

Apiculture

2006 Recommendations

Beekeeping practices which work best in Tennessee have been determined through many years of experience and testing. Leslie Little, State Apiarist 1949-1971, now deceased, published seasonal management practices as a guide to recommended beekeeping.

These seasonal management practices developed by Mr. Little prior to 1971 have been thoroughly tested by staff members of the Department of Agricultural Biology at The University of Tennessee during 1971-1974. In 1984, Professor Harry Williams published "Beekeeping in Tennessee", (PB697 of the Agricultural Extension Service, University of Tennessee.) Several additional publications (see list, page 364) have been added since 1990 to supplement PB697, especially concerning parasitic mite management, pollination, and Africanized bee awareness. In 2005 Beekeeping in Tennessee was updated and is now available as PB1745 from UT Extension or the AG Store on the UT web site. Publications and other information are available at <http://eppserver.ag.utk.edu/bees/test/intro.html> These revised management practices are now recommended as the better beekeeping practices for Tennessee beekeepers by The University of Tennessee Extension Service, Entomology and Plant Pathology Section.

Beginning with Bees

- * Start small. Two colonies is an ideal number for an inexperienced person to keep for one or two years.
- * Expand as your experience and confidence grow.
- * Start right. Avoid discouraging mistakes at the very beginning by thorough preparation.
- * Buy new equipment. The experience of assembling new hives is very informative for the inexperienced beginner.
- * Beekeeping information is important. There are many good books that are excellent for beginners. Most books are very reasonably priced.
- * Plan ahead. Order your bees, hives, and other equipment well in advance. Place your order for bees, hives, and tools in the fall. The hives and tools will be delivered in time to be assembled before your bees arrive the following April.
- * Be ready. When the package bees arrive, your hives should be assembled and located on the site selected for your apiary.

Colony Performance Standards

A strong colony has these characteristics:

1. **Bee Population**
 - A. Prolific queen
 - (1) Full brood pattern on frame
 - (2) Few skipped cells
 - (3) 8 to 16 or more frames of brood (beginning of honey flow on approximately April 15)
 - B. Worker bees
 - (1) 60,000 to 100,000 bees
 - (2) 30,000 to 40,000 or more field bees
 - (3) 3,500 bees per pound or frame
 - (4) 20 full frames of bees in brood chambers
 - (5) 10 frames of super covered with bees
 - C. Drone bees
 - (1) 1,000 or more in strong colony
 - (a) Appear in March
 - (b) Disappear in October
 - (c) Seasonal (45-day life span) for individual drones
2. **Disposition** - Gentle bees that are easy to work with; very little tendency to sting under good flight conditions.
3. **Low-Level Swarming Instinct** - Very few or no swarm cells. Swarm prevention can be a major problem. Colonies with a low-level swarming instinct are most desirable.
4. **Honey Production** - Colonies that produce 100 pounds or more of surplus honey are most desirable. This is above the 40 to 60 pounds of stores for their use. Productive colonies can do extremely well if moved to the mountains from the low elevation areas by July 1. Double cropping of productive colonies is definitely recommended for increasing your honey production per colony.

Equipment

- * All equipment or colonies purchased from another beekeeper should be inspected by the bee inspector from the Tennessee Department of Agriculture.
- * All hive equipment should be of the modern Langstroth type with hanging, movable frames as required by the Tennessee Apiary Law.

- * All hive equipment should be the standard size for interchanging as needed.

<u>Equipment</u>	<u>Depth</u>	<u>Width</u>	<u>Length</u>
Brood chamber, hive body, deep super	9 7/16	16 1/4	19 7/8
Shallow super	5 11/16	16 1/4	19 7/8
Illinois super	6 5/8	16 1/4	19 7/8

Brood Chamber Area

- * Two hive bodies are recommended as the best brood-rearing chamber.
- * Ten frames or 9 frames and a follower board are recommended.
- * One hive body plus one shallow super is the minimum amount of brood-rearing space.
- * One hive body or deep super plus the Illinois super is also recommended as a brood chamber.
- * Full sheets of brood foundation with crinkled wires embedded vertically are recommended. Frames should be wired with two strands of horizontal banjo-tight wire to prevent warping of brood comb.

Supers

- * Four to six supers are the minimum number required per strong colony.
- * Foundation with crinkled wire embedded vertically should be used in supers to be extracted.
- * Use special milled foundation for cut comb or chunk honey.
- * Section honey is not recommended for beginners. Production requires a strong colony and a very good honey flow and special management.
- * Beekeepers with four or more colonies should have an extractor. The beekeeper should produce three supers of extracted honey for every super of cut comb honey in order to properly pack chunk comb honey.

HONEY BEE MITES

Tracheal mite -*Acarapis woodi*

The Problem - The tracheal mites have spread throughout Tennessee since their introduction in 1987. In the next two years, this parasite was believed

responsible for 50% losses of bee colonies statewide with local losses reaching 100%. The mite became a severe problem in part due to the difficulty in detecting the minute parasite and to the ease in which contaminated bees can spread the mites. The mites are spread among colonies by drifting bees, or among apiaries by any activities of beekeepers involved in moving adult bees. Other sources of contaminated bees include bee swarms and from package and queen bee producers.

Another parasite, the *Varroa* mite, *Varroa destructor* formerly *Varroa jacobsoni*) has become a severe pest of honey bees in Tennessee. Detailed information about *Varroa* mites is available below.

Biology - The oblong mites are microscopic, averaging 160 microns long by 75 microns wide, about 1.5 times as long and 0.75 times wide as the diameter of a human hair (100 microns, 1/250"). They live and breed inside the trachea or breathing tubes of the bee especially in the large tubes in the prothoracic region. The mite penetrates the tracheal wall with its piercing mouthparts and feeds on hemolymph (bee blood). The effects of feeding, opening the surface to pathogens and the reduced capacity for air flow due to the wing muscles by the mites presence are the suspected damaging factors that kill bees.

Symptoms - The wings of infested bees are often unhooked, with one wing projecting 90 degrees from the axis of the body. These bees are unable to fly and crawl about the hive entrance (crawlers). Numerous bees have been observed on occasion to crawl out of the colony and die.

