it rains, it will also kill vegetation around the hives.
- Placing paradichlorobenzene (moth ball crystals) in jars with holey lids approximately one yard from the hives; the crystals need to be replaced and kept out of the rain.
- Trapping skunks, which may be illegal in your area and will cause the skunks to discharge, not making you popular with your neighbors. You can live-trap raccoons and move them to another area; use cat food or marshmallows as bait.
- Killing skunks and raccoons in their lairs, if you can find them (this may be illegal).
- Using poison baits; this method is not recommended because it is not selective enough and can harm other animals. Before killing any animal or using poison bait traps, contact your state game and wildlife departments, and comply with regulations for controlling fur bearers.
- Placing a strip of carpet tacking, nail side up, on the landing board; this does not always discourage the skunks, who many times pull it out.
- Extending a piece of hardware cloth in front of the entrance, which will allow bees to sting the skunk's belly; this is a good temporary measure. Make sure it is securely fastened to the bottom board, or the skunk will tear it off.

Bears

Bears (*Ursidae*) eat brood and honey and do extensive damage to equipment, especially in Canada, where large bear populations exist. However, bears are now found in almost all states in the continental United States and they are capable of destroying apiaries. Signs of bear damage are overturned hives; smashed hive bodies; frames scattered over the apiary; and entire supers that have been removed from the apiary and scattered 30–50 yards away.

An electric fence around the apiary is probably the only effective control against this large animal. Raised platforms where hives are kept are extremely inefficient and difficult to work. Locating apiaries away from bear routes may help, because these animals keep to knolls, forest edges, and stream banks. Do not leave combs or hive debris around an apiary; such material will attract not only bears but other pests as well. Paint hives to blend into the background.

Alternative ways to reduce bear damage include moving bees to a new location and seeking the assistance of local conservation departments.

Mice

Mice (*Mus*) are the most damaging animals to bee hives, next to vandals. They enter hives in the fall and winter and, although they appear not to harm the bees, can cause extensive comb and woodenware damage. They may destroy weak colonies by feeding on pollen, honey, wax moth larvae and cocoons, bee brood, and bees. Their droppings and urine are another irritation that often disrupts cluster behavior, especially if the colony is weak. Mice are often found in the winter packing.

Because mice carry viral diseases (Hanta) and vermin (fleas) that may affect humans, keeping them out of bee hives is important to your health. If you find mice in equipment stored in your bee house, make sure your room is well ventilated before sweeping it up, and clean the hive bodies outdoors. Signs of mouse damage are chewed combs or wood; droppings on the bottom board; holes chewed in entrance reducers, thus enlarging the opening to enable mice to enter; and nesting materials (grass, paper, straw, cloth, or such) in hives, usually among the comb.

Colonies at forest edges and in fields of tall grass-es are especially at risk. The following measures may help to control damage from mice:

- Place hives on stands (although mice can climb).
- Use entrance reducers; some beekeepers line them with metal sheeting to keep mice from chewing the wood.
- In the fall, close the entrance with 4-mesh hardware cloth or metal mouse guards. Mice can squeeze through a space that measures ⅜ × 3 inches (1 × 8 cm). Some beekeepers drill several ⅜-inch holes in deep supers to help with winter ventilation.
- Keep weeds down around hives.
- Place poison grain on bottom boards or around the base of the hive. This measure is not recommended because its effect is not selective. The only safe use of poison bait and traps is in an enclosed space where extra equipment is stored, such as your honey house.

Vandals (*Homo sapiens*)

There has been an increase in the number of hives stolen or otherwise vandalized in recent years, which makes vandals an important vertebrate pest of bees. The increasing demands and increased value of equipment, honey, bees, and hives for pollination services have contributed to the prevalence of thieves. Furthermore, colonies are also vandalized by the curious who think that they will be able to obtain free honey simply by opening up a colony. Those bent on mischief can overturn or otherwise damage hives.

Vandals can be discouraged by placing apiaries near year-round dwellings. If it is not possible to place them near one's own residence, land can often be rented from a homeowner for a few pounds of honey each year. Branding your hive bodies and frames is good protection. If your hives are stolen, for example, and the bee inspector finds your brand on hives in some other yard, the person responsible for the act is more likely to be apprehended and your equipment returned to you (see Chapter 3 for other ideas on personalizing your hive furniture).

Instead of painting your hives white and placing them in open, highly visible areas, try going to paint stores and getting cans of premixed colors that other consumers have returned. Mixing these together often results in a nice, mud-colored paint that makes your hive boxes disappear into the background. Tree hedges or judiciously placed shrubs to create screens around the yard also help to discourage would-be thieves. So does fencing with a locked gate!

Minor Insect Enemies

Although bees are often preyed on by other insects and spiders, such predators usually do not have any appreciable effect on a colony's well-being. In some areas, however, any of these predators might be a serious problem. Spiders (Araneae) also prey on adult bees; some species even wait for bees to arrive at a flower before attacking them. The most common types of spiders that would catch a bee are the orb weaver, grass, jumping, and house spiders.

Although not a serious problem in the temperate climates, in the subtropical areas ants (Formicidae) are a serious pest, and hives must be placed on top of greased posts or in oil-filled cans to keep out marauding ants. The more harmful ones in North America include the Argentine ants (*Iridomyrmex humilis*), a newer arrival from South America; fire ants; and carpenter ants (*Camponotus* spp.). Ants can be controlled by keeping the apiary free of weeds, debris, and rotting wood and by placing hives on stands and painting the legs with oil. For more serious infestations, poisons may be needed to control ants; consult your local extension agents on what to use.

Other ants, earwigs, and cockroaches may use various hive parts, especially the inner cover, as a shelter or nest. Earwigs (Dermaptera), found on top of the inner cover, may be annoying to bees. Keep vegetation mowed around hives. Nematodes, small worms, may also live on bees but are not really serious. Termites (Isoptera) can damage hive parts, especially those on the ground. As before, keep your apiary mowed and hives on stands and many of these problems will disappear.

To control these insect pests, store equipment in cold or freezing temperatures. NEVER use insecticides or pest strips in stored equipment or a storage area: these will also kill bees if absorbed by the wax combs.

Insect predators of bees are numerous but do not typically pose a serious threat to colonies, and no control measures are needed. Your bees may be caught by:

- True bugs (Hemiptera), including assassin bugs (Reduviidae) and ambush bugs (Phymatidae), which eat insects.
- Robber flies (Asilidae).
- Mantids (order Mantodea).
- Hornets and wasps (Vespidae). These may be a problem in the fall or if colonies have died from pesticides or mite predation. Wasps, hornets, and yellow jackets will clean out hives of dead bees, feeding on the dead insects, brood, pollen, honey, and even wax moths.
- Dragonflies (Anisoptera) and damselflies (Zygoptera).

Other insects live on the stored products in a colony or on the insects that eat the stored products, and they can be a problem if there are many dead colonies. These insects are:

- Moths: dried fruit moth (*Vitula edmandsae*) and Indianmeal moth (*Plodia interpunctella*).
- Beetles (Coleoptera), which may live inside a hive, eating debris and litter found there. The most common ones are dermestid beetles (Dermestidae), weevils (Curculionidae), sap beetles (Nitidulidae), and scarab beetles (Scarabaeidae);

Poisonous Plants

Name	Toxic Part
Abies alba, silver fir	some aphid's honeydew
Aconitum spp., monkshood	honey/pollen
Aesculus californica, California Buckeye	honey/pollen
Andromeda spp., andromeda	honey/pollen?
Arbutus unedo, strawberry tree	nectar
Astragalus spp., locoweed, tragacanth	nectar
A. miser v. *serotinus*, timber milk vetch	nectar
Camellia reticulata, netvein camellia	nectar
Coriaria arborea, New Zealand tutu	honeydew
C. japonica	honeydew
Corynocarpus laevigatus, New Zealand laurel or karaka	nectar
Cuscuta spp., dodder	nectar
Cyrilla racemiflora, southern leatherwood, titi	nectar
Datura stramonium, jimsonweed	honey/pollen
D. metel, Egyptian henbane	honey
Digitalis purpurea, foxglove	pollen
Euphorbia segueirana, spurge	honey/pollen
Gelsemium sempervirens, yellow jessamine	nectar/pollen?
Hyoscyamus niger, black henbane	nectar/pollen
Kalmia latifolia, mountain laurel	nectar
Ledum palustre, wild rosemary	honey
Macadamia integrifolia, macadamia	cyanide gas from bloom
Nerium oleander, oleander	honey
Papaver somniferum, opium poppy	pollen
Ranunculus, buttercup	nectar/pollen
Rhododendron spp., azalea and *R. anthopogon*, *R. ponticum*	nectar/pollen
Sapindus spp., soapberry	nectar?
Senecio jacobaea, tansy ragwort	nectar
Sophora microphylla, yellow kowhai	nectar
Stachys arvensis, nettle betony, staggerweed	nectar?
Taxus spp., yew	pollen
Tripetaleia paniculata, an azalea	nectar
Tulipa spp., tulips	stigma nectar?
Veratrum spp., Western false hellebore	nectar
Zygadensis (= *Zygadenus*) *venenosus*, death camas	nectar/pollen

the last two eat stored pollen. Some are predators, such as ground beetles (Carabidae), or parasites, like the blister beetles (Meloidae), which eat or parasitize live bees.

Certain flies (Diptera) bother bees at times but are mostly considered a minor nuisance unless their natural prey is unavailable. Some flies are predators, but others are opportunists, found in colonies that died of other causes. Others can parasitize bees, but these are found mainly in tropical climates.

The following have been noted in the literature as being pests of bees:

- Humpbacked flies (Phoridae), blow flies (Calliphoridae), thick-headed flies (Conopidae), flesh flies (Sarcophagidae), and tachinid flies (Tachinidae).
- The bee louse (*Braula coeca*) eats food at the bee's mouth. This fly, which looks like a varroa mite, except that it has six instead of eight legs, may reach damaging levels in some regions. It can be controlled by using miticide strips as you would treat for varroa.

Miscellaneous Minor Pests

Although many birds are insectivorous, few, if any, eat bees in large quantities in North America. Bee-eaters, common in Asia, Africa, and Europe, can decimate apiaries and can eat many virgin queens on mating flights. In North America, flycatchers and kingbirds feed on bees, and woodpeckers can damage old, abandoned equipment. But you should make no attempt to control birds by poisoning or shooting them, which is illegal.

Other minor pests that could be of major concern in some areas include frogs, toads, lizards, squirrels, opossums, rats, and shrews. Livestock will knock over hives if they are not otherwise protected in pastures; and remember, horses and bees do not mix.

There are many other mites (Acari), such as the pollen mite, which feed on stored pollen. And various other mites feed on one another, hive debris, or fungi that live inside a hive. They are generally harmless to bees and may even serve a beneficial function as garbage collectors.

Poisonous Plants

Sundew (Droseraceae), Venus flytrap (*Dionaea muscipula*), and pitcher plants (Sarraceniaceae) are insect-eating plants that attract their victims by secreting a sweet sap or odor or both. These plants grow in wet areas and are not usually attractive to bees; the number of bees lost to them in minimal.

The list on page 147 summarizes information on toxic plants. Certain environmental conditions, such as abnormally cold or dry weather, may cause otherwise nontoxic plants, such as linden (*Tilia*) trees, to yield toxic nectar or pollen or both. Furthermore, wild bees, such as bumble bees, can collect these substances that are toxic to honey bees without adverse effects.

Small Hive Beetle (*Aethina tumida*)

The small hive beetle (SHB) was first identified in Florida in the spring of 1998. Native to tropical or subtropical areas of Africa, it is not known how it came to the U.S. The beetle is not considered a serious pest in South Africa, but in Florida beekeepers have seen the quick collapse of strong colonies. As of February 2001, the beetle has been found year-round in apiaries in Florida, Georgia, and North and South Carolina. They have also been found along most Eastern states, to Maine, and in some Mid-Atlantic states but do not seem to be a serious problem.

Description

The adult beetle is small (about 1/3 the size of a bee), reddish brown or black in color, and covered with fine hair. The larvae are small, cream colored, and similar in appearance to young wax moth larvae. Beetle larvae can be identified because they have three sets of legs just behind the head. Wax moth larvae have three sets of legs behind the head plus a series of paired prolegs, which run the length of the body.

Life Cycle

Female beetles lay large egg masses on or near the combs, which hatch in a few days into larvae. Beetle larvae consume pollen and wax, honey, bee eggs, and larvae. After 10 to 16 days the larvae crawl out and drop to the ground, where they pupate in the soil. They require sandy soil for this stage in their life. Adults emerge from the soil in approximately 3 to 4 weeks, and the females can lay eggs about one week after emergence. Beetles are good flyers and easily disperse to new colonies, where they deposit eggs to begin a new generation. In northern states, beetles completely shut down reproduction during winter and overwinter in the bee cluster.

Damage

The SHB has the potential to be a pest of significant economic importance in areas where it overwinters. Whether or not it can successfully establish itself in temperate regions or in areas without sandy soil is not yet known. In addition to consuming the resources of the colony, the adult beetles defecate in the honey, causing it to ferment and run out of the combs. Full honey supers stored in the honey house or on hives above bee escapes and weak hives with honey but few bees seem most vulnerable to attack. When SHB infestations are heavy, even in strong colonies queens will stop laying eggs and the bees may abscond.

Detection

Beetles can be seen running across the combs to find hiding places or under top covers or on bottom boards. If an infestation is heavy, both adults and masses of larvae may be seen on the combs and bottom board. Corrugated cardboard with the paper removed from one side, placed on the bottom board at the rear of the hive, has been successfully used in detecting adult beetles. Fermented honey (smelling like decaying oranges) exuding from full honey supers in storage or on active colonies is a sign that SHB are present.

Control

Contact your state apiary inspector if you find or suspect SHB. In 1999, coumaphos received a section 18 (emergency use) registration of CheckMite+ strips to control SHB. Because this pest is not yet found throughout the U.S., however, beekeepers are strongly urged to freeze or burn any infested hive and bees. Freezing at 10°F (-12.2C) for 24 hours will kill all life stages of SHB. In addition:

- maintain only strong, healthy colonies
- keep apiaries clean of *all* equipment not in use
- extract honey as soon as it is removed from colonies
- destroy these beetles as soon as they are detected

Hive Treatment

Wear gloves when handling these strips (see coumaphos, under varroa mite control). Prepare a piece of corrugated cardboard about 6 inches by 6 inches (remove paper from one side). Cut the miticide strip in half crosswise and staple both pieces to the corrugated side of the cardboard. Then place the cardboard in the center of the bottom board with the strips facing down for at least 3 days but no more than 7 days.

Eliminating Varrora and Tracheal Mites for Good

Most of us beekeepers spend a lot of effort fighting with the Varroa mites. I'm happy to say my biggest problems in beekeeping now are things like trying to get nucs through the winter here in Southeastern Nebraska and coming up with hives that won't hurt my back from lifting or better ways to feed the bees.

This change in beekeeping from fighting the mites is mostly because I've gone to natural sized cells. In case you weren't aware, and I wasn't for a long time, the foundation in common usage by beekeepers results in much larger bees than what you would find in a natural hive. I've measured sections of natural worker brood comb that are 4.6mm in diameter. This 4.6mm comb was drawn by a hive of commercial Carniolans and this 4.7mm comb was drawn on the first try by a package of commercial Carniolans. What most beekeepers use for worker brood is foundation that is 5.4mm in diameter. If you translate that into three dimensions, instead of one, that produces a bee that is about half again as large as is natural. By letting the bees build natural sized cells, I have virtually eliminated my Varroa and Tracheal mite problems. One cause of this is shorter capping times by one day and shorter post capping times by one day. This means less Varroa get into the cells and less Varroa reproduce in the cells. I have mostly done this either with wax coated PermaComb (fully drawn plastic comb) or self drawn comb on foundationless frames or frames with blank starter strips. 4.9mm foundation is available from Dadant and Sons and from Brushy Mt. This size(4.9mm) has been found sufficient to resolve the mite problems. For more information on small cell beekeeping:

I've talked about a lot of different things I've changed over the years, but for the moment, let's look at just these four issues: comb; genetics; natural food; and no treatments. Let's gloss over the arguments and focus only on what we know to be facts.

Comb
I find all the arguments over cell size and whether it does or does not help your Varroa issues and all the rest a bit tiresome. Varroa is no longer an issue in my yards and yet I find that the obsession of every bee meeting I go to seems to be Varroa about half of what I end up talking about is Varroa. I went to natural cell and small cell at a time when no one believed it was possible to keep bees alive without treatments. After doing no treatments with repeatedly disastrous results before, I came to the same conclusion. But after going to small and natural cell size I was pleased to be back to keeping bees instead of managing mites. This anecdotal evidence is not enough for some, even as the same from others was not enough for me until I tried it, but unlike me they don't seem to be willing to try it. But let's consider your choices:

Choices
You can assume that cell size is irrelevant to everything, if you like. This seems like a doubtful assumption since we know for a fact it has everything to do with the size of bees. If scaling up the entire body of a bee to 150% of what it was naturally is not a significant change, then I don't know what you would consider significant. We've known this is a fact since Huber's observations and in addition we have reams of research by Baudoux, Pinchot, Gontarski and others as well as recent research by McMullan and Brown (The influence of small-cell brood combs on the morphometry of honeybees (Apis mellifera)--John B. McMullan and Mark J.F. Brown).