Population levels of mites are usually highest early in spring when bee population levels are low. As bees cluster in winter, the mite population builds up in the old bees and as brood rearing commences, mites move to young bees. If the wintering colony is weak due to food shortage or disease, the effect of mites is increased. Mite populations are lowest during summer when bee populations are high.

Detection and Diagnosis - To diagnose tracheal mites, the bees must be dissected and examined under a microscope.

Sampling for *Varroa* and Tracheal Mites - This method allows a single sample to be collected to detect both mites.

1. Select a frame from the brood area with bees on it.
2. Position the frame on end and scoop bees into the mouth of a quart mason jar until the jar is one third full. **Make sure the queen bee is NOT in the sample.**

3. Spray a rapid burst of ether (Starting Fluid) into the jar of bees, cap the jar quickly, and roll the mass of bees and liquid inside the jar.
4. Observe the inside jar surface for dark brown, oval, pin-head size *Varroa* mites. If you have many, this technique will reveal them in the field.
5. Add enough rubbing alcohol to half fill the jar, cap it tight and seal it with tape, if necessary.
6. Send the sample to office of county agent or this office including: name, address, phone number, number of colonies in apiary. Also, include the date of last re-queening and source of bees, if obtained commercially.

*University of Tennessee
Bee Disease Lab
Entomology and Plant Pathology
2431 Joe Johnson Dr., 205 PSB
Knoxville, TN 37996-4560*

Dissection - Fifty bees are randomly selected and placed on their backs. The front legs and head are removed with the edge of a razor blade and a thin cross-section of the prothorax containing the major tracheal trunks is made. The section is soaked overnight in an 8% solution of Potassium Hydroxide in water to dissolve muscle tissue. The trachea are observed at 20 to 40X under a dissecting microscope for mites. Infested trachea are usually discolored and darkened in the areas mites have fed.

Treatments for Tracheal Mites:

Resistant Stock Recently, several newly developed genetic stocks of honey bees have reported some resistance to the effects of tracheal mites. This resistance is not 100 percent, however research indicated significant improvement when compared to non-resistant lines. One stock, the BUCKFAST bee, can be purchased from Weaver Apiaries in Navasota, Texas. Additional stocks of the "Yugo" bee, tested by the USDA, have been released to queen producers to breed and sell. The New World Carniolan stock is also reported to express partial resistance to tracheal mite. Some queen producers are advertising "resistant" bees. We do not know whether the stocks are resistant or not, therefore, beekeepers should be careful when purchasing stock that claims to be resistant. It still may be necessary to apply additional treatment as explained below.

Menthol - is a crystal with fumigant action that kills tracheal mites. Temperatures must exceed 60°F for proper fumigation.

Application - Menthol should be applied after honey has been removed because it gives the honey a menthol flavor. Fifty gms, (1.8 ozs.) of crystals in a

"bag" are placed flat inside the colony on the frame top bars above and to one side of the brood area if temperatures are below 80°F. If temperatures exceed 80°F. degrees, the bag should be placed on the bottom board below the brood chamber.

Menthol is a fumigant that is not effective until air temperature is above 60°F. In Tennessee, portions of the state vary with temperature, however, a general "window" for treatment starts in late spring (May-June) and ends in early fall (August). I recommend early fall for first choice because most honey flows have ended.

Menthol can be purchased in individual pre-packaged "tea-bags" or 50 gms. can be placed into a window screen bag secured by staples. Leave the bag in place for ten to twelve weeks. Do not leave menthol on all winter because it reduces brood rearing and may affect clustering behavior.

Contaminated Honey Should Not Be Eaten:

Treatments for mites including menthol and Mite-AwayII™, coumaphos, Apiguard®, ApiLife VAR® and APISTAN™ for *Varroa* mite treatment should not be made when producing honey. The chemicals can be absorbed into the honey. Remove Apistan strips or menthol packets prior to adding supers to collect honey. To treat for *Varroa* mites, use Apistan strips after all honey has been removed. Contaminated honey should not be eaten. This honey could be left in the comb and fed to the bees in late fall for over-winter food.

Sources of Menthol

A. Bee supply companies such as:

1. Walter T. Kelley Co.
3107 Elizabethtown Rd.
Clarkson, KY 42726
(502) 242-2021
2. Mann Lake Supply
County Road 40 & First Street
Hackensack, MN 56452
(800) 233-6663
3. Dadant & Sons
2425 Carroll Ave.
Lynchburg, VA 24501
(804) 846-0666
4. Brushy Mountain Bee Farm
Rt. 1 Box 135
Moravian Falls, NC 28654
(800) 233-7929

B. Agricultural Co-op's and local bee suppliers in several counties.

C. Local bee associations for their memberships: for example, Knox County residents can purchase

medications from the Knox County Bee Association.

Vegetable Shortening - Vegetable oil/shortening has shown promise as a treatment against mites, probably by reducing the ability of the mite to detect young bees as hosts. A pattie containing 3 parts granulated sugar, 1 part shortening plus Terramycin will prevent American Foulbrood and combat tracheal mites. This treatment (one pattie per deep brood chamber) is applied after honey has been removed in the Fall and again early in Spring. Additional patties of sugar and shortening without Terramycin can be applied later for treatment of mites only. The pattie should be placed flat on the top bars in the brood chamber

A recipe for 12 patties follows: One 6.4 ozs. (by weight) packet of Terramycin is mixed with 2 lbs. 1 oz (4 3/4 cups) granulated sugar. (Note: a 6.4 ozs. Packet with 10 gms. Active ingredient = 25 gms/lb. This dosage is commonly referred to as TM25). Eleven ounces (1 1/2 cups) of all vegetable shortening is added, blended, and the mixture rolled flat on wax paper 1/4" thick. This mixture should be divided into 12 equal portions with each weighing approximately 1/4 pound. Individual patties can be sandwiched between wax paper and frozen for use as needed. For one pattie, mix 4 teaspoons Terramycin with 2/5 cup (2.7 oz; wt.) Sugar, add 1/8 cup (0.9 oz;wt.) 100% vegetable shortening, mix and roll.