Natural Cell Size
You can assume whatever you like about what size IS natural. But in the end the only way to get natural cell size, and let the bees end the debate, is to stop giving the bees foundation and let them build what they want. Since that is what bees do if you let them and since that is actually less work for you than using foundation and less expense and since that's the only way to get uncontaminated combs (see the Google video of Maryann Frasier on contamination by acaracides in new foundation) it seems like a win-win-win to me. Even allowing the assumption that cell size is irrelevant, no one is saying that natural cell size is bad for the bees and no one I know of thinks that clean wax is bad for the bees and most are very convinced at this point that clean wax is essential for truly healthy bees.

Why not let them build what they want?
Why wouldn't you let them build what they want? It seems there is a lot of fear that the bees will only build drones. I have heard this from many beekeepers. Obviously this is not true. If it were there would never have been any feral bees. If you want to know how much drone comb they will build and how many drones they will raise and how much influence you can have on it, read Clarence Collison's research on the subject (Levin, C.G. and C.H. Collison. 1991. The production and distribution of drone comb and brood in honey bee (Apis mellifera L.) colonies as affected by freedom in comb construction. BeeScience 1: 203-211.). The point is that in the end the amount of drones is controlled by the bees and leaving them that control in the first place will simplify life for them and you. The thing to do when the bees draw a frame full of drone comb, is set it to the outside edge of the box and give them another empty frame. Otherwise, if you take it out, their need for drones unfulfilled, they will draw another frame of drone and contribute to the myth that if you let them, they will draw nothing but drone comb.

Combs in frames?
Another fear seems to be that the bees will not draw the combs in the frames. They will mess up foundationless about the same rate as they mess up any other system of foundation. They will mess up plastic foundation a lot more than foundationless frames. But if they do, you just cut it loose and tie it into the frame, if it's brood, or harvest it, if it's honey.

Draw comb without foundation?
I've even heard old timers tell new beekeepers that without foundation the bees won't draw comb at all. This is so patently absurd that I don't see any need to respond to it.

Wire?
The last seems to be the myth that wire is necessary in order to extract. The wire was added to foundation to keep the foundation from sagging before it was drawn (see any older ABC XYZ of Bee Culture). It was not added to allow extraction. Extraction is done on unwired foundationless frames by many people, including me. But if wire is your hang-up, add some wire to the frames, level the hive and sleep well. I prefer to just use mediums and be able to lift the boxes and have had no need at all for the wires.

How do you do foundationless?
With standard wedge frame, just break out the wedge and nail it sideways. You were going to break it out and nail it anyway right? With grooved top bars, put popsicle sticks in the groove or a half of a paint stick or a piece of a one by ripped With drawn wax, just cut the center of the comb out leaving a row of cells around the edges. With an old frame with no comb, just put it between two drawn brood combs With a plastic foundation/frame, just cut the center of the foundation out leaving a row of cells around the edge. When making your own, cut a bevel on the top bar so it slopes down to a point. Also make them 1 1/4" wide.

Less work
So how much work is foundationless? If you buy standard wedge frames and turn the wedge 90 degrees and glue and nail it back on you have a foundationless frame. That is pretty simple. You were going to break it out and nail it in anyway weren't you? What about all the plastic foundation in grooved frames you have? Pop out the plastic and glue popsicle sticks or a half of a paint stick in the groove. What about frames with wax foundation already drawn? Just cut the comb out of the middle and leave a row of cells all the way around and one or two rows at the top. What about that old moth eaten frame that has nothing in it now but webs? Just scrape off the webs etc. and put it between two drawn brood combs and let them draw it out. The only slightly tricky thing would be plastic frames with built in foundation. Then you'd need to cut the center of the foundation out. That could be done with a number of tools, but I suppose a really hot knife would cut it out pretty quickly. A jig and a router would probably do ok as well and it would be simple to leave the corners and edges in for strength and for a guide. So how does this compare with putting in wire, crimping, foundation, embedding etc.? Or using plastic? You save as much as $1 a sheet if you wanted to get small cell or close to that if you wanted to get plastic.

Downside?
So, for less work and less money you can end up with clean wax, natural cell size and a natural brood nest as far as distribution of cell sizes and drones. What's the down side? If you don't wire the deeps you might end up with more collapsed comb if you have a migratory operation, because of bumpy roads combined with hot days and deep frames, but you could wire them and that would probably not be so much of a problem. You would also need to keep the boxes more level, which in a fixed operation isn't so hard; you just level the stands up, which you should have done anyway. But in a migratory operation it would take more work to level them than to just set the pallets down and not worry about them being level.

Timeline
Worst case timeline is you retool at whatever pace you would have done by the other method anyway. You buy foundation and put it in all the time, right? Some rotate their comb out every five years or less. Some just replace comb as they need comb but either way if you stop using the large cell foundation and stop treating you'll eventually have natural clean comb by the only possible method to get clean comb unless someone finds a source of clean wax and makes their own foundation.
If you have a lot of large cell foundation around, you can sell it to someone local who was going to buy some anyway for the catalog price and save them the shipping. Or, if you're impatient, sell it cheap, if you're willing to take a small loss for healthier bees. You can make up the difference on all those strips that weren't working anyway that you won't have to buy.

Worst case scenario
So let's look at worst case scenario. Let's assume that cell size isn't an issue one way or the other. It's unreasonable to assume that bees will be any LESS healthy on natural sized comb, so at worst they will be on a cell size no better. At worst the cost is less than rotating out your contaminated combs for contaminated wax foundation. There is hardly a down side to that. The WORK is less than wiring wax foundation. The *cost* is less than wiring wax foundation. The wax will be uncontaminated (at least unless or until YOU contaminate it) and we KNOW that wax contamination is contributing to lack of longevity and fertility in queens and drones. So we know the bees will be healthier and the queens will do better.

Best case scenario
This is the worst case scenario on all of the speculation on cell size and natural comb. I think if you're here reading this you probably know the best case scenario, which is that it will solve your Varroa problems.

No Treatments
I don't know what all the rest of you have experienced, but with no treatments (on large cell size) I lost all my bees whenever I wouldn't treat for a couple of years. But finally I lost them even after treating with Apistan. It was obvious that the mites had built resistance. I've heard of big outfits losing their entire operation WHILE treating with Apistan or CheckMite. So we have reached the point where whether you treat or not, they all die anyway quite often. I think the problem here comes down to us not wanting to "do nothing". We want to attack the problem and so we do whatever the experts tell us because we are desperate. But what they are telling us is failing anyway. Once I lost them all AFTER I treated them, I could no longer see any reason to treat them. Treating only perpetuates the problem. It breeds bees that can't survive whatever you are treating for, contaminates the comb and upsets the whole balance of the hive.

Ecology of the hive
There is no way to maintain the complex ecology of a natural beehive while dumping in poisons and antibiotics. The beehive is a web of micro and macro life. There are more than 30 kinds of benign or beneficial mites, as many or more kinds of insects, 8,000 or more benign or beneficial microorganisms that have been identified so far, some of which we know the bees *cannot* live without and some of which we suspect keep other pathogens in balance. Every treatment we dump in a hive, from essential oils that interfere with the bees smell (which is how everything in the dark of the hive is communicated) and kill microorganisms (beneficial and otherwise); to organic acids which kill microorganisms as well as many insects and benign mites to acaracides (which are always just things that kill arthropods which include insects and mites but kill mites at a slightly higher rate); to antibiotics which kill the microflora most of which is either beneficial or benign but useful in maintaining the balance and crowding out pathogens; even to sugar syrup which has a pH that is detrimental to the success of many of the beneficial organisms and advantageous to many of the pathogens (EHB, AFB, Chalkbrood, Nosema etc.) unlike the pH of honey that is much lower and detrimental to the pathogens and hospitable to many known beneficial organisms. I think we've reached the point that it's silly to act like we've been doing any good when the bees are collapsing in spite of, if not because of all of this.

Downside of not treating
So what is the downside of not treating? Worst case is they die. They seem to be doing that regularly enough already aren't they? I don't see that I'm contributing to that by giving them the chance to reestablish a naturally sustainable system. I'm just not destroying that system arbitrarily to get rid of one thing with no regard to the balance of the system. Of the people I know who are not treating for anything even on large cell, their losses are less than those who are treating. On small cell or natural cell they are even less. But even if you don't buy the cell size debate, not treating is working as well as treating is. I go to bee meetings all over the country and hear people who, like me, lost their bees when they were treating religiously and then decided to just stop. Their new bees are now doing better than when they were treating them. I feel bad when I see a dead hive, but I also say "good riddance" to the genetics that couldn't make it.

If you think you'll have too many losses (my guess is you already do have too many losses) and you can't take those losses, what would it take to make splits and overwinter nucs to make up those losses every spring with your own locally adapted stock? A bunch of walk away splits made in the middle of July (after cashing in on the main flow) will usually winter, at least around here, and not put a dent in your honey crop. You can also split the mediocre hives earlier since they weren't doing much anyway and not really affect your honey crop You can also do cut down splits on the strong hives right before the main flow and get good splits, well fed queens, more honey AND more hives.

Upside of not treating
What is the upside of not treating? You don't have to buy the treatments. You don't have to drive to the yard and put the treatments in and drive to the yard to take them out. You don't have to contaminate your wax. You don't upset the natural balance by killing off micro and macro organisms that you weren't targeting but who are killed by the treatments anyway. That would seem like upside enough, but you also give the ecosystem of the bee hive a chance to find some natural balance again. But the most obvious up side is that until you quit treating you can't breed for survival against whatever your issues are. As long as you treat you prop up weak genetics and you can't tell what weaknesses they have. As long as you treat you keep breeding weak bees and super mites. The sooner you stop, the sooner you start breeding mites adapted to their host and bees who can survive with them.

Breeding locally adapted queens from the best survivors
Here's another thing that I don't see a downside to. If you breed from your survivors you'll get bees that are surviving where you are against what they face there. They will mate with the local ferals who are also surviving. The propaganda that you can't raise queens that are as good or better than commercially available queens is just that - propaganda. The same with the need to requeen early in the Spring. Early queens are often not well mated and often not well fed. Assuming you don't treat, you don't requeen regularly and you use your most successful survivors, your queens are more likely to be better because of the following:
They are locally adapted.
They are bred from survivors.
You can raise them at optimum times to have plenty of nutrition and plenty of drones.
They are probably never caged and go from laying in the mating nuc to the hive they are put in with no break. This develops better ovarioles and that makes better pheromones. This results in them be more long lived, laying better patterns, swarming less and being accepted better.
You save a lot of work. If you keep queens longer and mate from those that succeed at superseding at appropriate times you have bees that can requeen themselves. This will save you a lot of labor in finding queens and introducing queens as the bees will take care of this.
Even on the hives you requeen, you can save labor by requeening with cells and not bothering to find the old queen. The new queen will typically be accepted and you didn't have to spend the day looking for the old one.
You save a lot of money. Open mated production queens go for from $15 to $40 and breeders go for much more.
You can easily keep spares in nucs and have queens whenever you need them.

What about AHB?
Those in AHB areas seem concerned about this approach. I'm not in such an area, but it seems to me that ancestry isn't my concern. Temperament is. Productivity is. Survival is. If you only keep the gentle ones and requeen the hot ones I think it will work fine. Those I know doing this in AHB areas have come to that conclusion.

Natural Food
It's quite simply less work to use natural food. If I don't feed pollen substitute in the spring then I don't have to make patties etc. If I don't feed syrup, I don't have to buy sugar, I don't have to make syrup, I don't have to drive to the yards and I don't have to feed it. If I leave them honey to winter on, there is less honey for me to pull, haul home, extract, haul back empty to get cleaned up and then pull off to store, make syrup, drive to the yards to feed it etc. This is less work all the way around. Even if you don't believe that honey is more nutritious to bees (although I have to wonder why you want to produce honey if you think there is no difference between honey and sugar). It is definitely less work to leave it. Even if you believe that the difference in pH is irrelevant (which I seriously doubt), it's less work than making syrup and feeding syrup. Even if you are obsessed with the difference in price ($0.40 per pound for sugar vs. some variable price from say $0.90 to $2.00 pound for honey) by the time you extract the honey, buy the sugar, make they syrup, haul it to the yards, feed it, go back and pull the feeders etc. do you honestly think you came out that far ahead? It's not just a $0.60 a pound difference by the time you factor all of that in, unless your labor is of no value. So let's assume that the difference in the health of the bees is only marginal between honey and sugar and ignore that Nosema multiplies better at the pH of sugar than honey and so does Chalkbrood and EFB and AFB. We'll ignore all of that and just assume it's marginal. If there is ANY difference it could tip the scale from a colony surviving and one dying and packages are up around $80 delivered here.

Pollen
If you don't use pollen substitute you can still leave pollen in the hives and if you really want you can set aside a hive or two or more (depending on the size of your operation) and trap a few pounds of pollen to put in an open feeder in the spring. Just freeze it in the meantime. I put it on a screened bottom board on top of a solid bottom board with an empty box on top with a lid. The screen keeps the bottom dry and the hive keeps it from getting rained on.

Pollen trapping
The cost of trapping is mostly the trap. If you do it in a yard close to or on the way home it's easy enough to empty the traps every night. And now you don't have to buy pollen patties and you have superior nutrition.
If you doubt the difference, look for research on bee nutrition that compares substitutes to pollen. Bees raised on substitutes are short lived and weak.

Synopsis
So what do you have to lose? You can get better genetics for your bees by breeding your own; cleaner comb by using foundationless and no treatments; longer lived bees from clean wax and feeding real pollen; and less work by leaving honey that you won't have to harvest and feed syrup back; and the worst case is that to get all this you'll work less and the best case is that it will all have a markedly positive affect on the health of your bees. Worst case, if you implement this a little at a time, you lose some bees, which you're already doing. Best case you lose less.

Profit formula
Let's try a different profit formula. How much time, gas, work, and money do you spend on syrup, feeding, putting in patties, putting in treatments, taking out treatments, harvesting that last little bit of honey that you then have to make up with syrup, putting in foundation etc.? How much money and time would you save if you stopped doing all of that? How many more hives could you handle and how much more honey would they make?
Michael Bush
bees@bushfarms.com

How to do Splits

What is the desired outcome?

I would choose my method for doing a split depending on what you want for an outcome.

Reasons for doing a split:

- To get more hives.
- To requeen.
- To get more production.
- To get less production (for people who don't want too many hives or too many bees).
- To raise queens.
- To prevent swarms.

Timing for doing a split:

As soon as commercial queens are available, or as soon as drones are flying depending on if you want to buy or raise queens you CAN do a split. It depends again on what you want for a outcome.

There are an infinite variety of methods for doing a split. Many of these are because of the desired outcome (swarm prevention, maximizing yields, maximizing bees etc.) Some of the variations are also due to buying queens or letting the bees raise queens.

The simple version is to make sure you have some eggs in each of the deeps and put them facing toward the old location. In other words put a bottom board on the left facing the left side of the hive and one on the right facing the right side of the hive and put one deep on each and maybe an empty deep on top of that. Put the tops on and walk away.

There are an infinite number of variations of this.

The concepts of splits are:

You have to make sure that both of the resulting colonies have a queen or the resources to make one (eggs or larvae that just hatched from the egg, drones flying, pollen and honey, plenty of nurse bees).

You have to make sure that both of the resulting colonies get an adequate supply of honey and pollen to feed the brood and themselves.

You have to make sure that you account for drift back to the original site and insure that both resulting colonies have enough population of bees to care for the brood and the hive they have.

You need to respect the natural structure of the brood nest. In other words, brood combs belong together. Drone brood goes on the outside edge of the brood and pollen and honey go outside that.

The old adage is that you can try to raise more bees or more honey. If you want both, then you can try to maximize honey in the old location and bees in the new split. Otherwise most splits are either a small nuc made up from just enough to get it started, or an even split.

Kinds of splits

An even split. You take half of everything and divide it up. Face both of new hives at the sides of the old hive so the returning bees aren't sure which one to come back to. In a week or so, swap places to equalize the drift to the one with the queen.

A walk away split. You take a frame of eggs, two frames of emerging brood and two frames of pollen and honey and put them in a 5 frame nuc, shake in some extra nurse bees (making sure you don't get the queen), put the lid on and walk away. Come back in four weeks and see if the queen is laying.

A typical split. Same as above, but you either introduce a queen you bought or walk away and let them raise their new queen. If you introduce a queen they will be three weeks ahead of the hive that is raising their own, so you will have to put them in a larger box than a nuc to start with.

Swarm control split. Ideally you want to prevent swarming and not have to split. But if there are queen cells I usually put every frame with any queen cells in it's own nuc with a frame of honey and let them rear a queen. This usually relieves the pressure to swarm and gives me very nice queens. But even better, put the old queen in a nuc with a frame of brood and a frame of honey and leave one frame with queen cells at the old hive to simulate a swarm. Many bees are now gone and so is the old queen. Some people do the other kinds of splits (even walk away etc.) in order to prevent swarming. I think it's better to just keep the brood nest open.

A cut down split.

Concepts of a cut down: The concepts of a cut down are that you free up bees to forage because they have no brood to care for, and you crowd the bees up into the supers to maximize them drawing comb and foraging. This is especially useful for comb honey production and more so for cassette comb honey production, but will produce more honey regardless of the kind of honey you wish to produce.

This is very timing critical. It should be done shortly before the main honey flow. The purpose is to maximize the foraging population while minimizing swarming and crowding the bees into the supers.. There are variations on this, but basically the idea is to put almost all the open brood, honey and pollen and the queen in a new hive while leaving all the capped brood, some of the honey and a frame of eggs with the old hive with less brood boxes and more supers. The new hive won't swarm because it doesn't have a workforce (which all returns to the old hive). The old hive won't swarm because it doesn't have a queen or any open brood. It will take at least six weeks or more for them to raise a queen and get a decent brood nest going. Meantime, you still get a lot of production (probably a lot MORE production) from the old hive because they are not busy caring for brood. You get the old hive requeened and you get a split. Another variation is to leave the queen with the old hive and take ALL the open brood out. They won't swarm right away because the open brood is gone.