Varroa mites -

Varroa destructor Anderson and Trueman

The *Varroa* mite, *Varroa destructor*, was discovered in Tennessee in November of 1990. This infestation originated from contaminated honey bee queens and packages of bees shipped from producers in South Georgia to beekeepers in more than 50 Tennessee counties. Currently, *Varroa* mites are found throughout Tennessee. After being discovered in 1987 in Wisconsin and Florida, they spread rapidly throughout North America. *Varroa* mites have a world-wide distribution, and are found on all continents except Australia.

This parasite is so damaging because it has recently been introduced to a new host, the European honey bee [*Apis mellifera* L. (EHB)]. The EHB has no natural defenses to this parasite. The original host, the Asian honey bee (*A. cerana*), has established an "equilibrium" with its parasite because this bee can physically remove mites and kill them.

Economic damage: This lethal, pin-head size parasite is causing severe economic loss by killing thousands of honey bee colonies annually. It has contributed to widespread death of one-half the colonies in Tennessee, on average with severe losses in some locations of 100 percent.

Colonies of EHB infested with *Varroa* almost always die unless the beekeeper uses effective measures to kill the mites. Colonies infested with the mites can die within one year.

Losses of bee colonies in Tennessee are believed to be affecting pollination of vegetable and orchard crops. Reductions in crop yields are suspected to be related to reduced numbers of pollinators. In some areas, growers are making contracts with beekeepers to provide adequate numbers of bees for pollination.

BIOLOGY - The *Varroa* mite is an external parasite of honey bee larvae, pupae and adults. The life cycle of the mite generally takes 11 days to complete [Fig 1] with female mite longevity of four to eight weeks. The infestation starts when a pregnant female mite enters the colony, attached to a returning bee (Fig 2). The adult female mite is oval (ca 1.2 X 1.6 mm), brown, with eight legs and is about the size of a pin-head (Figs 2 and 3). She searches for a larva with preference for drones>workers>queens, and crawls into the cell in the comb containing the larva. The cell is then capped over by workers. The female mite lays eggs which hatch and begin to feed on the bee larva. The mites literally suck the life out of the host bee by penetrating its internal membranes with their mouthparts and withdrawing fluids. The puncture wounds can become the entry points for disease organisms.

Bees that emerge after being parasitized by a single female and her offspring have a shorter life span than do nonparasitized bees. Bees parasitized by more than two mites may die before emerging, or if they do emerge, they weigh less, may appear deformed and seldom leave the colony. The number of bees in the colony diminishes steadily as the number of mites increases. Less nurse bees are produced to feed the brood, and brood production ceases. At this stage, the entire colony collapses. All remaining adults usually leave the colony at one time, with each bee carrying numerous mites. These heavily infested bees often fly into nearby colonies and transfer mites in the process.

Often, the total collapse of a colony comes as a complete shock to the beekeeper. One day the colony appears "strong" (many bees), and two weeks later, the colony is dead, without a single live bee present.

Mites can be dispersed quickly whenever infested bees come in contact with uninfested ones. This can happen easily when infested bees (especially drones) drift (enter a colony that is not their own) into an uninfested colony, or during robbing, as uninfested bees remove honey from a colony occupied by infested bees.

Detection: Several methods can be used to detect *Varroa* mites: (Please see **Sensitivity** below).

1. Observing pupae - In this method, pupae are examined for mites by uncapping the cells, extracting the pearly white pupae and looking for

the dark brown mites adhering to the surface.

Use a capping scratcher or table fork to uncup several cells at a time, and spear the pupae beneath. A pair of tweezers can also be used to extract a single pupa from the cell. Select pupae that have pigmented eyes, because these can be extracted from the cell without breaking apart. Select drone pupae if they are present, because *Varroa* prefer drones. If drone pupae are unavailable, then look at worker pupae. Sample at least 25 drone or 50 worker pupae to determine infestation level.

2. A sticky board trap is used to sample a whole colony for mites. A sticky board trap is placed on the bottom board inside the entrance of the bee colony. The board can be used alone or in combination with a treatment to detect mites. Mites die from natural causes, fall off the bees and land on the sticky board. A sticky board is made using stiff cardboard with a smooth, light-colored surface that is cut to fit inside the hive. A sticky substance such as "insect stickum" or spray cooking oil is applied to the upper surface to catch and hold mites. A metal screen made from eight-mesh (per inch) hardware cloth (same dimensions as the sticky board) is placed above the board, to prevent bees from removing the mites, and from becoming trapped on the board themselves.

The sticky board must be examined within two or three days, because other natural debris in the beehive will accumulate on the board, making it difficult to distinguish mites from debris. The examination process can be improved by hanging an Apistan® strip between frames in the brood area. These plastic 1-by-8-inch strips are impregnated with fluvalinate, an insecticide which kills the mites on the adult bees.

3. The ether roll method is used most often because it is quick and easy to perform. All that is needed is a sample of bees, a screw top glass jar and a can of ether starting fluid. This technique is not as sensitive as some other methods (see **Sensitivity** below).

Select a brood frame with worker bees on it. Make sure the queen is not on this frame because the bees will be sacrificed. Shake 200 to 300 bees from the frame into a quart jar. A funnel may aid in this transfer. A temporary funnel can be made using a rolled up piece of paper or a plastic gallon container. Cut the plastic container in half, insert the "mouth" of the container (it becomes the spout of the funnel) into the sample jar. Spray two squirts of ether starting fluid into the jar with bees, cap the jar and shake vigorously. Roll the mass of ether coated bees in the jar. Observe the inside surface of the jar for the mites that will fall off the bees and stick to glass. Be careful not to confuse

wax scales produced by the bees, or lumps of pollen, with *Varroa*. Wax scales are white. Probe any dark objects of similar size to *Varroa*. Pollen lumps are soft and will break apart when probed.