Confining the queen. Another variation on this is to just confine the queen two weeks before the flow so there is less brood to care for and free up nurse bees to forage. This also helps with Varroa as it skips a brood cycle or two. This is a good choice if you don't want more hives and you like the queen. You can put her in a regular cage or put her in a #5 hardware cloth push in cage to limit where she can lay. They will eventually chew under the hardware cloth cage, but it should set her back for a while.

Cutdown Split/Combine. This is a way to get the same number of hives, new queens and a good crop. You set up two hives right next to each other (touching would be good). Two weeks before the main flow you remove all the open brood and most of the stores from both hives, and the queen from one hive, and put it in a hive at a different location (the same yard is fine, but a different place). Then you combine all the capped brood, the other queen, or a new queen (caged), or no queen and one frame with some eggs and open brood (so they will raise a new one) into one hive in the middle of the old locations so all the returning field bees come back to the one hive.

Frequently Asked Questions about splits

How early can I do a split?

It's very difficult for a split to build up unless it has an adequate number of bees to keep the brood warm and reach critical mass of workers to handle the overhead of a hive. For deeps this is usually five deep frames of bees with three of them brood and two of them honey/pollen in each part of the split. For mediums this is usually eight medium frames of bees with five of them brood and three of them honey/pollen. I'd say you can split as early as you can put together nucs that are this strong. Later in the year when it's not frosting occasionally at night, you could get by with somewhat less, but you'll still do better with this much.

How many times can I split?

Some hives you can't do any splits as they are struggling and never get on their feet. Some hives are such boomers that you can do five splits in a year, although you probably won't get a honey crop.

How late can I do a split?

What you really need to ask yourself is "when is the best time to do a split". By the bee's example that would be sometime before the main flow so they have a flow to get established on. However this tends to cut into your harvest, so you could do them right after the main flow and probably still have time to build up for the fall, if you make them strong enough and give them a mated queen.

I'm in Greenwood, Nebraska. In a year with a good fall flow, I can do a split on the 1st of August that may build up enough to overwinter in one or two eight frame medium boxes. But if the fall flow fails they may not build up at all.

Michael Bush

Splitting Hives

by Donnie Chapman

Keep in mind most all beekeepers do things different. What works for one person is not necessarily the best thing for someone else. What is easiest for a commercial beekeeper is not the best thing to do if you're a hobbyist and vise-versa. What works best for a hobbyist is not practical for a commercial beekeeper. Always pick what works best for you and suits your needs. Don't be afraid to experiment, but do not put everything you've got into experiments until you know it will work.

We split to…

Increase our number of colonies

Prepare for pollination

Swarm control (creating an artificial swarm so we do not loose bees)

Make Nuc's to have spare queens on hand or to have spare bees to boost weak colonies

First of all, remember that bees are insects. They have little bee brains. They act on bee instincts. A bee's instincts are basically two things, #1, care for and protect their brood, and #2, gather food. Both ensure survival of the colony. Insects can't be trained to do exactly what we want them to do. It is best to observe the bees at work, then try to think like a bee. Compromise and develop a way allowing the bees to do what comes natural to them, but, on our terms.

Bees live in our hives because we make conditions right for them, like pests (roaches, ants, spiders, scorpion's etc.) will live in our homes. We place removable frames in our hives, allowing us easy inspection of the colony. We place supers over the colony for our convenience. These things are not a true part of nature, but the bees meet us halfway and tolerate our intrusion.

North Florida Maple blooms usually occur in January. Spring Titi is almost a sure thing, blooming in late January, February, and March. Both of these plants are early nectar sources, allowing colonies to build strength for the spring nectar flows. When these plants bloom, it is an excellent time to split colonies. Weather is the main obstacle. Cold spells and frost can be harmful to the bees and blooms.

Bees can be fed pollen substitute and syrup, (corn or sugar), to encourage early brood rearing to prepare for splits. Queens may be purchased or the bees can be allowed to make their own queen. Don't put a lot of worry into spending money on queens. The sale of two jars of honey will cover the cost of a queen. It is well a known fact, bees will make a queen from an egg if something should happen to their queen. Bees in a split colony will do the same thing when there is no queen present. If planning to allow the bees to make their own queen, select the colony you wish to split. Consider the traits you like in certain colonies such as, honey production, gentleness, housekeeping etc. Queens made by the bees in the split are usually superior to any queens you can buy. Also feed other colonies with desirable traits to encourage their brood rearing so drones will be available. Drones should be hatching from drone cells when the splits are being made to breed queens. You want the drones to be a couple of weeks old when the queens hatch.

My preferred method of splitting colonies is using a double screen board. A double screen board can be made by using a piece of plywood 16 ¼" x 20", with a 6"x 6" hole cut in the center. Cover the hole on both sides with a metal screen. Metal screen is easy to clean with a blow dryer if it becomes clogged, and the bees can't chew through it. Double screen boards can also be made from ¾" square boards or by ripping ¾" rings off of old supers with a table saw, and covering both sides with screen. Either kind needs a spacer put around it on one side, making the double screen board look like a thicker than normal inner-cover or bottom board without an entrance on one end. A 3/8" to ¾" space needs to be cut into one end of the double screen board for an entrance.

Select the colony you wish to split. Move two or three frames of brood into the center of a new box. The frames should contain eggs, larva and capped brood and be covered with nurse bees. Place a frame of honey and pollen on each side of the brood and fill the rest of the box with frames of comb or foundation. Place frames of comb or foundation in the empty spaces in the parent colony. The bees in the parent colony will rebuild their brood nest. Place the double screen board on top of the parent colony with the spacer up and the entrance to the rear. Place the split on top of the parent colony and put a hive cover on the split. A feeder placed above the split's brood nest is not a bad idea.

The bees above the double screen board will soon find they are queenless, and start to make a new queen. If you purchased a queen, introduce the queen cage in the split a few hours after splitting. If you plan to have the bees make a new queen, check in 3 to 4 days and make sure there is a queen cell present. If no queen cell is present, add another frame containing eggs to the center of the brood nest in the split. Handle the frames containing queen cells carefully. Do not shake or bump these frames. An indication of a superior queen will be eggs in the brood nest no longer than 15 days after she hatches.

The double screen keeps the bees on opposite from trying to feed each other and keeps the queens from fighting. Most important it allows the heat created by the parent colony to rise and help keep the split colony above nice and warm.

This method of splitting can also be used if you find queen cells in a colony while doing routine inspections. Just put the frame with the queen cell and nurse bees above the double screen board. Soon you will have another colony.

If the split should fail, lightly smoke the bees and remove the double screen board. The colony will be reunited and nothing but your time is lost. If the split was made by putting the brood in another box in the apiary, and the split failed, moths quickly move in and destroy the comb, with you wasting more time cleaning the mess up.

The weather and available food effect bee biology. A couple of things to consider if allowing the bees make their own queen are; will the new queen build a colony strong enough to produce a honey crop when the honey flow arrives? And, are their drones in the apiary to mate the new queen?

A queen takes 16 days to hatch from an egg. It is usually 7 days, (sometimes three weeks) until she has been mated and lays her first egg. 21 days later, a worker bee will emerge. The new worker spends a day or two as a cell cleaner. She then feeds and caps brood until she is 11 days old. From 11 days to 21 days old, she works as a house bee, grooming and feeding other bees, storing food, building comb, ventilating and performing guard duties. At about 21 days old, she will become a forger, working in the field collecting pollen and nectar. On a heavy honey flow, she might live to be 6 weeks old before she wears her body out and dies.

The life cycle needs to be mentioned because it is important to have a strong colony with a force of field bees when the main honey flow starts. A colony boiling over with nurse bees only, will not make a honey crop. If the bees make their own queen, it will be 65 to 79 days before she puts a worker in the field.

16 days for the queen to hatch

7 to 21 days to mate and start laying

21 days for the egg to hatch

21 days to become a field bee

65 to 79 days

If you wish to have a colony ready to gather nectar on April 15 when Tupelo starts to bloom, the split needs to be made by February 10. Of course, the weather can change bloom dates by a week or more. If you purchased a queen, she will be putting bees in the field about 42 days after she is released from the queen cage. But, remember, the best queen will be made by your bees.

A field force can be added to the split after the queen has started laying quite easily, but, there will still be "down time" as for colony strength. Simply add workers to the split by replacing the parent colony with the split and moving the parent colony to another apiary at least 2 miles away during the daytime. Any returning field bees will move into the split since it is now where their home once was. The parent colony and split share hives odors, so no or little fighting will occur. If the parent colony is not moved far enough away, most of its field bees would move into the split, leaving the parent colony short of field bees.

ber. These supers may vary in size from full-depth supers (deep hive bodies) to the shallow or section comb supers (see the figure on super sizes). There is no hard-and-fast rule about which super size to use; personal preference, one's physical strength, and the quantity of the expected surplus should be your guide. Some beekeepers keep all hive furniture the same size so they don't have to mix and match different sizes of supers and frames or foundation. There are pros and cons to mixing or to keeping the super sizes the same, so chat with some beekeepers about which super sizes are best in your region.

Rules for Supering

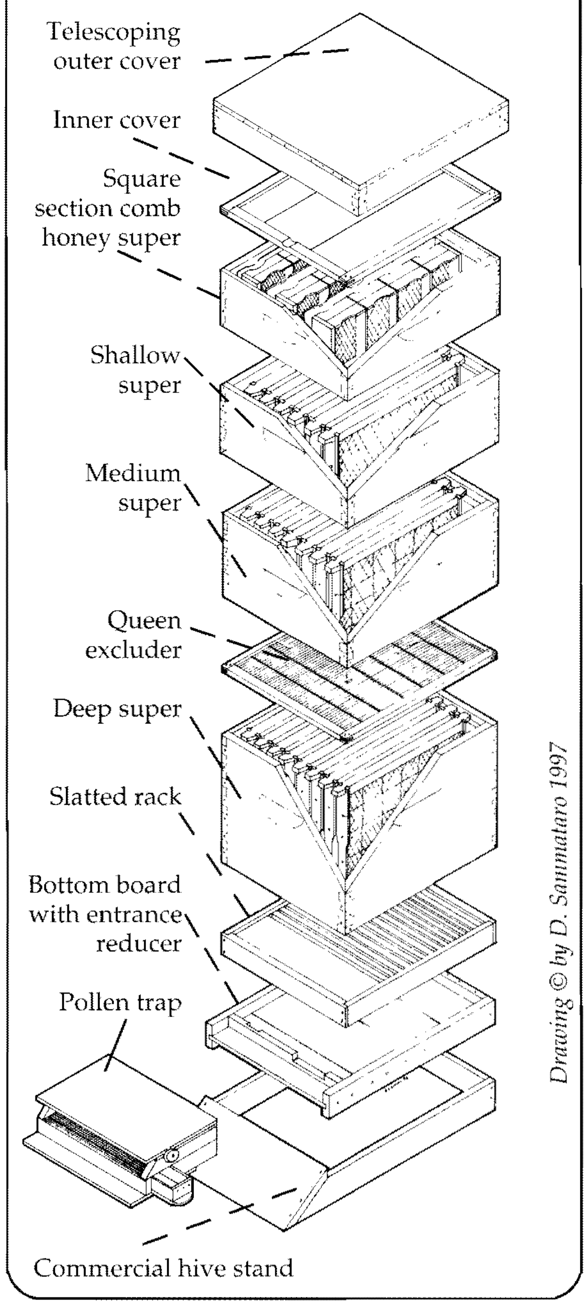
The most important rule for supering is to keep the queen out of the honey supers. The presence of brood would make the honey (when extracting) unsanitary because of larvae and pupae floating in the tank, and brood would be wasted. In addition, it is difficult to cut away the cappings of brood combs that have been darkened with propolis. Cull any dark and old frames and save them for other uses, such as bait for swarm traps; otherwise, melt them down for the wax.

Use one of the following methods to restrict the queen from laying in the honey supers:

- Place a queen excluder above the broodnest (see the figure on beehive components).
- Place a super of light-colored comb or foundation above the broodnest; as long as the queen is not crowded for space, she will prefer to lay her eggs in the darker comb.
- Keep a hive body filled with honey directly above the broodnest. Such a honey barrier often keeps the queen from moving upward.
- Place a section comb honey super above the broodnest; queens generally will not lay in the section boxes.

Some general guidelines for supering bees during a honeyflow are:

Beehive Components



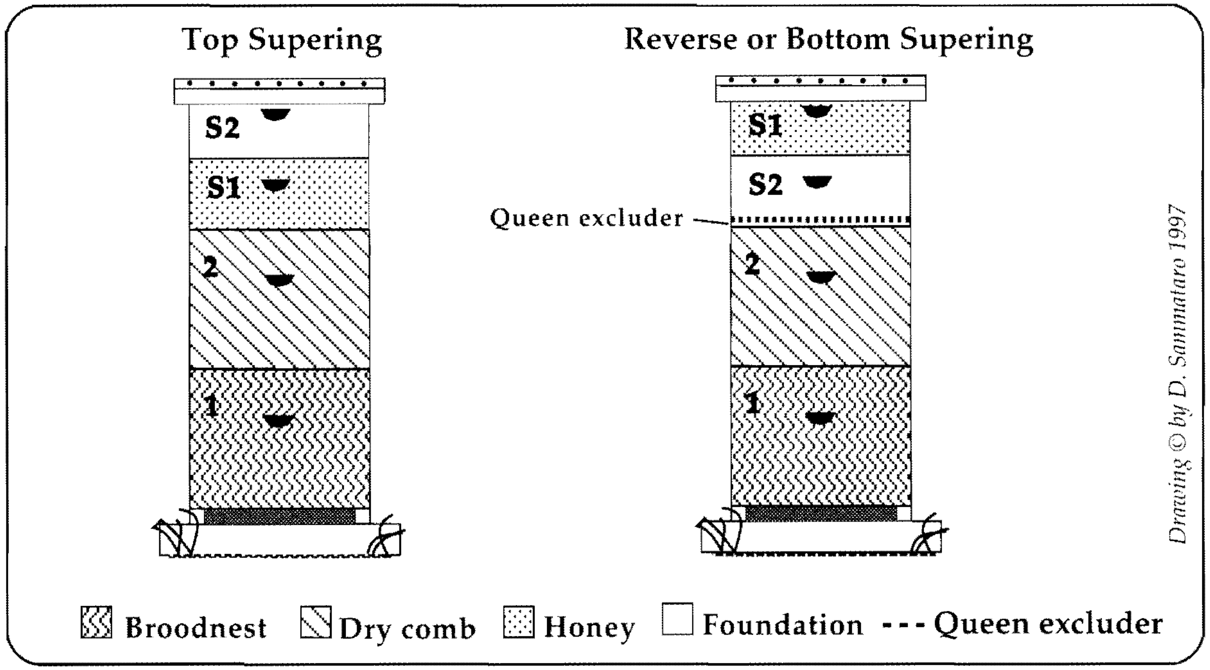
- Stagger the honey supers to hasten the ripening of honey, especially in hot, humid areas.
- Use only eight or nine frames in the supers destined to be extracted, so the bees will draw the foundation out wider than normal; this makes it easier to cut the cappings off when extracting honey.
- Bait an empty honey super with one or two frames of capped or uncapped honey if the bees seem reluctant to move up; this will attract bees to move into the super.
- Some beekeepers use drone comb foundation in their honey supers: the cells are larger, and honey seems to extract readily from them. Drone foundation can be obtained from bee supply houses.
- Rearrange frames in supers, periodically, so the full ones are at the ends and the empty ones are in the middle (bees fill the middle ones first). Doing this will buy you time if you run out of supers and the bees are filling only the center frames.

Methods of Supering

There are two basic ways to super for honey: reverse supering and top supering (see the figure on supering).

Reverse or Bottom Supering. This method generally requires a queen excluder to keep the queen from laying in the honey supers (see the figure on p. 74) and can also be used for comb honey production. A super with foundation or dry combs (S2) is always placed below a super at least one-half full of honey (S1). Because the emptier supers are on top of the broodnest, the queen excluder is necessary. As the supers are filled, they are taken off, or full supers can be stored above emptier ones.

Top Supering. This method does not require a queen excluder, because the queen rarely will go into a super full of honey. Put supers with dry comb or foundation (S2) *above* honey supers that are at



least half filled with honey (S1). Keep adding supers as the bees fill the ones below, until you take the honey off in the fall.

There are many methods of supering using these two themes; talking with local beekeepers may be helpful in determining how to super in your particular area. Success of either method often depends on the type of honeyflow in your location—fast and quick or slow and long. Fast and quick flows will enable you to make comb honey; slower ones should be reserved for extracted honey. See also figures on pp. 75 and 76.

Comb Honey

Harvested honey can be left in the comb or extracted from it. Honey in the comb is referred to by various names. Normally found at fairs and honey shows, *bulk comb honey* is an entire frame of capped honey that is packaged without cutting. If the honey-filled comb is cut and packaged, it is referred to as *cut comb honey.* Cut comb placed in a bottle that is then filled with extracted honey is called *chunk comb honey.* Comb honey contained in small wooden frames (section box), plastic rings (Ross Rounds), or plastic boxes (Half-Comb Cassettes) that is not cut out of the frames is referred to a *section comb honey* (see Chapter 12).

Foundation for the bulk, cut, chunk, and section comb honey should be the thin, unwired type. As soon as the combs are sealed, they should be removed from the hive to prevent the white cappings from becoming darkened with propolis, soiled by travel stains, or damaged by wax moths or the bee louse, which lays its eggs in honey caps.

The supers containing frames for comb honey production should be placed only on the strongest colonies, either those consisting of two brood chambers or colonies reduced to one brood chamber (as described for the production of section comb honey in the chart on p. 77). Place an excluder above the broodnest and super the hive using the same rotation as that illustrated for reverse supering. It is a good idea not to mix the comb honey supers and the extracting honey supers on any one hive, although if the honeyflow is very fast and strong, the bees will fill any available space quickly. Some bee races fill section boxes rapidly and with very white cappings—such colonies should be reserved for section comb honey only.

SUPERING FOR SECTION COMB HONEY

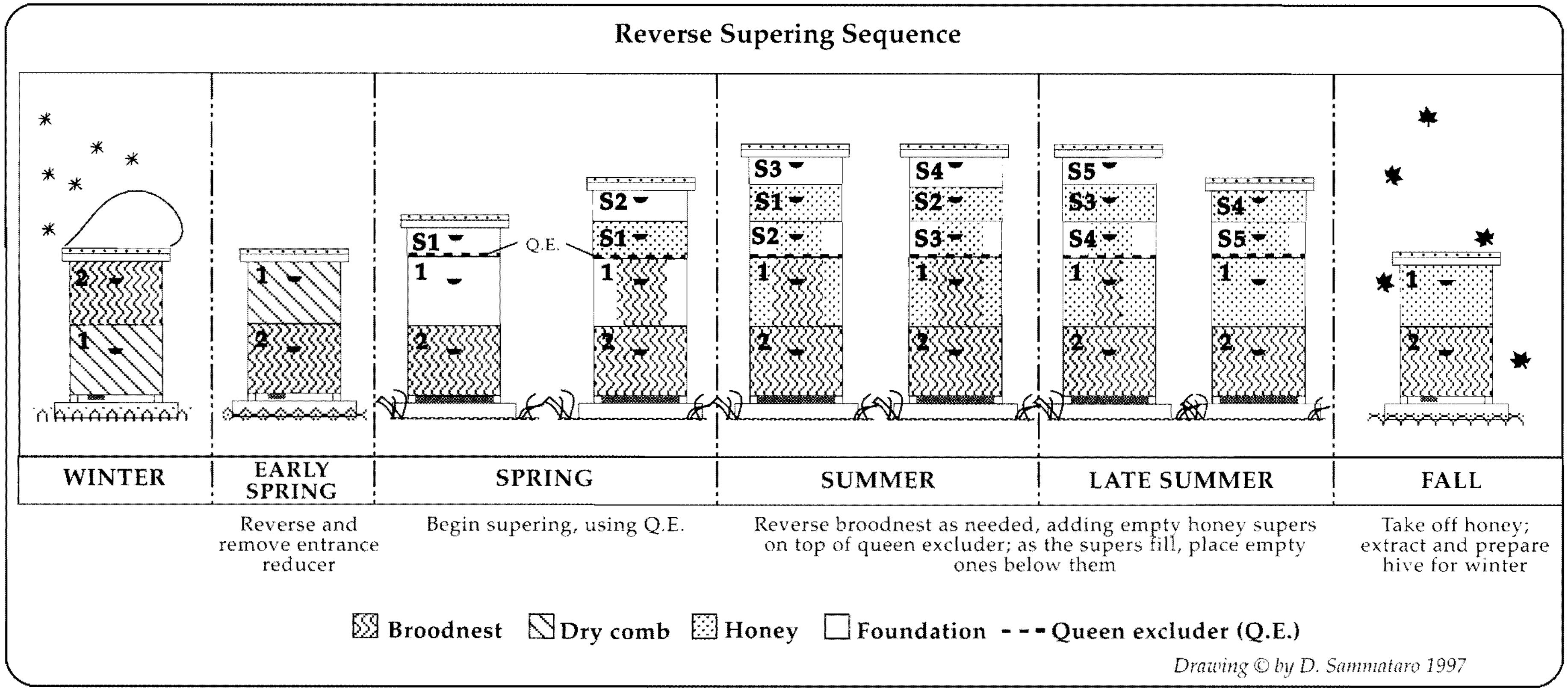
Comb honey, especially section comb honey, is difficult to produce because success depends on a heavy honeyflow, exceptionally strong colonies, and time-consuming hive manipulations at the correct intervals. The Miller method of supering is one that is used for section comb honey; this is described below and is illustrated as method A in the chart on page 77.

A colony used for section comb honey production is generally wintered in two deep hive bodies (1 and 2). In the spring, this colony must be built up to full strength before the major honeyflow, and the brood chambers should be reversed to provide ample room for the queen to lay. This may need to be done several times to maintain enough room for the queen.

As soon as the honeyflow begins, reduce the strong two-story colony to one deep (2). Set up this colony so it contains two empty brood frames (in the middle) and as many frames of capped brood as possible on either side, with accompanying queen and worker bees.

Follow this procedure (method A):

Step 1. Reduce hive to one deep (2); frames of honey and any remaining brood frames should be given to other colonies.



Step 2. Over the reduced hive (2), place the first section super (ss1), with thin foundation in the section boxes or rounds (or half-comb cassette supers that require no foundation).

Step 3. When ss1 is one-half full of honey, place a second section super (ss2) below it.

Step 4. When ss1 is almost filled, reverse it with ss2 (so the full super is above the empty one).

Step 5. If the honeyflow is strong, add a third (ss3) (and, later, subsequent supers) above the broodnest until ss2 is half filled, then reverse again so the full supers are above the emptier ones. Before placing another empty super on top, make sure the section supers are full from end to end, or the bees may funnel up the center, ignoring the end frames. You can correct this (the chimney effect) by removing the full frames or rearranging the super so the full frames are on the ends and the emptier ones in the center.

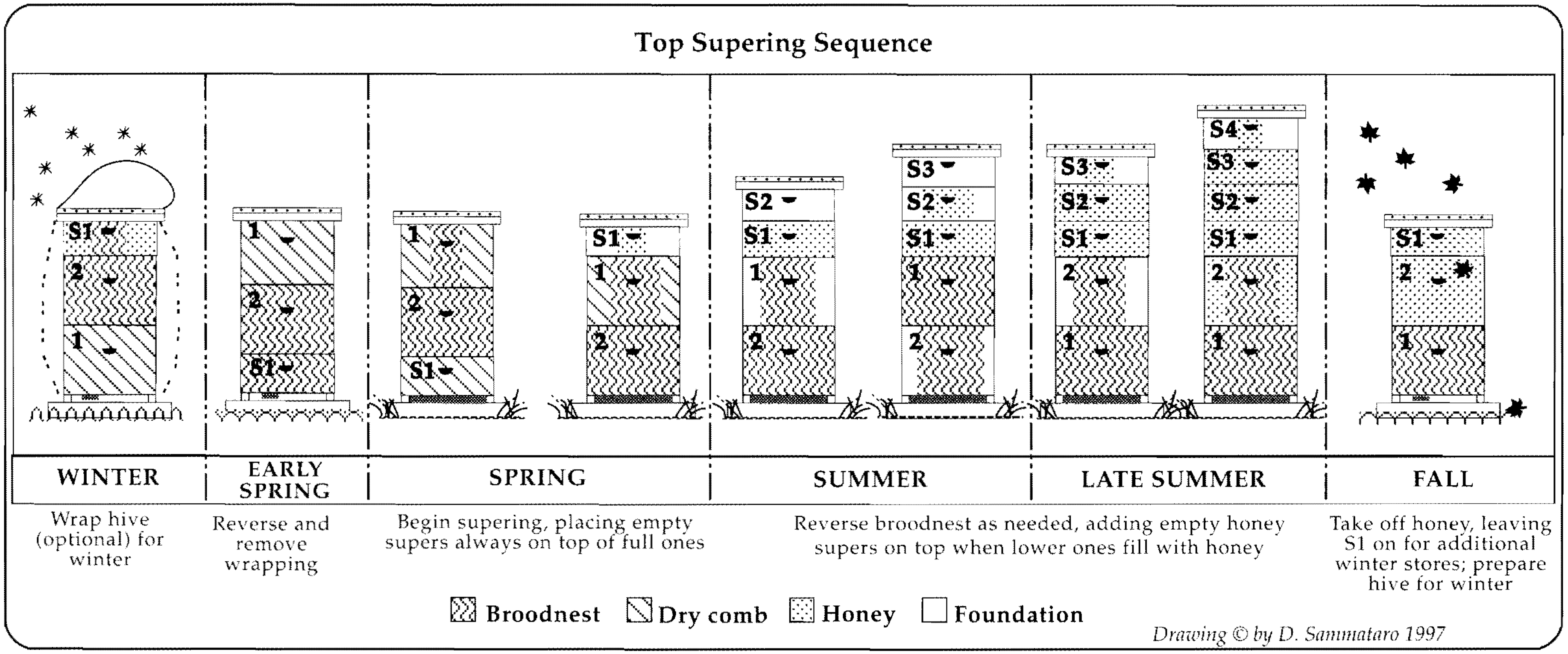
Step 6. Remove the completely filled section supers either as they are filled or all at once. Use bee escapes to clear the bees out of the supers. Fume boards are not recommended because the honey might be adversely flavored.

Method B is slightly different: use a queen excluder and a single deep brood chamber plus a shallow super. The idea is always to have a full honey super above the section boxes so as to encourage the bees to move upward.

Comb honey should be marketed as soon as possible to reduce the danger of its granulating or being damaged by wax moths or the bee louse (*Braula coeca*). Storing comb honey in the freezer will help eliminate these problems (see Chapter 12). After the honeyflow is over and the section comb honey production ceases, take off all section supers and unite the reduced colony with another hive or otherwise allow it to build up enough stores to overwinter in two deep hive bodies.

Harvesting the Honey

In some regions, two crops of surplus honey can be expected, one in the summer and another in the fall. Some beekeepers harvest the summer and fall



crops separately; others harvest both at the end of the fall honeyflow. Recently, it has become necessary to treat bees again in the fall with Apistan strips to control varroa mites. It is advised to take off honey supers as soon as possible, rather than leaving them on the bees until late fall.

Average yields of surplus honey depend on the amount of open land filled with honey plants. Yields vary from as low as 25 pounds of surplus per colony to over 100 pounds. For hives located in temperate climates, 90 pounds or more of honey should be left on for overwintering each colony (see "Wintering" in Chapter 8).

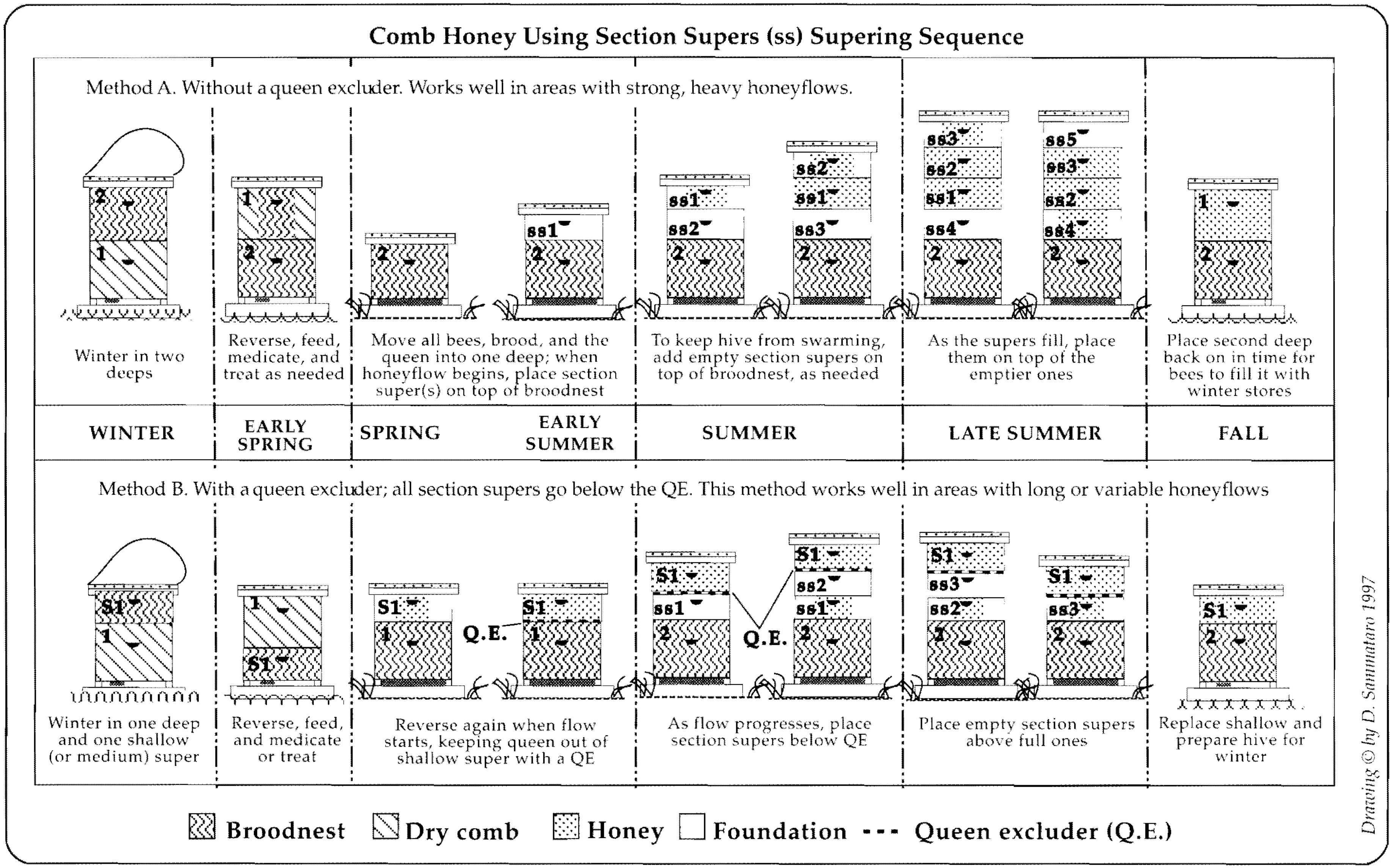
Today, the populations of varroa mites are at their height when beekeepers take off the late-summer honey harvest. Consider taking off your honey a little earlier in order to treat your hives with Apistan strips, thus allowing enough time for the strips to work for two bee generations and still be removed before winter. For more information, see "Varroa Mite" in Chapter 13.

REMOVING BEES FROM HONEY SUPERS

The five methods given below describe ways of removing bees from honey supers. Honey supers are often free of bees when it gets very cold (in the early fall), because the bees leave the supers to join the warm cluster below. But remember, once you commit yourself to taking off honey, be prepared to extract or otherwise process your honey in a few days. You cannot store supers of capped honey for very long, unless you freeze them, because of the danger of wax moth or braula infestations.

A good tip to make honey removal less messy is to go to your hives the day before you are removing honey and break apart the supers (or clean off the honey-filled burr comb). By at least breaking the seal, the bees can clean up any dripping honey before you remove the supers. But this works only if you have fewer than 30 colonies; otherwise, it is too time consuming.

Shaking or Brushing. Remove a frame with sealed honey from the super and shake the bees off in front of the hive entrance, or gently brush off the bees with a soft, flexible bee brush or a handful of grass. Allow the bees to fall at the hive entrance. Then place the frames, free of bees, into an empty su-



per and cover it with burlap or a thick, wet cotton sack (robbing cloth) to keep out robbers. If robbing is particularly intense, an additional cloth might be needed to cover the super you are working. If robbing becomes unmanageable, put the honey frames into a vehicle and close all doors and windows; stop taking honey from colonies in that apiary for the day.

Advantages:

- Able to select frames containing capped honey (honey covered by thin layer of wax).
- Relatively easy if bees remain calm and only two or three colonies are involved.
- Inexpensive.

Disadvantages:

- Timing is critical to avoid robbing.

Spring management changes.

The inspection should accomplish the following:

1. Discovery of possible disease problems and insertion of preventive medication.

2. Inventory of honey stores and addition of feed.

3. Assessment of the queen's strength.

4. Reversal of brood chambers and partial cleaning of hive components.

Because the colony has been living in the upper box for most of the winter, it's a good practice to reverse the positions of the boxes at this time. This relocates the queen and most of the brood into the lower box, encouraging more efficient use of the available space. The queen tends to move upward during the year and needs some encouragement to stay in the lower two boxes. While making this switch, scrape the bottom board to remove the winter's accumulation of trash and dead bees.

Each frame should be inspected for evidence of disease and amount of honey stores. Hold the frame directly over the hive so that if the queen happens to fall off the frame you are inspecting, she won't be lost. It's not necessary to find the queen to assess her strength; the quantity and pattern of her egg laying are sufficient evidence. Depending on the mood of the bees, use this time to scrape off excess propolis and burr comb from the frames and hive bodies to make future frame removal a little easier.

Frame Rotation

If brood laying has been strong, rotation of the frames can be started. This procedure benefits the hive in two ways; it works the outside frames into the active center of the hive to encourage cleanup of possible disease while under medication and, it concentrates the brood into the bottom box and discourages the queen from moving up so rapidly. A word of caution; don't rotate the frames in such a manner that the brood nest will be split apart by frames without brood.