4. An alcohol shake is a method used in the laboratory to more closely examine a sample. A sample is collected as mentioned above for ether roll. Add several ounces of 70 percent rubbing alcohol (isopropyl) to the sample. Place the sample jar into a laboratory shaker and shake for 30 minutes. Pour the bees and liquid through a coarse (60 mesh) soil sieve that is suspended above a vacuum filtration funnel. The bees are collected on the sieve screen; the liquid passes through the filter; and debris, including mites, is collected onto a piece of filter paper. Mites are easily observed, if present, on the white background of the filter paper. If necessary, a magnifying hand lens or microscope can be used to confirm the presence of mites.

Sensitivity of Method

Observing pupae is the only method that examines mites when they are present in the brood. *Varroa* spend 80 percent of their life in brood and only 20 percent outside on adult bees. A brood frame with a standard semi-circle pattern of capped brood (both sides) has approximately 5,000 cells. Therefore, three full frames of capped brood may contain 15,000 pupae. If you find 10 mites in 100 cells (10 percent) you may have 1,500 mites in the brood. If there are another 20 percent in the adult bees, then there are 1,875 mites in the whole colony. These figures are a crude estimate only because the amount of brood varies seasonally and with the health of the colony. When there is less capped brood, you may find more *Varroa* per cell.

Methods, such as the ether roll, that examine a small sample (300) from a colony of 30,000 are not very sensitive. The ether roll only samples 1 percent of the adult bees in the colony. The number of mites found in the jar should be multiplied by 500 to estimate the total number in the colony (including brood). This test may not detect the mites if they are present in low numbers. However, the ether roll method is easy to perform and results are available immediately, allowing the beekeeper to start treatments, if needed. If an ether roll reveals mites in a single colony in an apiary, additional tests may be used to discover a low infestation in other colonies.

The sticky board test is more sensitive than the ether roll, because it samples the entire adult population at one time. However, this test is more involved, it requires the hive to be manipulated to install the trap and requires a return visit, one or two days later, before mites can be discovered. The number of mites on the board should be multiplied by five to estimate total mite population in the colony. *Varroa* spend only 20 percent of their time on adult bees.

TREATMENTS -Apistan®, ApiLife VAR®, Mite-AwayII™, Apiguard® and CheckMite+™ are current miticides available for use for management of *Varroa* in Tennessee. Apistan® consists of a pyrethroid chemical, fluvinate, impregnated in plastic strips. Apistan® is available in several dosages for treatment of queen bee cages, packages of bees and whole colonies. The 1 percent active ingredient (AI) formulation for queen cages is called a queen tab and is placed into the queen cage with attendant bees for three days prior to shipping. This treatment has been shown to be 100 percent effective. A 2 1/2 percent AI Apistan® strip for packaged bee treatment is placed inside the cage with bees for five days prior to shipping.

To treat a whole colony with Apistan®, suspend two 10 percent AI Apistan® strips (8 X 1 inch) between brood frames 3 and 4 and frames 7 and 8 and leave for at least 45 and no more than 56 days. Remove the strips after 56 days. Wear plastic gloves (e.g. nitrile) while handling the strips.

Beekeepers should insist that any queens or packages they order be treated with Apistan® before shipment. Be sure to check the packages at a later date for any mites not killed with the first treatment.

In 1998, *Varroa* mites were found in Tennessee and several other states that were resistant to Apistan® treatment. These mites were found in colonies that had been overwintered in Florida. We suspect that resistant mites are not widely distributed in Tennessee, but this has not been scientifically verified. Therefore, beekeepers should be advised that they may discover colonies that have mites not controlled by Apistan®. A test has been devised to detect resistant mites by the USDA. Please contact our office to conduct the test if you suspect resistant mites are present. Resistant mites can be controlled by coumaphos (CheckMite+™) as described below, however this material can accumulate in wax and if used repeatedly may harm bees, including the queen. Therefore, unless resistant mites are found, we recommend using Apistan® for *Varroa* control.

The Environmental Protection Agency (EPA) granted a section 18 emergency exemption label in Tennessee, for the calendar year for 1999 for use of coumaphos (CheckMite+™) to control *Varroa* mite and small hive beetle (see below). An extension of this exemption for year 2006 is expected. CheckMite+™ strips are similar physically to Apistan® mentioned above. Remove honey supers before application of CheckMite+™ and do not replace until the end of the control period. Chemically resistant gloves (e.g. latex) must be worn when handling the strips. To use the strips, bend the hanger portion horizontally (found at one end of the strip) before hanging the strip between frames of bees. Use one strip per five frames of bees. Hang the strips within two combs of the edge of the bee cluster. If two deep supers are used for the brood nest, hang CheckMite+™ strips in alternate corners of the cluster,

in the top and bottom super. Leave the strips in place for at least 42 days and no longer than 45 days. Discard used strips and do not reuse. No more than two treatments of coumaphos for *Varroa* are allowed in Tennessee per year. The label is the law. CheckMite+™ can be purchased from Mann Lake Ltd. (800)233-6663.

Mite-AwayII™ (formic acid) was developed in Canada and is an improved version of the original Mite-Away pads developed by Dr. Medhat Nasr and tested by our personnel in Tennessee eight years ago. This material can be very effective to manage tracheal and *Varroa*, but only if you apply it when temperatures are between 50 and 79 degrees F. At higher temperatures formic acid vaporizes too fast. Before using this material it is important to understand exactly how to use it and carefully observe the safety precautions to avoid serious health problems. See <http://www.miteaway.com/> (Or call 866-483-2929) to view all details on the label that includes safety instructions (precautionary statements, hazard statements for humans and animals, environment, physical and chemical and handler personal protective equipment), directions for use in the U.S. and specifications for storage and disposal. Why so much safety? The material is a very corrosive acid that is listed as a hazardous material because "it can be fatal if inhaled, absorbed through the skin or swallowed." If not handled properly, "it can cause skin burns and irreversible eye damage."