When both hive bodies are almost filled with honey or brood a new super should be added. Do not use a queen excluder. It is important at this time that the queen and bees have free access to all the space they can use. The queen excluder, if used, should not be added until the nectar flow has started and then it should only be added under a super in which the bees are well established with brood and honey. The queen excluder is widely misused. It is usually placed on the colony too early so the bees hesitate to go into the supers. The hive body or brood nest becomes overcrowded with honey, and the colony is likely to swarm. Once they are established in a super, bees usually continue to work even through a queen excluder.

It is possible to operate bees without a queen excluder if supers are added properly for extracted and comb-honey production, but not cut-comb honey. Top-supering (adding the empty super on top of the colony) is recommended. The new empty super is added when the bees are well established in the last super. Stop adding supers before the end of the nectar flow so that bees will fill and seal the combs and force the queen and brood out of the super. When no queen excluders are used, it is important that the beekeeper know about the plants from which bees gather nectar, as well as the time and length of the nectar flow.

PURDUE UNIVERSITY

PURDUE EXTENSION

4-H-593-W

4-H Beekeeping

Division III

Year in Project: ________________

Date Started in Beekeeping III: ______

Name: ________________________________

Club: ________________________________

County: ______________________________

Advanced Beekeeping Methods

Purdue Extension
Knowledge to Go
1-888-EXT-INFO

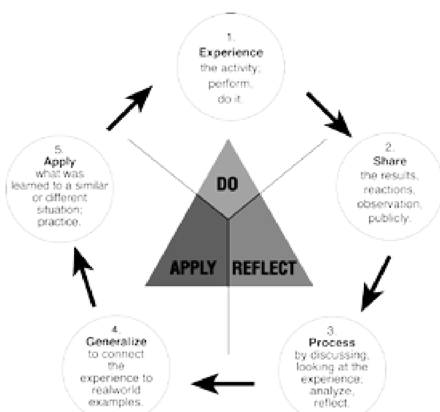
4–H Beekeeping, Division III: Advanced Beekeeping Methods

The 4-H beekeeping project is intended to help you learn about bees and how to be a beekeeper. Beekeeping offers many hands-on educational experiences, from learning about bees and honey plants, to learning to raise bees and produce honey, to learning how to market your honey.

If you have completed the 4-H beekeeping manuals, *Division I, Understanding the Honey Bee,* and *Division II, Working with Honey Bees,* you are now experienced and knowledgeable enough to study more advanced topics. These may include increasing the number of your honeybee colonies, increasing honey production, producing special kinds of honey, and learning more about the bee societies. If you have not studied the Division I and II beekeeping manuals, you should review them and start slowly in *Advanced Beekeeping*.

Note to Parents and Volunteer Leaders:

The 4-H beekeeping project helps youth learn about raising honey bees. Beekeeping offers many exciting educational experiences, from learning about bees and honey plants to learning to raise bees to make and sell honey. The *4-H Beekeeping Leader's Guide* (4-H-576-W) has information about youth development stages, experiential learning, and other resources that might be useful. The learning experiences in this manual have been planned to initiate "experience centered" activities. Youth are encouraged to take responsibility for their beekeeping projects. They can enhance their learning by consulting resources on the Internet, at school, and at the library, or by talking to someone who raises bees.



Experiential learning distinguishes 4-H youth development education from many formal educational methods. Activities are designed so youth experience a learning activity, reflect on what they did (explore the meaning of the activity), generalize what they learned (to test the 4-H members' comprehension and appreciation of the activity), and then think about how they can apply what they learned to other situations (generalize). You can help guide youth as they explore each activity by discussing each section.

Purpose

Division III Beekeeping is intended to help youth learn many things, including
- how to increase the number of their honeybee colonies;
- how to increase honey production, producing special kinds of honey;
- more about the bee societies;
- how to compile beekeeping records;
- how to present the results of their work to others; and
- how to develop inquiring minds — the habit of asking questions and searching for answers.

Authors

- Greg Hunt and Natalie Carroll
- Reviewer Larry Segerlind

Advanced Beekeeping Methods

Table of Contents Page

Introduction

When you feel confident in your ability to maintain a beehive throughout the year and have been successful in producing surplus honey, you are ready to undertake more complex and difficult projects with your bees. In *Advanced Beekeeping*, you will continue to develop your skills as a beekeeper. Good beekeepers not only care for their colonies, but also manage them to increase honey production.

Your goals for advanced beekeeping should be
- keeping strong, populous colonies with young queens,
- continuing to improve your understanding of the ways of bees, and
- experimentation.

As your beekeeping experience increases, your ability to work more quickly and competently also increases. You will be able to add new hives to your small original apiary until it contains the maximum number of hives that you can care for. Good beekeepers know what their maximum apiary size should be and do not try to overextend themselves. To determine the number of hives you can tend, you will need to consider a variety of factors: time, expense, space considerations, your own physical condition, local climate, etc. The maximum number of hives differs from beekeeper to beekeeper. For a hobby, the maximum may be two hives; for a young farmer, it could be 200.

To achieve the greatest amount of honey production, you must realize that your beehive is a dynamic, changeable system with much potential for growth. Be alert to the apiary operations that can be improved and consider experiments that will help you understand more about your bees. As you learn more, you will be able to help your bees produce more honey.

Although you have had some practical experience in beekeeping, you should not neglect the help that other beekeepers can still give you. As you continue this project, the advice of more experienced people will be as valuable as it was the first time you watched a beehive being opened. Continue to read all you can and to take your questions to your beekeeping advisor, local bee inspector, and local and state associations.

In the *Advanced Beekeeping* project, you are in charge. No longer will you be told what to do and when to do it. No longer will you be asked specific questions to show your understanding of a concept or procedure. Now you are basically on your own. You choose your activity, do it, and when you believe you have mastered it, move on to another.

Projects

The project suggestions given later in this manual are just that: suggestions. They are intended to develop your beekeeping skills. You can pursue any beekeeping project of your own design. Choose one that fits your own interests and the needs of your bees. See the list under Project Suggestions for ideas. Select a project that you are interested in and read about it. If you are still interested, begin work on the project. Undertake as many activities as you think you will be able to complete, but do at least two projects each year. Keep a notebook with an up-to-date description of your work. With the aid of a beekeeping diary, you can write a detailed report explaining your project from start to finish. Consider taking photographs, making drawings, or using other ways of adding to the explanation of your activities.

Use the Resources section to find sources of information. Many projects may be done using the **Scientific Method** (page 33). Following the steps listed for the scientific method helps to organize your thoughts and experiment. This makes for a nice comparative project. Make your own data sheet following the five steps listed.

An **Action Demonstration** (page 34) is a good way to show others what you have learned and to interest them in beekeeping. Read the action demonstration guidelines in this manual for ideas about how to present and score your demonstration. Ask your county Extension educator about doing an action demonstration at the Indiana State Fair, if you are interested in doing that.

Resources

There are two books that are recommended for the serious beekeeper, *Honey Bee Biology and Beekeeping* and *The Hive and the Honey Bee*. These books contain a lot of information about bee biology and products of the hive, including most of the information a beekeeper would ever need. Therefore, it is a good idea to purchase a copy of one of these books or to make certain that your local library has one. *Honey Bee Biology and Beekeeping* is the better one, but is more expensive. See the Resources section of this booklet for ordering information and for information on subscribing to a beekeeper trade journal.

Record Sheets

Keeping accurate records is important. Records help you remember what you did and evaluate the success of your work. They also help you keep track of how much time and money you are spending on your beekeeping project. The record sheets given in the manual may be copied, or you can use them as guides to create your own record sheets.

Managing Honey Bee Colonies

Choosing a Good Apiary Site

The site you choose for your apiary should have plenty of floral sources within two miles of your hives. In much of the Midwest, wild clover will be a major source of nectar for your bees. Any place that has a mixture of trees and unplowed fields is good. There should be water available within a quarter mile of the hives. The apiary should be accessible at all times of the year. The hives should be placed on hard, dry ground that you can drive up to in a truck. It is best to place the bees near some trees that block the wind from the west and on a slight hill to avoid frost pockets. A protected site with good air drainage will improve the chances that your bees will survive over the winter.

Increasing the Number of Colonies

You can make an increase in your colonies by either buying nucs, installing package bees, or dividing your existing colonies.

Buying nucs

Purchasing nucleus hives or “nucs” is a very good way to increase your colonies. The nuc is a small hive of three to five frames containing comb with bees, brood, honey, and pollen. A nuc will build up more quickly than a package of bees that is installed on foundation, because there already are some capped brood and empty cells where the queen can lay eggs. Nucs purchased locally are more likely to have queens that produce bees adapted to your local conditions. Ask at beekeeper meetings or look on the Internet for beekeepers that sell nucs. Usually, you will need to supply the brood box and enough frames with foundation or comb to fill out the box.

Installing Packages

Sometimes you cannot find a provider of nucs or they are not available early in the year when you want to get your bees. In this case, buying package bees is a good option. Package bees are produced in southern states early in the year for shipment up north. They can be purchased from a supplier and shipped to you directly, or you can make arrangements with someone who is plans to bring a truckload of packages to your area.

1. Order a 2- to 3-pound package of bees with a marked queen to arrive at a specified date. Order early (preferably by January), because some years they sell out. Packages can usually be installed in the Midwest about April 1.
2. Prepare all of your equipment before your bees arrive. For each colony, you will need the following:
    a. Hive stand to keep the bottom off the ground
    b. Two deep brood boxes with ten frames of foundation each (or 9 to10 frames with comb)
    c. Bottom board
    d. Entrance reducer
    e. Inner cover
    f. Two supers for the honey flow
    g. Cover
    h. A way to feed the bees (A “friction pail” or gallon jar with small holes in the lid both work well.)
    i. Division board feeders (These can be used with floats to keep the bees from drowning. Entrance, or “Boardman,” feeders are convenient, but don’t work well in temperatures below 40°F.)

3. When the package arrives at the post office, check to make sure the bottom is not covered with dead bees. If there are 2 to 3 inches of dead bees, notify the shipper and ask for compensation. Keep the package in a dark place at about 50° to 70°F. Spray with 1:1 sugar syrup, but do not soak the bees too much. If you need to wait a day or two before installation, spray with sugar syrup twice a day.

   Install the package as soon as possible. Just before dusk is ideal. Packages can be installed at other times of the day if it is raining or cool (45°F or less). Installing in the evening keeps the bees from leaving the hive and drifting into others. If you only have one hive, this is not important. If installing during the day, block the entrance with some grass for an hour to keep the bees in the hive, otherwise the bees will tend to drift into the most visible hive (usually the bees fly into the one on the end). Remove the grass after a few hours or the next morning. Spraying the bees with 1:1 sugar syrup right before shaking them into the box can also help keep them from flying. Installation steps:

   a. It usually is not necessary to use smoke when installing a package, but it is a good idea to have a smoker lit. It may encourage them to go down into the box.
   b. Pry out the syrup can with your hive tool and set it aside.
   c. Remove the queen cage and put her in your pocket.
   d. Jar the package sharply to knock the bees down to the bottom. Turn it over and shake it vigorously from side to side to get the bees into the box. You may need smoke to encourage the bees to go down between the frames.
   e. Let the bees release the queen by eating the candy. Remove the cork from the candy and put a small hole in it with a frame nail (being careful not to stab the queen). Then, position the cage at an angle between the middle frames with the screen facing down so the bees can feed the queen. It is a good idea to put the candy end of the cage at the bottom, just in case it gets wet. This prevents it from flowing onto the queen.

4. Feeding packages is very important. Your colony will decline in population until the new brood hatches and the queen needs comb to lay eggs in. Feeding will allow them to draw out the comb from the foundation. Feed the bees with a gallon jar of 1:1 sugar syrup (at least 50 to 60 percent sugar by volume) that is inverted over the

Figure 1. Bees and hive

hole in the inner cover and has a dozen or so small holes in the lid so the bees can feed on it. In cold weather, it might help if the first two gallons of syrup contain the medication fumagillin, which is sold as a powder called Fumadil-B. This will prevent dysentery (Nosema). Place the feeder jar over the inner cover hole, leaving a space for bees to come out. Cover the jar with an empty hive body. Check the feeder jar regularly and refill it whenever it is empty. You may need about 5 to 7 gallons of 1:1 sugar syrup per package if installing the package onto foundation. If you are installing the package onto comb, much less syrup will be needed. It is also possible to feed the hive with a division board feeder or Boardman feeder.

5. Check the feeder the next day to make sure your bees have consumed some syrup. If the bees are not clustered in the middle, rearrange the empty frames so that the bees are in the middle.
6. Check the queen in three days. If she is still in the cage, make sure the bees are not biting the cage. It will be easy to push them aside with a finger unless they have latched onto the cage with their mandibles. Then, pry off the screen and allow the queen to walk between the frames. If the bees are latched onto the cage, do not release her, because they will kill her. In this case, you may have another queen in the colony, or it may just require more time for the introduction. If the queen was released by the bees already, check for eggs in the bottom of the comb by tilting the cells up to the light. If there are no eggs and no queen, you may need to order a new one. But it is also possible that she just hasn't laid any eggs yet because she is too young or because there are no cells to lay them in, and you just can't find her!
7. Check the bees one week after installing the package. Always carefully remove an outer frame first to avoid crushing the queen. Look for drawn comb containing eggs. If there are no eggs, search for the queen. If you can not find her you will need to buy a replacement queen. If you are planning preventative treatments for American foulbrood disease, Terramycin (mixed with powdered sugar) can be given to the bees now. However, this usually is unnecessary.
8. Inspect the bees every 7 to 10 days to make sure there are eggs and a queen. Observe the expansion of the brood nest, but do not disrupt the nest by putting empty comb in the middle of it. Replace the frames in roughly the same configuration.
9. When all of the comb is drawn from the foundation in the first box, or at least started by the bees, add a second deep

box. You can take one or two outer frames of drawn comb that have little or no brood from the first box and place them towards the center of the upper box to encourage the bees to move up and draw out the foundation and expand the nest.

10. Watch. Give the bees new boxes as soon as they fill up the old ones. When adding supers that contain foundation, place them directly above the brood nest even if you have one super of drawn comb and honey in place already. This will encourage them to draw it out. Supers with a foundation should have ten frames; those with comb can have 8 to 9 frames if properly spaced.

Splitting Colonies

There are many ways to divide colonies. Two examples are given below. You need to complete the following preparations before using either method.

- Choose strong colonies to divide. The best time is 4 to 6 weeks before the time swarming usually occurs. This is early to mid-April for most Midwestern states.
- Ideally, the colony should have brood on 8 to 10 frames or more.
- Arrange for a new queen to be delivered either the day before you want to divide the colony or the same day that you will divide the colony. She will be shipped in a cage with candy and worker "attendants." If the queen of the strong colony is more than a year old, you may want to order two queens and replace the older queen with a new one. If necessary, a queen can be kept in the cage with the attendants or several days to a week in a location that is 65-70°F. Give them a tiny droplet of water with your finger once or twice a day on the screen.
- Have your equipment ready for another colony. You will need the following items.
    - Another hive stand
    - A bottom board
    - Top and inner covers
    - Two deep hive bodies with combs or frames with foundation
    - A feeder is a good idea if there is no nectar coming in from the flowers or you are adding foundation instead of drawn comb (feeder pail or gallon jar with a few nail holes in the lid and 1:1 sugar syrup).
    - An empty, deep hive body to enclose the feeder

For Method 2 (below), you will also need a double screen and a queen excluder (if you are not taking the time to find the queen).

1. Simple Divide Method

Four days before the queen you ordered is expected to be delivered, divide the brood up equally between two boxes of the existing hive. If you find the queen, put her in the bottom box or put her in a queen cage while you prepare to remove the top box and move frames around. This is the safest way to avoid hurting her. If the queen was not seen, put a queen excluder between the boxes. The presence of eggs four days later will tell you where the queen is.

When the divide is made, remove the queenless box to a new location and introduce a queen the next day. To make an even split, it is best to move the divide at least a mile away to prevent all the foragers from returning to the new location, but this may be impractical. If placing the divide in the same apiary, put all of the oldest brood (about to emerge as adults) and one frame of very young (larvae in uncapped cells) into the upper box that you are going to remove. You can tell if brood is nearing the time of emergence by uncapping some cells and looking for older pupae. It is also a good idea to make sure both boxes contain pollen and honey. You can also put extra brood into the new hive from other colonies later (after shaking the bees off the brood frame). The new adult bees will help make up for the loss of foragers that will return to the original hive. You can introduce the new queen with the candy-cage 24 hours after you make the divide. If you are requeening the other hive, be sure to wait 24 hours after de-queening before introducing the new queen.

2. Double-Screen Method

This method is similar to the first and can be used for making splits or for making up nucs. The double-screen fits over the brood chamber of the old hive and allows heat and the hive's odor to be transmitted to the upper part. The heat from the lower box helps to keep the brood warm in the upper box. The double-screen does not permit queen pheromone to pass to the queenless box, because the bees cannot touch each other, so the bees in the queenless box are soon ready to accept a queen. If the upper hive does not accept the queen, the screen can be removed and the hive can be merged again with no fighting, because the bees still share a common colony odor. With this method you can make up many nucs or splits, because you do not have to find the queen.

Double screens are frames that have a screen on each side and that fit over the brood box. They can be purchased or made from parts of hive frames. Use a double screen that has movable pieces of wood to create an upper entrance. You also can make your own double-screen by stapling window screen over both sides of the hole in an inner cover and making a notch in the side of the inner cover to provide an entrance for the bees in the top box.

Choose a strong hive and decide which brood frames you want to move to the top box to make the nuc or split. Use one or two frames of young, uncapped brood and most of the frames of sealed brood that are about to emerge as adults.

Inspect the frames for brood and honey, and decide which ones you want to go in the upper box. It is convenient to bring an empty box to set frames in, or you can just lean them on end against the hive. Replace the frames that you removed from the bottom box with frames from the top box. You can also temporarily add a third brood box and replace frames you move with new frames of comb or foundation. If using frames with foundation, place them between frames containing comb that do not contain much brood. Try to keep the brood in the center of the nest.

Then, place a double-screen over the bottom brood chamber and put the box containing older brood, honey, and pollen above it. Or, if you happened to find the queen, just put these frames of brood in the upper box, put the queen in the lower box and place the double screen in between the top box and the original brood chamber. Make sure that the upper box has an entrance, and face it opposite the direction of the lower entrance.

Introduce a queen to the queenless box 1-4 days after the brood chambers are separated by the double-screen. It takes three days for an egg to hatch, so if you do not know where the queen is in the beginning you will know which box is queenless in 3-4 days (the one without eggs).

Check the box with the new queen within a week after introducing her. If the queen was accepted, it can be moved it to a new location with a new bottom board and covers. If it needs more bees, you can shake some into it from the bottom box, but be careful you do not shake the old queen into it!

Taking Care of Your Queens

The key to having productive colonies is to always have vigorous queens in disease- and mite-free colonies. Young queens are productive egg layers and are much less likely to swarm. It is a good idea to check all of your hives at least briefly every 10 days, but you should at least check them during critical times, like early spring, just after harvest when treating for mites, and before winter. Check to make sure there are eggs and a good laying pattern — lots of brood in the combs, not a scattered brood pattern. Requeening once a year will insure that you always have young queens. Many beekeepers leave the queen in for two seasons if she is still laying a good brood pattern the second season, but they run the risk that she will begin to fail during the colder months. It is good to have marked queens so that you will have an idea of how old she is and where she came from.

If you have supercedure queens, you can mark these yourself with just a little practice. *(Supercedure - replacement of a reigning queen by her workers)* Catch the queen as she walks on the comb by grabbing her wings. Pin her against your clothes and hold her gently but firmly on either side of the thorax between your thumb and forefinger. Have an open bottle of enamel paint (e.g., Testor's), and an open queen cage ready. Use the stem of a grass blade to put a small spot of paint on her thorax, rubbing it into the hairs. Be careful not to use too much or to get paint on other parts of her body, like the eyes and antennae. An easier way is to use enamel paint marking pens, which can be found at hobby stores or in certain bee supply catalogs. Let the queen dry off for about five minutes in the queen cage before releasing her back into the colony so the workers do not remove the paint. Clipping off half of one of one of her front wings also is an option that some beekeepers use to prevent her from flying away with a swarm. That way, if the colony swarms, the queen may be lost in the grass, but the bees will return to the hive where they will have a new queen. However, they may still swarm again with a virgin queen if you do not relieve the crowding of the brood nest. **Warning:** Make sure she is a mated queen before you clip her wing! If you clip a virgin queen's wing, she cannot fly out and mate.

Young queens are more readily accepted by bees than older queens. Also, queens are more likely to be accepted in small colonies and it is easier to find the old queen to remove her in a small hive than it is in a hive with lots of bees. Therefore, it is easier to requeen in the spring because that is when the colony population is lowest. But there are several advantages to requeening during the summer in northern states. Northern-bred queens may be better adapted to your conditions, and these queens are only available in the summer. For example, someone raising their own queens in the Midwest may be able to have new queens by about the first of June. At this time, it is more likely that there will be good weather for mating queens than earlier. There should be plenty of drones for the queens to mate with as the strong colonies prepare for swarming. Finally, introducing queens during the summer can also insure that you have young queens that are likely to start laying eggs earlier in the year the following spring. Also, young queens are less likely to swarm or be superceded than old queens. If you are trying to maximize honey production, you may want to wait until just after the honey harvest to requeen, or you may want to do it gradually over the summer.

Requeening Methods

A number of requeening methods are covered below. The first step in replacing the queen is to find and kill the old queen. If you are only requeening some of your colonies, replace queens that are no longer laying large patches of brood or ones that you know are old or never produced big colonies. The usual method of killing a queen is to pinch her head. **Do not try to introduce a new queen until the old queen has been out of the colony for at least 24 hours.** In some cases, you can wait longer. Do not wait more than three days, however, if at all possible. The simplest way to introduce a queen into a queenless hive can also be a little risky. If a queen is young and laying eggs, it is often possible to just place her onto a frame of bees and watch as the bees accept her. If they start surrounding her, it is a sign that they are going to kill her. This is referred to as "balling" behavior.

1. **Candy Cage**

   This is the most common method used to introduce a new queen. The introduction is done as was described for installing package. Queens are usually shipped in candy cages. You can make up your own queen cages and candy if you are raising queens. Make the candy by mixing high-fructose clear corn syrup or honey with powdered sugar. It takes a surprising amount of powdered sugar. The candy must be soft but firm. If it is too soft, it will melt in the heat of the hive and may kill the queen by covering her. Put a piece of wax paper between the candy and the screen of the cage to keep it from drying out, and then staple the screen on. The hole in the non-candy end of the cage is sealed with a cork or piece of wood.

2. Nucs

Since queens are more easily accepted into small colonies, one method of requeening is to make up small nucs to introduce the new queens into. A nuc can also be used for introducing virgin queens and queen cells that you find in your other colonies. It then serves as a mating nuc as the queen flies out and mates. Once the queen is accepted and laying, combine the nuc with a larger colony that you made queenless one to two days before merging them.

3. The Newspaper Method

Perhaps the safest way to merge colonies is to put a sheet of newspaper between them. Put a few small slits in the newspaper with your hive tool so the bees can chew threw it more quickly. This allows time for the two boxes of bees to acquire the same colony odor, which prevents fighting. To do this with a nuc, first place the frames from the nuc into a deep hive body. Put one sheet of newspaper over the open hive you are going to merge it with and place it on top. Make some slits in the newspaper with your hive tool so that the bees will chew their way through.

4. Push-In Cage

Make a rectangular 3-by-5-inch cage to push into the comb with the queen underneath. It should be made out of 8-mesh hardware cloth (eight openings per inch, see Figure 2). This method is often used when introducing artificially inseminated queens. When done properly, it is the safest method.

You can also buy plastic push-in cages that work a little better, because the bees are less likely to chew around the edges. The advantage of a push-in cage is that it allows the queen to begin laying eggs before she is released. Shake the bees off of comb that is fairly dark (they are stronger). Place the cage in an area with a little open nectar or honey (preferably) over a small patch of emerging brood so the bees that emerge will tend her. It is not necessary that the cage is over brood, but there should be a few cells of honey. You MUST make sure that the push-in cage is pressed in firmly. Check the cage in 3 to 5 days to make

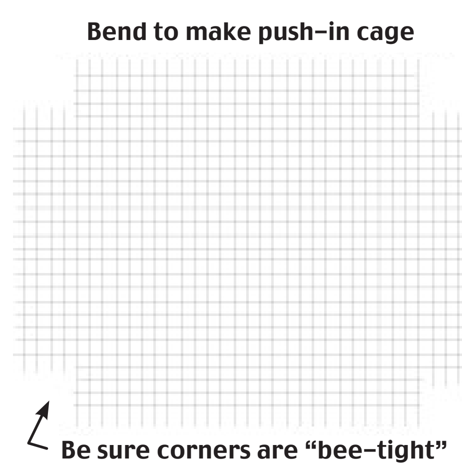


Figure 2. Push-in cage

sure the bees have not chewed underneath. If they are beginning to do this, you must move the cage. Once the queen is laying eggs or you are satisfied the bees are not biting the cage, you may release the queen directly. **Hint:** If the bees have their mandibles clamped onto the cage, it will be difficult to dislodge them with your finger. <u>Never</u> release a queen if they are biting the cage.

5. **Virgin Queens**
   Virgin queens can be introduced the same way as other queens, but they are sometimes more difficult because they are less attractive to the bees. A new queen will take 5 to 10 days to take her first mating flight, and another week after that before she is laying lots of eggs. If she doesn't mate in 14 days, she is too old to properly mate. You have to expect a two-week break in brood rearing with a virgin queen. For this reason, you may want to consider introducing her to a mating nuc before killing the old queen and introducing her to the main hive. Another good alternative is to introduce her ABOVE the old hive. Take a notched inner cover and place it with the notch up and facing the back of the hive to provide a second entrance. Take two frames of brood and bees and one frame of honey (but not the queen) and put them in a deep box above the inner cover. Seal the hole in the inner cover with a double-screen. After 24 hours, introduce the virgin in the top box. In two weeks, check for eggs and brood. You can then use the newspaper method to merge the two colonies, or you can just remove the double screen and allow them to merge. The new queen should be the one that survives, but it is safest if you remove the old queen first.

6. **Queen Cells**
   Queenless hives accept queen cells very well. Just find a dark comb in the middle of the nest and mash down some cells with your fingers. Carefully, push the thickened bottom portion of the queen cell into the comb and use the mashed area to give space for the cell to hang downward. The bees will attach the cell to the comb and the queen should hatch out and be accepted. Handle queen cells very carefully to avoid damaging the queen inside. She is very sensitive to mistreatment while at certain stages of development. Do not bend the cell at all when attaching it. Try to keep the cell warm during transport: 75° to 90°F is best, but don't let it dry out, either. If the weather is cool (below 60° F), the best place to attach the cell is in the middle of the brood nest near the top of the comb.

Seasonal Management

With the problems now faced with mites, beekeepers are finding that they need to be a little more flexible on the timing of certain operations, such as medications, queen introductions and the honey harvest. Each spring, there is a swarming season and a nectar flow that will depend on the weather and its influence on flowers. It is good to be aware of the weather and to know what important flowers are blooming. This makes you a better beekeeper, because you will be prepared to help your bees at the right time, and it keeps you in touch with nature. Some suggestions for a seasonal management schedule are given below (dates are typical for the Midwestern region, but your schedule will have to adapt to the local weather).

December to February
Downtime. Work on equipment and read beekeeping magazines and books.

February
This is usually a time when you can check your bees, if the temperature is above 40° F and there is no wind. Check your hives briefly. If a hive is dead, it can be marked as such or stored. The comb should be protected from wax moths by putting moth crystals on it or storing it in a cold place. If there is any brood, immediately close the hive to keep from chilling the brood. Brief inspections of brood can be done on days that are above 50° F with no wind, or above 55° F with light wind. This can be a time to put in mite strips for thorough mite control, but this is usually done after the honey harvest. If there is no sealed brood, all of the mites will be exposed to the pesticide because they will not be able to hide beneath the cell cappings. The need for mite control will depend on mite populations, but one or two treatments per year are usually required: an optional treatment in the spring if mite populations are low, and a treatment as soon as honey is removed every year. If you are using mite treatments that rely on evaporation of something (like thymol), these must be done when it is warm enough. Read the directions for the particular product you are using to determine if the weather is warm enough.

Hives should be inspected for food stores about the time that they are beginning to rear brood (usually January or

February, weather permitting, or this may be put off until March). If colonies did not have adequate stores going into winter, they may be starving in February even without brood rearing. Colonies can be fed in cold weather by putting granulated sugar (white) on the inner cover. Another efficient feeding method for the winter is to make a cake of candy following the recipe given on the next page:

Winter Bee Candy
15 pounds granulated sugar
3 pounds clear high-fructose corn syrup
4 cups water
1/3 tablespoon of cream of tartar

Mix the ingredients and heat it to 242°F (use a candy thermometer to determine the temperature). Pour the heated mixture into molds to make flat cakes that will fit on top of an inner cover. Place the hardened cakes over the inner cover (keeping the opening free for the bees to feed).

Late February or early March is usually the best time to put on pollen substitute in the Midwest, if supplemental feeding is planned to stimulate earlier egg laying by the queen. Pollen feeding should be done about six weeks before reliable sources of nectar can be obtained from early flowers (like maple trees and dandelions). However, too much early brood rearing can also encourage swarming, since colonies become crowded and may be confined during rainy spring weather in April. It also causes bees to consume honey at a much greater rate, because they increase the temperature of the brood nest to incubate the larvae, and this requires energy. Pollen substitute can be purchased from a bee supply company and should be mixed according to the directions. Some people trap bee pollen and store it in their freezers to add to their pollen substitute and make it tastier for the bees. **Hint:** Make pollen substitute the day before you intend to use it to make sure it doesn't get too hard or soft when it sets up. If it gets hard, the bees won't eat it. If you put the pollen substitute between wax paper, it will not leave a mess on the frames and will be easier to apply.

March
Make sure that hives have adequate food. More colonies starve to death in March than any month because as bees begin rearing brood, they eat up honey and pollen at an alarming rate.

Combine very weak colonies with stronger ones. Equalize colonies somewhat by stealing a frame of brood from each of the strongest hives and giving them to the weakest hives. Colonies that need honey can be given a frame from the stronger hives, or fed syrup.

Some beekeepers do a preventative treatment for American foulbrood disease at this time. This is probably unnecessary unless your colonies have had this problem in the recent past, or if you do not know what the symptoms are and want to be sure your bees are safe. Mix one 6.4 oz pack of terramycin with 2.5 lbs of powdered sugar. This should be fed to the bees in three doses, five days apart. Each feeding should consist of about three tablespoons of sugar/terramycin mix. Alternatively, you could try rolling it up in newspaper and making a “terra taco” that is about six inches long and taped at the ends to keep the sugar from spilling. These should be consumed within three weeks or removed from the hives. Prolonged exposure to antibiotics may select for antibiotic-resistant foulbrood.

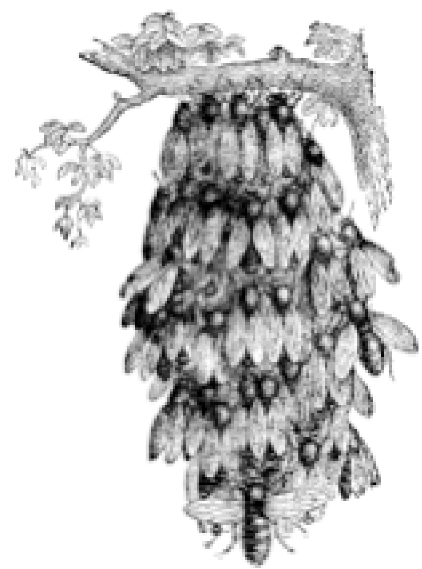
You may choose not to use preventative treatments of antibiotics. If you inspect your hives regularly, you will see when a foulbrood problem occurs and can cure it before it gets out of control. If you do have combs with a lot of foulbrood, they should be burned or put in a well-sealed garbage bag and thrown away.

April

Continue to make sure there is adequate food if the weather is cold or rainy. A strong colony that is occupying two boxes should have at least three full frames of honey. However, if the weather is good and the honey isn’t available, the bees should be able to forage on dandelions and spring flowers and get by. Feeding in bad weather will stimulate more rapid brood rearing, and may be necessary to prevent starvation in some cases.

Begin swarm control in April. Split the strong colonies, if you have the extra equipment to start new colonies (perhaps using equipment from winter losses). Another practice is to reverse the brood boxes. The brood nest is usually at the top of the hive at the end of winter. Placing this box on the bottom board and putting the nearly empty bottom box above it should reduce crowding of the brood nest and may prevent swarming. Another practice that might help curtail swarming is to use a slatted rack on the bottom board with the deep side of the rack facing up. This gives the returning foragers a place to cluster so they stay out of the brood nest. It also tends to keep the brood nest lower in the hive. Note, however, that the slatted rack is not very compatible with monitoring Varroa mites with sticky boards, or with the use of screened bottom boards. You can also put a super with empty combs underneath the brood nest. Most of the foragers will stay in this box. You may want to use a queen excluder to keep the brood out of that box. Most beekeepers do not use slatted racks for swarm control.

If the swarming instinct is not curtailed, only the most tedious methods can prevent swarming. For a hobby beekeeper with a few colonies, these methods are feasible (but not always successful). Once the bees start constructing swarm cells at the bottoms of the frames, go through the colony every 7 to 10 days and cut all the cells. But **BE CAREFUL.** Before you cut cells, make sure that you see eggs in the colony. The queen may have stopped laying eggs and be about to swarm, or she may have already swarmed, and you didn't notice that there are fewer bees. You do not want to make the mistake of cutting all of the cells and leaving your colony hopelessly queenless!



May
Make sure the bees have plenty of room. Give them new brood chambers or supers before they need them to reduce crowding. The extra empty comb will stimulate increased foraging and honey production. Flowers are starting to give nectar – dandelions, autumn olive, European honey suckle, tulip poplar, and others. Sometimes black locust trees produce a short nectar flow at the end of May and basswood trees can produce honey in late May or June.

If you are raising your own queens, May is a reasonable time to start. There should be drones for them to mate with when they are ready.

June
This is the month the honey flow really starts. The clovers are producing nectar and should be in full gear by the end of the month or early in July. Make sure all the supers are on. If you raised your own queens in May, you could introduce them to small nuc hives and let them mate in June.

July
If you are raising queens, you could remove the queens from some of your hives as you have time towards the end of the nectar flow. The honey flow from clover usually stops about

the end of July or beginning half of August in the Midwest. Finding queens in big colonies is difficult. It is best to keep marked queens! The day after the old queen is removed, fuse the nuc with the large queenless colony to introduce the new mated queen, or introduce her with some other method.