One Mite-AwayII™ treatment pad is used one time only per colony for 21 days and then removed and discarded. The material is not used when making honey and honey supers should be removed. You need to use protective goggles, an organic acid cartridge respirator, and wear acid resistant gloves (PVC, neoprene or nitrile). The pads are packaged individually in a plastic bag in groups of 10 in a polyethylene pail. To apply you slit the outer bag, remove the wet pad (don't remove inner bag in contact with pad) and place with the side having holes down over top bars of top hive body above two ½ inch wooden sticks that are spaced 4 inches apart. With treatment installed, place a 1 ½ inch rectangular spacer (same dimensions as hive body) over the top hive body and install the inner cover above. The spacer, and placing the pad on sticks allows air flow around the treatment needed for proper vaporization. Entrance reducers should not be used and the pads should not be placed on any metal surface (like metal covered outer covers).

Cost of the product varies with quantity ordered and the cost of shipping and handling. A tentative estimate varies between \$2.60 and \$3.50 per treatment. It will be much more cost effective if beekeeper associations pool their orders. A more accurate estimate will be available in June, 2005. This cost is competitive with current available treatments and is also effective for both mites. Mite-AwayII™ can be an important tool in an IPM program to manage mites.

Apiguard® is a natural product specifically designed for use in beehives for 2006. It is a sophisticated slow release gel matrix, ensuring correct dosage of the active ingredient thymol. Thymol is a naturally occurring substance derived from the thyme plant. It has a proven high efficacy against the *Varroa* mite and is also active against both tracheal mite and chalkbrood. Apiguard® is a specially designed and patented slow release gel containing thymol. Apiguard® gel, presented in 50gm ready to use aluminum trays, regulates the liberation of thymol within the honeybee colony and provides a much more efficient control of hive pests than was possible before.

Apiguard® is also available in 3kg and 1kg tubs for use by beekeepers with larger numbers of hives. Dosage tools are presented with each tub to ensure correct and easy dosing.

Apiguard® is extremely easy to use. It is simply a matter of placing the opened tray face upwards in the top of brood frames, preferably centered over the colony. After 10 days examine the tray and if depleted replace with a second tray. If there is product left in the tray after 10 days leave until day 14 and then replace. Leave a second tray in position for a further 2-4 weeks and treatment has been completed (duration of treatment therefore lasts 4-6 weeks).

Mode of action: After administration of the product homogeneous distribution within the bee colony is assured by vapor release and also by the bees' social behavior (feeding exchange and cleaning activities).

Contact: Worker bees climb into the Apiguard® tray and begin to remove the gel, as a hive cleaning behavior. The gel adheres to the bees' body hairs and as the bees run through the hive they distribute the product to the colony.

At low temperatures Apiguard® takes longer to evaporate and the lower activity of the bees means that gel is not distributed as efficiently. It is therefore essential to use Apiguard® when the colony is active and when temperatures are not too low (above 15°C/60°F). Apiguard® will work at lower temperatures although the treatment period may need to be extended; the level of efficacy is generally better at higher temperatures.

ApiLife VAR®, a natural essential oil product, containing 74.08% thymol, 16.00% eucalyptus oil, and 3.70% L-menthol (currently there is no EPA Registration number), manufactured by Chemicals LAIF, may be used for the control of *Varroa* mites.

Applications can be made in any season (spring, summer, fall, winter) in which all applicable restrictions, precautions and directions for use can be followed. Do not use when surplus honey supers are in place. Use when daily temperatures are between 59° F and 69° F. Do not use ApiLife VAR® at temperatures above 90° F.

Two treatments per year may be made. A treatment (3

tablets) consists of the following: Take one tablet and break into four equal pieces. Place pieces on the top corners of the hive body. Avoid placing pieces directly above the brood nest. After 7-10 days, replace with a fresh tablet broken into pieces as above. Repeat procedure again, 7-10 days later and leave last tablet for 12 days. After 12 days, remove residuals from the colony. To prevent the bees from gnawing the tablet either enclose each piece of tablet in an envelope of screen wire (8 mesh/inch) or place the uncovered pieces above a sheet of metal screen that prevents bees from contacting it. Remove ApiLife VAR® tablets from hive at least 1 month (30 days) prior to harvesting the honey.

PESTICIDE CAUTION: Fluvalinate, formic acid and coumaphos can cause health risks by being absorbed in honey and beeswax if not applied according to the label directions. The treatment should not be applied during a honey flow or when supers (boxes with honey in comb) of honey are present. Please read the label and follow instructions closely.

Parasitic Mite Syndrome

This new malady was discovered in 1995 by USDA scientists. This syndrome is not defined as a disease because no causative agent has been isolated. Detection of the syndrome is based on presence of symptoms identified in adult or larval (brood) bees listed below:

Adult Symptoms:

1. *Varroa destructor* is present.
2. Reduction in adult bee population.
3. Evacuation of hive by crawling adult bees.
4. Queen supersedure.
5. *Acarapis woodi* may or may not be present.

Brood Symptoms:

Some of the more puzzling aspects of this syndrome are observed as the affected brood are examined.

1. *Varroa destructor* is present.
2. Spotty brood pattern.
3. Symptoms resembling European Foulbrood, American Foulbrood, and sacbrood disease may be present. These symptoms may disappear following feeding of oxytetracycline, sugar syrup and the use of fluvalinate strips.
4. The age of affected brood can vary from "C" stage larva to prepupa. As a result, the affected brood may be seen anywhere on the comb.
5. Individual larva may appear in the "C" stage, twisted in the cell, "molten" to the bottom of the cell,

light brown in color as in the early stages of American Foulbrood disease.

6. The affected individuals do not display any ropiness.
7. Some scale formation has been noted, scales are not brittle as with American Foulbrood disease and are easy to remove.
8. No typical odor can be associated with the syndrome.
9. Microscopically, the affected larva has no characteristic microbial flora. The flora is variable but no one bacterial type predominates.
10. To date, no known bee pathogen has been isolated from the affected brood with parasitic mite syndrome.

Tracheal and *Varroa* mites are believed to carry and spread the unknown agent, probably a virus, from colony to colony. Treatments for this syndrome are based on controlling mites and reducing other stresses to the bees. The syndrome is more common when bees are under stress. Maintaining young queens (less than 2 years old), feeding the colony with sugar/water syrup containing Fumadil-B, and preventative treating with Terramycin for American Foulbrood will help reduce stress.