August

Often, the real honey flow is done by the end of the first week of August. It is important to get the honey off as early as possible and to treat for Varroa mites. This is perhaps the most critical thing to help your bees survive the winter. If you are monitoring your hive for Varroa mite populations with sticky boards, you will have a good idea of whether you need to treat them and which hives need it the most. As soon as the supers are off, Apistan strips or Checkmite strips can be put in the hives, using one strip for every five frames covered with bees and leaving them in 6 weeks. In many areas mites are becoming resistant to Apistan strips. It is also possible to treat with Apilife VAR, which is a less toxic product containing thymol. Read more about this in *Parasitic Mites of Honey Bees* (http://www.entm.purdue.edu/Entomology/ext/targets/e-series/EseriesPDF/E-201.htm). Controlling the mites now will insure that healthy bees are raised during September. They will be your "winter bees." They will need to live all winter long and still be able to forage and feed the brood in the spring. In contrast, working bees in the summer only live about six weeks.

Once the honey supers have been harvested, the honey needs to be extracted and bottled. The wet supers can be returned to the hives (after the mite treatments are out) to let the bees clean them up. Sometimes beekeepers just set the supers out in a shady place and let the bees rob them out. Some people store their supers wet, which is OK, but they will smell a little sour from fermentation. The bees will clean them up in the spring. Stored comb will require moth crystals. It is important that you reduce the entrances of any weak colonies that may get robbed out by stronger colonies when the nectar flow stops in August. When you work your bees, do not leave honey exposed too long or your bees will get used to robbing from each other.

September

Hopefully in late August and early September the bees found lots of nectar in goldenrod and aster flowers. The small, white asters are often important for the fall flow in the upper Midwest. Weak colonies should be combined with stronger ones before the winter. Colonies that are merged should be reduced to two or three deep boxes. You could use three boxes for very strong ones that you will split next year. Extra boxes and comb should be stored in an unheated building with covers on the top and bottom. When storing equipment in hot weather, note that wax moths can destroy the comb in two weeks. If it is going to be warm, you should keep several tablespoons of moth crystals (PDB, para-dichlorobenzene) on them. Stack the boxes and put crystals on newspaper on tops of frames for every four to six boxes. Either nail wooden entrance reducers in place leaving the smallest opening (three-eighths inch high), or staple three-eighths inch hardware cloth all across the entrance. Half inch also works and is easier to find, but some mice are small enough to get through it.

October to November

If your colonies do not have at least nine frames of honey for the winter, it is best to feed them 2:1 syrup (twice as much granulated sugar as water, by volume). You can dissolve it in hot water. Fumidil-B powder can be added to help control for Nosema disease (dysentery). It is only necessary to feed your bees in the early spring or late fall, or when you are trying to get them to draw comb on foundation. Often in the Midwest the bees make enough fall honey for themselves, and we do not have to feed them.

Colony Troubleshooting

Your primary concern is the presence and well-being of the queen. It often is unnecessary to find the queen. If you do not see her, look for eggs. If eggs are present, there was a queen at least three days ago, because it takes three days for an egg to hatch. Also, look for queen cells. Swarm cells are queen cells made in preparation for swarming in the spring and are usually toward the bottom of the comb. Emergency and supercedure queen cells are found towards the middle of the comb. When a queen is failing and they are making a supercedure queen cell, sometimes it is best to let the bees replace her. However, this may cause a break in brood rearing of 2 to 3 weeks.

1. **Problem:** I can’t find any eggs or brood!
   Possible Causes and Solutions:

a. The queen has quit brood rearing because of the season (winter time or about to swarm) – no action needed.

b. No queen – buy and introduce a new queen ASAP. Optional test: add a frame of eggs and young larvae from another hive. Check for the start of queen cells on third day. This indicates they were probably queenless and will now raise a new queen.

c. New queen present, but is not yet laying (you may find some sealed brood left from the last queen) – be patient. Queens normally begin laying eggs roughly two weeks after emerging from the cell.

d. Extended shortage of pollen

2. **Problem:** There are eggs present, but no other brood.
Possible Cause: Brood rearing has just resumed after being halted. Perhaps they raised a new queen that just mated.
Solution: This is good! No action needed.

3. **Problem:** I see wet-looking pollen.
Possible Cause: When pollen is not needed, pollen in the center of the brood nest may look wet or shiny on top. This pollen can be used by the bees, but they will first move it and make it look fresh again, indicating a need for pollen (because brood rearing is under way).
Solution: No action needed.

4. **Problem:** There are clean, shiny-looking cells in the middle of brood nest.
Possible Cause: The workers have prepared the cells for egg laying. They should look clean and shiny on the bottom.
Solution: No action needed.

5. **Problem:** I see eggs, but more than one egg per cell.
Possible Causes and Solutions:
a. The queen is freshly mated, or not mated — be patient. She will soon learn to put only one egg per cell. However, you should check again in 5-10 days, and replace the queen if this is still happening.
b. Probably the colony has been queenless for two weeks or more and you have a laying worker colony. Some of the workers ovaries have developed and they are laying drone eggs – do not introduce a new queen to this colony. Laying workers usually kill queens that are introduced because the laying workers produce some queen substance as if the colony had a real queen. Usually the laying worker colony

is a weak one and can be combined with another colony without too much danger to the queen. Use one of the following methods in this case:

- Merge the colony with another colony. Use the newspaper technique and place the laying worker colony above the one it is to be merged with.

- Try to introduce a queen. Take the hive 20 feet away from its stand and shake all the bees off the frames and out of the box onto the ground. The theory is that the laying workers usually do not find their way back to the hive, or the disruption helps them accept a queen. Set up the hive in its original position. Introduce a queen under a push-in cage that is pushed into dark comb that contains some open honey, and possibly a little capped brood. Be careful to push the cage well into dark comb. Release the queen in three days if the workers are not biting the cage. (They cling to the cage with their mandibles when biting it and are not easily brushed aside.)

6. **Problem:** The brood is scattered in an uneven pattern.
   Possible Causes and Solutions:
   a. Queen is running out of sperm – if this is the cause, requeening is advisable. If nothing is done, the bees will raise a new queen and the current queen will be superceded by her daughter.

   b. Something is killing the brood. Cold nights in the spring can kill some brood. Rarely, pesticides and poisons may cause the brood to have an uneven pattern. Or, the problem could be mites or disease.
      - check for possible sources of pesticides or other poisons, if you have not had cold nights recently.
      - check for disease symptoms of foulbrood, chalkbrood, and parasitic mite syndrome.

   Clue: Is one colony showing the symptoms or are several? If one, situation (a) is more likely. If several, (b) is more likely.

7. **Problem:** I found the queen, but I also see a new queen cell that has a neat, round opening at the bottom.
   Possible Cause: A virgin queen has recently emerged from this cell.
   Solution: If the old queen is present and doing well, and you want to keep her, you should try to find the virgin queen and kill her. Otherwise, the virgin will probably kill

the old queen and there will be a break in brood rearing. Another possibility is that the old queen is not performing well. You should evaluate the brood to make sure she is still laying lots of eggs and filling frames with brood. If the brood is spotty, it may be best to let the new queen take over. Queens usually take about two weeks to mate and begin laying eggs.

8. **Problem:** I opened my hive and suddenly found virgin queens emerging from several cells!
   Possible Cause: Your colony was preparing to swarm. When bees are going to swarm and they have multiple queen cells, the worker bees prevent the queens from emerging too soon by sitting on the cells and thumping them. Sometimes the queens are not completely inhibited and begin to chew their way out, but the workers re-seal the opening before the queen can emerge.
   Solution: It is too late to prevent the bees from swarming, if they haven't done so already. If you want queens to requeen other hives, this is a good opportunity. You can capture some of these queens and put them in cages with attendant bees. Add some bee candy (made of powdered sugar and white corn syrup) or give them a drop of honey and put them right into new queenless hives (wait 24 hours after dequeening). Remember to give them a small droplet of water twice a day if you are keeping them for a while. You can keep them in the cage with candy for about a week. These queens can also be mated in small nucs and kept for colonies that need new queens later.

Short Guide to Using Honey Bees in Pollination

General Considerations

Why use honey bees?

Many crops are dependent on pollination by bees for adequate fruit set. North America has over 3,000 species of wild bees. Some of these species are much more efficient than honey bees on a per-bee basis for pollinating specific plants. But, almost all of the wild bees are solitary. A single female makes a nest, forages, and cares for the brood, so solitary bees do not have colonies. Honey bees are social – they have a colony containing one queen that lays all the eggs, and tens of thousands of worker bees to do the foraging. Many wild bees only visit specific kinds of plants or are only active for part of the season.

- The *orchard mason bee* is useful because it is active during the spring and is an efficient pollinator of apples. Mason bees can be encouraged to nest in plastic straws or holes drilled in wood. Their progeny will return to the same orchard each year.

- *Bumble bees* are important because they are large, active foragers and are also social - living in small colonies that are active throughout the season.

- *Honey bee* colonies also are active throughout the growing season. Worker honey bees will visit any flowers that provide good amounts of nectar or pollen, the two resources bees need for energy and protein. The main advantage of using honey bees is that you can manage colonies with tens of thousands of bees to serve as mobile pollination units.

What's a good pollinating hive?
A hive that was just started from shaking a package of bees onto a foundation is not a good pollination unit, because the population is low and will continue to decline for at least a month while the bees draw comb for the queen to lay eggs in and the first new workers hatch out. A good pollination unit is a strong hive (meaning it contains lots of bees). If it is a strong hive, it should have many bees coming and going from the entrance on a warm day. If you take the lid off, there should be bees filling at least one or two large brood chambers, with a carpet of bees covering the tops of the frames. A good pollinating unit will have at least one deep brood chamber full of bees, brood, and eggs (indicating that they have a queen).

When do you move your hives?
Bee hives are usually moved after sunset to avoid losing foraging bees. Beekeepers that move only a few hives usually just screen off the entrances and load the hives individually on a truck. Straps can be used to make sure boxes to not come apart if the hive is knocked over. Beekeepers with larger operations often move hives on pallets with four hives per pallet. The grower should expect the hives to come at night and should jointly decide with the beekeeper where the hives will be placed – in the orchard or the edges of the field.

How do you time the move?
The importance of timing depends on what flowers are competing for the attention of the bees. One thing to consider is the attractiveness of your crop as a nectar source. Bees are

very good at locating the sweetest nectar in the area. Often this comes from weeds in the surrounding fields. Bees like to forage within 300 feet of the hive, but will travel two miles or more for a good nectar source. Ideally, it is best to have the bees moved into the crop just as flowering has started in earnest, so that the bees do not get used to foraging on the nearby weeds. If they are moved in too soon, there may not be enough of the crop blooming to effectively compete with the weeds.

Consider drawing up a pollination contract.
When contracting for pollination, it is important that the beekeeper and grower discuss details, including all of the following:

- Which pesticides will be used, if any, while the bees are present? Bees are extremely sensitive to sprays on flowers It is possible for a beekeeper to lose all 300 of their colonies in one week to pesticide-poisoning during pollination.

- The beekeeper should have access to the colonies at all times to inspect them and make sure they still have queens and are healthy.

- The beekeeper and grower should know which **pesticid**es are most toxic to bees. All of these points should be decided ahead of time. It is best to sign a formal contract with the beekeeper and owner of the crop to be pollinated. This protects both the grower and the beekeeper.

How many hives are needed?
The number of hives needed depends on the crop. (See Table 1.) Crops with more than one seed per fruit benefit from multiple bee visits to the flowers to get large fruit. Examples of such crops are apples, cucumbers, melons, and blueberries. Blueberries need perhaps the most hives per unit of area, because they are not that attractive to the bees. Examples of some estimates of the optimal number of hives per acre are given in the box on the right.

Crop	Hives per acre
Apples	1.2
Blueberries	4.0
Cantaloupe	2.4
Cucumber	2.1
Squash	1.0

Table 1. Number of hives needed for different crops.

LD50s (µg/bee)	Toxicity
less than 100	virtually non-toxic
11-100	slightly toxic
2.0-10.99	moderately toxic
greater than 2.0	highly toxic

Table 2. Classification of toxicity based on LD50s (µg/bee)

Pesticides and Bees

Pesticide Toxicity
The acutely toxic effects of pesticides to bees are measured by experiments in which the test compound is administered to bees as a contact pesticide in a controlled way. Table 2 indicates how pesticides are rated based on their LD50s (the concentration in microgram/bee needed to kill 50 percent of the test bees).

Residue Exposure
Some pesticides are very toxic to bees but can still be applied to the blossoms in the evening, because they rapidly decay to less toxic compounds. The residual activity of pesticides is often expressed as an RT25 value. This is the time that needs to pass for the pesticide to degrade enough that bee mortality is reduced to 25 percent of the initial mortality of the freshly applied product. This test is done by spraying the pesticide on alfalfa leaves and keeping the leaves in a cage with bees at 75°F. But cooler temperatures can dramatically increase the time needed for residues to become nontoxic to bees. Be especially careful when the weather is cool. More information can be obtained from reading *Protecting Bees from Pesticides* (http://www.entm.purdue.edu/Entomology/ext/targets/e-series/EseriesPDF/E-53.htm).

Inventory

List all of your beekeeping equipment.

Date Obtained	Item	Number	Cost
		Total:	

Receipts

Date	Item	Value – Used at Home	Value – Sold
		Total:	

Financial Summary

Assets:

Total value of bees, equipment, etc., on hand January 1.	
Total value of supplies, equipment, etc., purchased during year.	
Miscellaneous expenses during the year. Explain:	
Total:	

Inventory:

Total value of bees, equipment, etc., on hand December 31.	
Total value of bee products available for sale December 31.	
Total:	

Total pounds of honey produced:

extracted (__________ pound) + chunk (_________ pounds) + comb (__________ pounds)

= ____________________ pounds

Value of bee products sold: ______________________________

Yearly Profit (or Loss) =

Assets – Inventory + Value of bee products sold.

______________ - ______________ + _____________ = ___________________

Yearly Profit/Loss: ________________

Work Record

Record all time spent working on your beekeeping project.

Date	Location	Kind of Work	Time Spent
		Total:	

Apiary Record

(Maintain a record book for your hives with a chart for each individual colony.)

Colony No.								
Date	Queen	Brood Amount	Amount Pollen	Amount Honey	Bee Pop-ulation	Honey Removed	Equip-ment	Notes

Colony No.								
Date	Queen	Brood Amount	Amount Pollen	Amount Honey	Bee Pop-ulation	Honey Removed	Equip-ment	Notes

Colony No.								
Date	Queen	Brood Amount	Amount Pollen	Amount Honey	Bee Pop-ulation	Honey Removed	Equip-ment	Notes

The Scientific Method

Scientific Method – an organized way to address a problem you are having with your bees.

1. Stating the problem
Think about what you want to learn.

2. Forming the hypothesis
After you choose a problem to study, describe what you think is happening.

3. Observing and experimenting
Observe or set up an experiment to test your hypothesis. Tally your data. You can make your own charts by hand or on the computer.

4. Interpreting data
Once you have collected your data, you need to understand what it tells you. The data can be interpreted by comparing numbers visually or in graphic form.

5. Drawing conclusions
Consider how your observations and/or experiments affect your hypothesis. Is the hypothesis supported or rejected by your observations and experiments? How do the results give you ideas for future studies and a new hypothesis? Should you run your experiment again? Should you change one of your variables?

Worksheet components:

1. State the problem.
2. Write a hypothesis.
3. Observe and experiment (create a data sheet).
4. Tally, study, and interpret your data.
5. Draw conclusions.
    a. Was your hypothesis supported, or not? (circle one)
       Yes   No
    b. What else did you learn?

Demonstrations and Talks

Any one of the suggested projects could be an excellent topic for a demonstration or discussion at your school, county, or state fair. You might also be able to find other clubs and groups that would be interested in such a presentation. Talks are generally more interesting if you do an "action" demonstration. General guidelines and a checklist for an Action Demo are given in this manual.

Action Demonstration Guidelines

What is an action demonstration (action demo)?
An action demo is a fun way to share with others what you have learned in your 4-H project. It's a kind of "show and tell" but with more action. An action demo is not like a regular demonstration, where the audience sits and listens to a prepared talk. An action demo lets the audience get involved.

Action demonstrations can be given anywhere there are a lot of people, such as a county or state fair, shopping mall, street fair, or any 4-H event. Your job as a demonstrator is to interest the audience in your topic so that they stop and learn something new or try their hand at what you are doing.

How do I choose a topic for my action demo?
An action demo can be done on almost any subject. The topic should be something that you enjoy and are knowledgeable about. Consider the following questions when choosing a topic.

- Can you complete the action demonstration in 3 to 5 minutes?
- Can it easily be repeated over and over again to fill the assigned time?
- Is your action demo showing something that would interest the general public?
- Is there a good way to involve your audience in your action demo (hands-on or answering questions)?
- Can the supplies for the "hands-on" section be used over and over again, or will they need to be replaced? (Remember, if the materials must be replaced, it will cost more to do the demonstration.)

How can I get the audience involved?

The first thing you need to do is be enthusiastic and attract people's attention as they walk by your table. You might have a colorful tablecloth or poster to spark their interest. You might ask them a question, like: "Would you like to play this game?" or "Have you ever made pretzels? Would you like to try?" The best way to attract their attention is to have people around your table doing something. People love to do hands-on activities, so once you get a few people at your table, they will attract others. For more information on action demonstrations, see V-4-H-28.

Involve your audience by having them:
- Do what you are doing
- Do a "hands-on" section
- Judge the quality of various items
- Play a game
- Answer questions

Remember, the key to a good action demo is getting your audience involved.