ALERT

THE SMALL HIVE BEETLE - A NEW PEST OF HONEY BEES

A new pest of honey bees was found in Tennessee (2000) where a beekeeper discovered beetles damaging beehives. The beetles were identified as *Aethina tumida* Murray, **the small hive beetle**, a pest from South Africa. The adults are 6 mm (1/4") long, dark brown to black, flattened, oval to oblong in shape, with the head often "tucked" below the thorax (see Figure 1). If the head is in view the short antennae have a conspicuous club on the last segment. The larvae are elongate, whitish grubs, tapered at front and rear ends, which under magnification have rows of spines on the dorsum. Adults and larvae inhabit beehives, where they feed on stored honey and pollen. As they feed the brood and honey combs are damaged, especially as the larvae burrow through it. As the infestation increases, the honey ferments and bubbles out of the cells. Brood rearing stops when beetle numbers are high. Honey bees have been observed to abandon colonies infested by the beetles. As the infestation builds, honey is observed to run out of the hive and this is often the first external symptom that is

noticed. Pupae of the beetles are white to brown and can be found in the soil beneath and near the hive. The development of the beetle from egg to adult in South Africa requires 38 to 81 days, with five generations possible during warm months.

Mr. Lawrence Cutts, Florida State Apiarist, said recently that beetles are most likely to be found in colonies that have been weakened by something else, usually mites. He reported that larvae congregate in corners, possibly to cluster together to retain heat. This clustering distinguishes the beetle larvae from wax moth larvae that are found scattered throughout weak colonies. Hive beetle larvae make a slime as they feed. This slime acts as a repellent to the bees and when the larvae become numerous the slime is believed to cause the bees to leave the hive. Honey bees will not reenter "slimy" comb. The slime must be washed off with water.

To detect the beetles, Lawrence is using corrugated cardboard squares (4"x 4") with one surface peeled to expose the ridges inside. The cardboard is placed ridge side down on the bottom board of the hive. The next day the cardboard is removed and adult beetles, if present, should be found under it. The adults hide in dark, moist places. Adults do not get caught on sticky boards.

A coumaphos treatment for small hive beetle was approved for 2006. The Section 18 emergency exemption for use of CheckMite+™ for *Varroa* explained earlier also included treatment for small hive beetle. To treat for small hive beetle prepare a cardboard square as mentioned above for detection. Cut a CheckMite+™ strip in half (crossways), staple the pieces to the ridged side of the cardboard and place this side down in the center of the bottom board. Leave in place at least three days and remove after seven days. Do not treat more than four times per year. CheckMite+™ can be purchased from Mann Lake Ltd. (800) 233-6663.

The soil drench Guardstar™ can also be used before colonies are placed in a new apiary to kill small hive beetle larvae and pupae in the soil. Follow label instructions carefully.

Beekeepers located in areas where beetles have been found are advised not to store honey in comb for long periods, especially if pollen is present. Also, they should be careful about stacking weak colonies and extracted supers onto strong colonies. Freezing combs will kill *A. tumida* eggs, larvae and adults.

Since the original find in May (1998), the beetles have been found in several states including Georgia, South and North Carolina. The original source of infestation may have been Georgia, but the first confirmed find was in Florida. Major infestations appear to be confined to the southeastern coastal plain where soil moisture and makeup may be optimal for beetle pupation and survival. A small infestation of the beetle was detected in Polk Co. in 2000 in southeast Tennessee.

Tennessee Department of Agriculture personnel contained the infestation and continue to monitor bee colonies there. In 2001 the beetles were found in Hamilton and Dyer counties. In 2005 shall hive beetles were found throughout most of the state, with the exception of upper East Tennessee.

Beekeepers should be made aware of this pest and any suspected "finds" should be forwarded to this office for confirmation. Please call this office before sending a sample. Samples of adults or larvae can be sent in vials containing alcohol.

Information was provided by Michael Thomas, Division of Plant Industry, Florida Dept. of Agriculture and Consumer Services; Tom Sanford, Entomology & Nematology Dept., University of Florida; and Lawrence Cutts.

Locating an Apiary

The location of the apiary should provide the essential elements for maximum performance by your colonies.

1. An abundant source of nectar and pollen should be near the apiary.
2. Nectar- and pollen-producing plants that bloom in late summer, fall, winter, and early spring are very beneficial to colonies for brood rearing and overwintering.
3. A good supply of clean water should be available within one-quarter of a mile.
4. The apiary should be located on a hillside for maximum air drainage to reduce humidity.
5. Late afternoon shade is desirable to aid in cooling the colony.
6. A good vegetative growth on the North should be available to protect colonies from the cold winter winds. Trees or shrubs are good wind breaks and protect colonies from the cold winds.
7. An apiary should be near a hard-surface road. It is necessary to visit your apiary in all kinds of weather.

Major Honey Flows

Tennessee has two major honey flows during the spring and summer months.

Spring Flow - The major spring flow occurs between April 15 and June 15 at lower elevations across the State. Colonies should be developed to maximum strength by April 15 for maximum production.

Summer Flow - The major summer flow occurs between June 25 and August 15 at higher elevations. Colonies in the higher mountain elevations should be at peak strength by the last week of June for maximum production.

Colonies which have produced a good crop or well-developed packages should be moved from the valley to the mountain by July 1.

Lima beans, soybeans, and cotton produce nectar during July and August. These crops are grown primarily in the western part of the State.

Seasonal Management

Good management practices are the key to your success as a beekeeper. Honeybee colonies should be opened, checked, or manipulated one to four times each month from February through October. Timely management practices, applied when the colonies are opened, are the basis of productive beekeeping.

Colonies may be opened for checking on warm days during the winter months when the bees are flying freely. Avoid overexposure of the brood to cold winds during these inspections. Complete your work and close the hive as quickly as possible.

Winter Season

December - Shop Work

- * Apply Apistan strips, if not done in November, when temperatures are as warm as possible.
- * Repair and paint equipment.
- * Clean supers, hive bodies, covers, and frames of burr comb and propolis.
- * Cull combs. Cut all combs with more than two square inches of drone cells from the frames.
- * Render (if equipped) or pack all old comb or beeswax into a shipping container. Old comb or wax can be exchanged for foundation.

January

- * Clean, paint, and repair equipment.
- * Check the apiary for wind damage.
- * Check the apiary for skunk damage.
- * Feed a pollen substitute, if needed.
- * Check the honey stores and feed colonies that have less than 15 pounds (6 frames of capped honey in shallow super or 2-3 frames in deep super).

February

- * Open colonies on a warm day and check for laying queen, brood, and diseases.
- * Check amount of honey stores
- * Feed all colonies with less than 15 pounds of honey.
- * Feed pollen substitute, if needed.

- * Unite weak or queenless colonies with another colony (bees should cover 5 or more frames).
- * Select the best of the two queens before uniting the two colonies. Remove one of the two queens before uniting.
- * Feed one gallon of a 2:1 sugar syrup containing one tsp. of Fumidol-B.
- * Treat colonies with Mite-AwayII™(formic acid pads) for *Varroa* and tracheal mites.

Spring Season

March

- * Check brood chambers. If all of the brood is in the upper part of the brood chamber, reverse the upper and lower brood chamber units.
- * Reversing the chambers will cause the queen to use both units for egg laying.
- * In two weeks, the upper unit should be filled with brood. Reverse the units again.
- * Repeat reversing the units every two weeks or as often as necessary until the honey flow begins.
- * Check the brood for diseases and mites each time you open the colony. Treat with Apistan if damaging levels of *Varroa* are detected.
- * Feed the antibiotic Terramycin to the colony during this heavy brood-rearing period. This may be done by either adding Terramycin to a shortening/ sugar pattie (see above) or by adding the antibiotic to powdered sugar. (TM 50 Terramycin powder can be mixed with 25 parts of powdered confectioners sugar.) Use one ounce of this mixture sprinkling it on the tops of the outside frames in each of the two brood chamber units.
- * Repeat the use of the antibiotics at seven-day intervals until you have treated a colony three times if the powder method is used.
- * Check the honey stores. Feed all colonies that have less than 15 pounds of honey stores.
- * Feed pollen substitute to all colonies that are low on pollen reserves.
- * Prepare supers with foundation in a warm room and store under fumigation (para-di-chloro-benzene crystals).

April

- * Strong colonies will consume large amounts of honey stores in April. If all reserves have been used up, the colonies will starve just prior to the honey flow.
- * Check stores and feed all colonies that have less than 15 pounds of honey.
- * Check brood chamber for diseases and mites.
- * Install package bees in April. Package bees will do well when installed on all new foundation in the hive. When drawn comb and two frames of swarming brood are available, packages get off to a better start.
- * Add new foundation for drawing comb in upper hive body during a honey flow. Slatted bottom boards and entrance reducers also reduce degree of light and aid in producing better drawn comb.
- * Wings of the queen may be clipped to prevent her leaving the hives with swarms. Clipping also aids in identification in event of supersedure.
- * Colonies with prolific queens and ample food will be strong in population and may need room. Add a super of drawn comb to relieve crowding.
- * By April, you should have developed colony strength to 80,000 worker bees to produce a maximum honey crop.
- * Add supers for honey storage by April 15.
- * Check for the development of the swarming instinct. Raise the super just above the brood chamber and check for swarm cells along the bottom bars of the frames. If cells are present, all frames containing brood should be checked thoroughly for swarm cells. Remove all queen cells. Give additional room by adding one or two supers of drawn comb.
- * Top ventilate the colony to prevent overheating the colony.
- * Recheck for swarm cells every seven days.
- * Feed package bees two gallons of a 2:1 sugar syrup containing one tsp. of Fumidol-B per gallon.
- * Colonies that continue to build swarm cells should be divided to prevent swarming.
- * Colonies that develop a strong swarming

impulse will swarm if you permit the cells to be capped before removing.

- * Prepare supers with foundation in a warm room and store under fumigation with para-di-chloro-benzene.
- * Prepare supers with cut comb foundation just prior to using them.
- * Store supers of prepared foundation in plastic bags to prevent drying out prior to use.
- * Remove entrance reducer from overwintered strong colonies by mid-April.
- * Remove entrance reducers from colonies installed in April by mid-June.

May

- * It is time to add another super when the super on a colony is one-half to two-thirds filled (6-7 frames).
- * Raise the partially filled super and place the empty super on top of the brood chamber. Place the partially filled super on top of the empty super.
- * Supers of cut comb honey foundation should be added on top of the honey super which is on top of the brood chamber to reduce the amount of pollen in the cut comb honey.
- * Continue to check for swarm cells every seven days. Remove all swarm cells from the colony.
- * Keep empty storage space in the supers on all colonies until the honey flow has ended.
- * Remove and extract capped supers from your colonies if you need additional supers.

Summer Season

June

- * Swarms may be infested with tracheal mites.
- * Combine all swarms issuing after June 1 with weak colonies. Continue to check for swarm cells every seven days.
- * Continue to add supers of drawn comb as needed until the honey flow ends.
- * Remove the capped honey after June 15.
- * Uncapped honey can be removed two weeks after the honey flow ends.

- * Prepare to move your bees to the mountain or to lima bean-, soybean-, and cotton-growing areas from the second honey flow if you want maximum production.
- * Store all supers of honey in a warm, 90° F, dust-free, screened room.
- * Extract the honey as soon as possible.

July

- * Have your bees on their new location by the first week of July.
- * Extract honey you removed in June to have the supers available for the sourwood honey flow.
- * Return extracted supers to the colonies just before dark to prevent robbing.
- * Fumigate all supers of extracted combs that will be off the colonies for more than four days.
- * Pack honey in a quality, attractive package--all new glassware and lids.
- * Continue to check for swarms in mountain areas; combine swarms issuing after July 15 with weak colonies.
- * Check for *Varroa* mites.

August

- * Check brood nest for diseases and mites.
- * If 10 *Varroa* mites are found per 100 pupae or 6 mites from ether roll (see above), apply Apistan strips.
- * Check for swarm cells in mountain areas.
- * Remove surplus honey leaving some space in supers for later summer and fall flow.
- * Treat colonies of honey bees with 1.6 ozs. of menthol crystals enclosed in a screen wire pouch to suppress tracheal mites. Treat when temperature is in 70°F range.
- * Colonies will need 40-60 pounds of honey for overwintering.
- * Extract supers of honey removed from colonies.
- * Return extracted supers to colony for cleaning

just before dark to prevent robbing by colonies.