Action Demo Checklist

Topic	Yes	No
Was the topic interesting to the general public, causing them to stop, watch, or participate?		
Did the topic stimulate questions from the audience?		
Was the topic of suitable length?		
Did the topic include something "hands-on" for the audience to do?		

Organizing the Content	Yes	No
Was the topic organized into short “show-and-tell” segments that were done repeatedly?		
Were segments presented in logical order?		
Were segments explained so that the audience understood “why?”		
Was it evident that the 4-H member was knowledgeable about the subject and could answer questions?		
Did visuals, pictures, posters, or actual objects clarify the important ideas?		
Presenting the Demonstration	**Yes**	**No**
Did the 4-H member seem enthusiastic?		
Did the 4-H member encourage the audience to become involved in the demonstration?		
Did the 4-H member speak directly to the audience?		
Did the 4-H member show evidence of practice and experience?		
Did the 4-H member show that she/he enjoys talking to the audience?		
Did the 4-H member show enthusiasm, friendliness, and a businesslike manner?		
Did the 4-H member tell about what they learned through this 4-H project?		
Comments:		

Exhibits

You should get information about the 4-H Beekeeping exhibit from your county Extension educator. Indiana State Fair guidelines are available at the 4-H Web site (www.four-h.purdue.edu).

The displays that you could design are as numerous and varied as the many types of projects you have to choose from.

Project Suggestions

- Hive increases
- Uniting hives
- Fall and spring management
- Dividing hives and introducing a queen to a hive
- Dividing colonies for increase
- Queen production
- Queen rearing
- Double queen method
- Two-queen system of honey production
- Hive swarms
- Summer management
- The bee language
- Bee hunting
- Construction of an observation hive
- Research on honey bees and pesticides
- Home-built beekeeping equipment
- Protecting honey bees from pesticides
- Bee behavior
- Section comb honey production
- Selective honey gathering
- U.S. standards for grading honey
- Collecting pollen for supplemental feeding
- The value of the honey bee as a crop pollinator
- Use of honey bees for crop pollination
- Construction of a simplified pollen trap for use on colonies of honey bees
- Processing and uses of beeswax
- Pollination of agricultural crops
- The history of hive bodies
- Designing and building a hive stand

Resources

Recommended Magazines:

American Bee Journal
http://www.dadant.com/journal/
Bee Culture
http://www.beeculture.com/

Recommended Books:

Honey Bee Biology and Beekeeping,
by Dewey M. Caron. Wicwas Press.
Cheshire, Connecticut. 1999. ISBN 1-878075-09-8.

The Hive and the Honey Bee
Dadant and Sons Publisher. 1992. ISBN: 0-915698-09-9

Recommended Video:

A Year in the Life of an Apiary, by Keith Delaplane,
University of Georgia. 1-800-359-4040
http://www.gactr.uga.edu/tv/videocatalog/bees.html

Purdue University Beehive Website

There are many beekeeping resources listed at the Purdue University Beehive site:
http://www.entm.purdue.edu/Entomology/research/bee

Indiana Department of Natural Resources (IDNR) http://www.in.gov/dnr/

The state apiary inspector is employed by the Indiana Department of Natural Resources (IDNR, http://www.in.gov/dnr/), Division of Entomology and Plant Pathology, and is located in Indianapolis. The Apiary News & Information Web Site http://www.in.gov/dnr/entomolo/apiary/apiarynews.htm has a variety of information for the beekeeper.

- Beekeeping meetings
- Indiana apiary regulations
- Applications for shipping bees and elements of beekeeping into Indiana
- Assistance for beekeeping in Indiana (state apiary inspector, Purdue bee specialist, beekeeping associations, etc.)
- Plants attractive to native bees
- Links to Purdue bee publications
- Links to state and federal programs and services

Sources for Figures

Michener, C. D., 1974. *The Social Behavior of the Bees: A Comparative Study,* Harvard University Press, Cambridge, MA.

Ruttner, F., 1988. *Biogeography and Taxonomy of Honey Bees*. Springer-Verlag, Berlin.

Snodgrass, R. E., 1956. *Anatomy of the Honey Bee*, Comstock Publishing Associates, Ithaca, NY.

Winston, M., 1987. *The Biology of the Honey Bee*, Harvard University Press, Cambridge, MA.

Suggested Reading

Brother Adam, 1983. *In Search of the Best Strains of Bees*, Dadant and Sons, Hamilton, IL.

Furgala, B., M. Spivak and G. S Reuter, 2000. *Beekeeping in Northern Climates*, University of Minnesota, St. Paul, MN.

von Frisch, K., 1967. *The Dance Language and Orientation of Bees*, Harvard University Press, Cambridge, MA.

Gould, J. L. and C. R. Gould, 1988. *The Honey Bee*, Scientific American Library, W. H. Freeman & Co. New York.

Graham, J. M. (ed.), 1992. *The Hive and the Honey Bee*, Dadant and Sons, Hamilton, IL.

Laidlaw, H., and R. E. Page, 1999. *Bee Genetics and Breeding*, University of California Press, Davis, CA.

Spivak, M. and G. S. Reuter, 1997. *Successful Queen Rearing*, University of Minnesota, St. Paul, MN.

Wilson, E. O., 1971. *The Insect Societies*, Harvard University Press, Cambridge, MA.

Glossary

Afterswarms – Swarms that leave a colony with a virgin queen after a swarm of the same season has already left the hive.

American foulbrood – An extremely contagious disease of bees that affects them in the larval (worm) stage of development caused by the bacteria *Bacillus larvae*.

Apiary – A collection of colonies of honey bees; also, the yard or place where bees are kept.

Apiculture – Beekeeping.

Bee escape – A device to remove bees from supers or buildings; constructed to allow bees to pass through in one direction but to prevent their return.

Beehive – A box or other structure for housing a colony of honey bees.

Bee space – An open space (1/4 to 3/8 inch) that permits free passage of a bee but too small to encourage comb building.

Beeswax – The wax secreted by honey bees from eight glands within the underside of the abdomen and used in building their combs.

Bee veil – A wire screen or cloth enclosure worn over the head and neck for protection from bee stings.

Bottom board – The floor of a beehive.

Brace comb – Small pieces of comb built between combs and the hive.

Brood – Young developing bees found in their cells in the egg, larval, and pupal stages of development.

Burr comb – Small pieces of wax built upon a comb or upon a wooden part of a hive but not connected to another comb or part.

Castes – The different kinds of adult bees in a colony: workers, drones, and queen.

Cell – A single compartment in a honeycomb in which brood is reared or food is stored.

Chunk honey – A piece or pieces of comb honey packed in a jar with liquid extracted honey.

Clarification – The removal of foreign particles from liquid honey or wax by the straining, filtering, or settling process.

Cluster – The hanging together of a large group of honey bees, one upon another.

Colony – A community of honey bees having a queen, thousands of workers, and (during part of the year) a number of drones.

Cut comb honey – Squares of honey in the sealed comb in which it was produced; cut from a shallow super size frame of sealed honeycomb and then packaged in clear plastic.

Drifting – The return of field bees to colonies other than their own.

Drone – A male honey bee.

Dysentery – A disease of honey bees causing an accumulation of excess waste products that are released in and near the hive.

European foulbrood – An infectious disease affecting honey bees in the larval (worm) stage of development; caused by the bacteria *Streptococcus pluton*.

Extracted honey – Liquid honey.

Extractor – A machine using centrifugal force for removing honey from the comb without destroying the combs.

Field bees – Worker bees, usually at least 16 days old, that leave the hive to collect nectar, pollen, water, and propolis.

Foundation - Used to form base on which bees can construct complete comb, made of either wax or plastic.

Frame – Four strips of wood joined at the end to form a rectangular device for holding honeycomb.

Granulated honey – Honey that has crystallized, changing from a liquid to a solid.

Hive – Worker bees available for purchase. As a verb, to put a swarm in a hive.

Hive body – A single wooden rim or shell that holds a set of frames. When used for the brood nest, it is called a brood chamber. When used above the brood nest for honey storage, it is called a super.

Hive cover – The roof or lid of a hive.

Hive tool – A metal tool with a scraping surface at one end and a blade at the other; used to open hives, pry frames apart, clean hives, etc.

Honeycomb – The mass of six-sided cells of wax built by honey bees in which they rear their young and store their food.

Honey flow – A time when nectar is plentiful and bees produce and store surplus honey.

House bee – A young worker bee, 1 day to 2 weeks old, that works only inside the hive.

Inner cover – A thin wooden board placed just beneath the hive cover for added protection and insulation from the elements.

Job shadowing – Learning from others by following, watching, and studying what they do in their jobs.

Larva – The grublike or wormlike immature form of the honey bee in its second stage of metamorphosis

Metamorphosis – The series of stages through which an insect passes: egg to larva to pupa to adult.

Movable frame – A frame of comb that can be easily removed from the hive. It is constructed to maintain a proper bee space, which prevents the bees from attaching comb or fastening it too securely with propolis.

Nectar – A sweet liquid secreted by plants, usually in their flowers, and converted into honey by bees.

Nosema – An infectious disease of the adult honey bee that infects the mid-gut, or stomach. It is cause by a protozoan parasite. Symptoms of this disease closely resemble those of dysentery.

Observation hive – A hive made mostly of glass or clear plastic to permit observation of the bees at work.

Pesticide – A general name for materials used to kill undesirable insects, plants, rodents, or other pests.

Pollen – Dustlike grains formed in the flowers of plants in which the male elements are produced. Honey bees use pollen as a protein food for their young.

Proboscis – The tongue of a honey bee.

Propolis – A kind of glue or resin collected by the bees for use in closing up cracks, anchoring hive parts, etc. It is also called bee glue.

Pupa – The third stage of a developing bee, during which it is inactive and sealed in its cell. The adult form is recognizable during this stage.

Queen excluder – A device, usually constructed of wood and wire or sheet zinc, having openings large enough for the passage of worker bees but too small for the passage of larger drone and queen bees.

Robber bee – A field bee from one colony that takes, or tries to take, honey from another colony.

Sacbrood – A slightly contagious disease of brood that is caused by a virus.

Sealed brood – Brood, mostly in the pupa stage, that has been capped or sealed in cells by the bees with a somewhat porous capping of wax.

Section comb honey – Honey in the sealed comb that was produced in thin wooden frames called sections.

Smoker – A device that burns slow-burning fuels to generate smoke for the purpose of keeping the bees calm while working in their hive.

Solar wax extractor – A glass-covered box for melting down beeswax by the heat of the sun.

Super – A receptacle in which bees store surplus honey placed “over” (above) the brood chamber. As a verb, to add supers in expectation of a honey flow.

Supersedure – rearing a new queen to replace the mother queen in the same hive.

Swarm – A large group of worker bees, drones, and a queen that leaves the mother colony to establish a new colony.

Travel stain – The darkened appearance on the surface of comb honey when left in the hive for some time; caused by bees tracking propolis over the surface as they walk over the comb.

Uniting – The combining of two or more colonies to form one large colony.

Virgin queen – An unmated queen.

Wax moth – A moth whose larvae feed on and destroy honeycomb.

PURDUE UNIVERSITY

Purdue Extension
Knowledge to Go
1-888-EXT-INFO

18 USC 707

Revised 7/06

Colony Number:							Queen (Year/History):				
Date & Time	Queen	Queen Cells	Frames Used	Brood Frames	Health	Varroa	Feed	Supers	Weather	Temper	Notes

Notes:

Queen:	√ - queen seen M - queen marked
Queen Cells:	n - number seen nX - number seen & removed
Frames Used:	n - number of frames with bees
Brood:	√n - number frames brood seen √ne - eggs also seen
Health:	√ - appear healthy CB/EFB/AFB - possible problem

Notes:

Varroa:	n - varroa mites in colony when measurement taken tB/tA/tG - treated with Bayvarol/Apistan/Apiguard
Feed:	any feed given
Supers:	any change to number of supers
Temper:	1 - Calm and lovely 10 - Stingy buzz monsters sn - stung n times
Weather:	c - cloudy, s - sunny. R - raining. W - windy

The Record Book

The record book is used to give an overview of the beekeeper's beekeeping activities and to help plan the work in the season. If it is kept as a Filofax it is possible to insert the hive record cards into the book to provide a complete record of the beekeeping season. However, many beekeepers prefer to keep their hive record cards with their hives. If this is done it is important to keep the cards dry and away from the bees otherwise they will chew up the card and the records will be lost. The record book comprises three parts:

- **The apiary layout**

  This can be a pictorial record to show the location of each colony in the apiary and its identifying mark. Hives on out-apiaries should be marked to reduce the possibility of theft and so that the owner can be identified. Talk to your local beekeeping Association about the marking system used in your area. Individual record cards may also be kept with this section.

- **Plans for work in the season**

  This section will hold your plans for managing the colonies in the apiary. It is particularly useful to record the activities and timing you plan to use for queen rearing and swarm control. It can also be used as a reminder for repairing hives or buying new equipment. There is no special format for this section but most record keepers find it useful to plan activities using a simple diary approach.

  If there is any concern over the general vigour or health of the colonies it can be marked here as a reminder to replace certain queens or re-site colonies.

  Information may also include the dates when specific operations must be carried out e.g. for queen rearing or preparation of an observation hive for a particular occasion.

- **Records of the season**

  This will give information on the quantity of honey collected during the season and the quality of the queens. Records will also include the state of the hives and the work needed during the winter months to prepare for the next season.

This leaflet is provided for general interest and information only.
No liability is accepted for any injury or loss arising out of the contents of this leaflet.

British Beekeepers Association Advisory Leaflet Number B8

Beekeeping Records

A requirement for attaining the 'Certificate in Beekeeping Husbandry' is to maintain a record book of beekeeping for at least a season. Most beekeepers develop their own approach over the years and find that keeping records help them to manage their stocks more effectively. There is no specific format of records required for the Certificate in Beekeeping Husbandry as long as the records are sufficiently comprehensive to show the work the beekeeper has done over a season and how the colonies have progressed.

This leaflet gives guidance to those who have not developed their own recording system and is a good starting point. There are no foolproof ways of keeping records. Some beekeepers use computers, others use Filofaxes or filing cards and diaries. The important aspect is to record adequate and useful information in a readily accessible format.

Records comprise two elements:

- Hive or colony records that indicate the state of the colony each time it is inspected.
- Record books that identify the location of your hives in your apiaries and are used to plan the management programme for the coming season.

Hive Records

A hive record is a convenient way of showing the state of the colony each time it is inspected or manipulated. A simple marking system will give sufficient information to make decisions on what needs to be done next time and whether the colony will be useful for breeding new queens etc. The diagram on the next page illustrates a record card with columns that can be used to record the state of a colony. The columns are also described with a suggested marking system that you may find helpful. In time, beekeepers who keep records will develop their own marking system to suit their approach to the bees. This is fine. The important point is that records are kept.

Example of a Hive Record Card

Apiary 2 Colony 4									Queen bred from Apiary 1 Colony 1 in 1999			
Date 2000	Q	QC	Brood	Stores	Room	Health	Varroa	Tem-per	Feed	Supers	Wea-ther	Notes
4/3	x	X	✓	5	5	✓	l	10	1 LS	0	S, 15	Removed mouse guard
1/4	x	X	e ✓	5	5	✓	l	10	1 LS	+1	S, 17	Replaced floor board with varroa floor
22/4	✓ B	X	e 4	10	5	CB	200	9	0	+2	C, 19	Roof needs repainting
7/5	✓	X	e 7	25	5	✓	200	10	0	-1	S, 21	Cut grass under hive

- **Date** Date of the inspection
- **Q** Presence of the Queen

  [✓ Queen seen, x Queen not found, c Queen clipped, **W,Y,R,G,B** Queen marked with appropriate colour code]
- **QC** Presence of Queen cells

  [x = none seen, 10X = 10 seen but all removed, 2L = 2 seen and left alone]
- **Brood** State of the brood

  [e = eggs seen, ✓= brood pattern ok, 3 = brood covering 3 frames, x = no brood]
- **Stores** The quantity of stores available

  [10 = equivalent of 10 super frames available]
- **Room** The available space for the queen to lay eggs

  [5 = equivalent of 5 brood frames available]
- **Health** The state of the brood and adult bees

  [✓ = all ok, CB? = Possible chalk brood, EFB? = Possible EFB, etc.]
  If you are not sure whether a disease is present, it is advised that you consult a more experienced beekeeper. If you think EFB or AFB may be present it is mandatory that you call the Appointed Bee Inspector.
- **Varroa** The number of Varroa mites in colony

  [l,m,h = low, medium or high, (say) 1000 = the estimated Varroa population in the hive calculated from natural drop, or other estimation methods].
  It is recommended that the mite drop is checked regularly and a numerical value of the Varroa population estimated.
- **Temper** The docility of the colony

  [10 = nice calm bees, 8 = bees agitated, 6 = bees sting, 4 = bees that follow too much, etc]
- Feed How much feed given

  [2 LS = 2 litres of light syrup, 1 HS = 1 litre of heavy syrup, etc.]
- Supers How many supers removed or added

  [+1 = one super added, -0.5 = 5 frames removed, etc]
- Weather The temperature and cloud cover

  [c = cloudy, s = sunny, r = rainy, f = fair]
- Notes Anything of interest to add

  [lot of propolis, brood box needs repair, etc.]

The examples given in brackets illustrate how a numerical scoring system can be derived. If the records are to be used for the Certificate in Beekeeping Husbandry the scoring system should be explained to the assessor.

Either metric or imperial units may be used.

The headings marked in bold are important and must be maintained for the Certificate in Beekeeping Husbandry.