- * Remove cleaned supers form colony, and store under para-di-chloro-benzene fumigation to prevent wax moth damage.
- * Requeen all colonies every year that you double crop. All colonies that you do not move with honey flows should be requeened every two years.
- * Before placing new caged queen in the colony, remove the old queen and all queen cells. Check the brood chamber and make sure you have two or more frames of sealed brood in the colony. Place the caged queen over the frames of brood.
- * Recheck the requeened colonies in 10 days for a laying queen. If eggs are present, do not disturb the colony.
- * Requeen colonies every other year unless they are used for double cropping on the valley and mountain honey flows.
- * Order your queens clipped and marked for easy location and identification. This can also aid in swarm prevention.

Fall Season

September

- * Check colony for *Varroa*. If numerous (see **Sensitivity of Method** above), apply Apistan strips for mite control.
- * Treat colonies with Mite-AwayII™ (formic acid pads) for *Varroa* and tracheal mites.
- * Requeen colonies that you did not requeen in August or that rejected the introduced queen in August.
- * Consolidate frames in supers that may have some empty space for storage of fall nectar flow. Fill supers with capped frames. Partially filled supers can be rearranged with empty frames in the center and the filled and capped frames on the outside.
- * Remove and store under fumigation all empty supers of comb.
- * Replace all hive parts that need repairing or painting with reconditioned parts. Repair and painting can be done much better in the shop.

October

- * Check colony for *Varroa*. If numerous (see **Sensitivity of Method** above), apply Apistan strips for mite control.
- * Place entrance reducers in the entrance.
- * Check each colony for a laying queen.
- * Treat with antibiotics every 7 days until 3 treatments are completed to prevent diseases.
- * Leave one shallow super completely full of honey plus the honey in the brood chambers.
- * Feed all colonies that do not have at least 40 pounds of honey stored. (A deep super or brood frame holds 6 pounds; a shallow super frame holds 2 1/2 pounds.) A deep super completely filled will hold 5-30 pounds of honey.
- * Feed a mixture of 2 parts of sugar to 1 part hot water.

November

- * Check colony for *Varroa*. If numerous (see **Sensitivity of Method** above), apply Apistan strips for mite control.
- * Rake all leaves and dead grass away from around the colony to prevent fire. Cut tall grass.
- * Feed Fumidol-B to prevent Nosema disease.
- * Fence apiary to protect the colonies from livestock.
- * Check all tops to be sure they are waterproof.
- * Place a weight on the outer cover to prevent the wind from blowing the top off the hive.
- * Top ventilate all colonies. Cut two or three 5/8-inch slots out of the rim of the inner cover. Invert the inner cover and place the openings in the rim to the front of the hive. Place the outer cover over the inner cover, sliding the outer cover forward; and secure the cover in place with a weight on top of the cover.
- * Sample a colony for tracheal mites. One hundred bees collected in alcohol. Forward to state bee inspector or UT Bee Disease Laboratory.

Wax Moth Control

- * Strong queen-right colonies with a balance of young housekeeping bees resist wax moth invasion.
- * Return all extracted supers to strong colonies just before dark for cleaning by the bees before storing equipment. Pollen and honey left in supers attract wax moths.
- * Supers of hive bodies that are to be kept off a colony for four or more days should be inspected periodically for the presence of wax moths. The larvae eat the wax, make webbing and ruin the comb.
- * Supers with dry drawn comb can be frozen for a week in a freezer to kill all stages of wax moth. Be careful when handling frozen frames because the wax will shatter easily if the frame is dropped.
- * Wax moth damage can be reduced by exposing the combs to light and air flow since wax moth prefer dark moist conditions. Supers can be hung up individually or when stacked they are alternated by placing a side front forward and then an end front forward in sequence.
- * Para-di-chloro-benzene (PDB) crystals can still legally be used to fumigate supers with dry comb. However, this material is suspected to cause cancer, therefore, the decision is yours to make.
- * Fumigation with PDB: Stack supers 8 high; seal holes and cracks with masking tape. Pour 2 tablespoons of para-di-chloro-benzene crystals in a shallow dish setting on frames in top super. Seal top of stack with inverted inner cover and outer cover.
- * Check stored supers occasionally for signs of wax moth damage.
- * Air fumigated supers for 24 hours before using this equipment on a colony.
- * Requeen weak moth-infested colonies.

Protect Honeybees from Insecticides

Pesticide Applicator

1. Use spray applications instead of dusts.
2. Apply sprays to plants when bees are not foraging on the plants.
 - a. plants not in bloom
 - b. after petal fall
 - c. late in the day when blossoms are closed
 - d. mow cover crops under fruit trees before applying cover sprays
 - e. mow blooming plants foraged by honeybees around field borders
3. Use insecticides which are less toxic to honeybees when possible.
4. Use insecticides with short-residual life.
5. To reduce drift, apply insecticides during periods when wind velocity is less than 5 miles per hour.
6. Keep sprayers in good repair for efficient coverage of crop plants.
7. Direct spray application on and under target plant in fine mist for effective coverage of crop.
8. Do not spray over colonies. Do not spray when drift is in the direction of colonies.
9. Notify beekeepers in your area at least 2 days in advance when frequent spray applications are scheduled for the following crops:
 - a. sweet corn
 - b. fruit
 - c. cotton
 - d. vegetables

Beekeeper

1. Register colonies with State Apiarist's office by July 1 each year, as required by law.
2. You are responsible for protection of your colonies.
3. You can confine your colonies for 3 days during periods of heavy insecticide spraying in your area. The colonies should be released for at least 1 day of flying at the end of the 3 days. Confining bees is not practical when a large number of colonies are located a considerable distance away from a good source of water. Draping with burlap is not practical in that it requires the application of water every 1-2 hours. However, this is the only protective measure we have short of moving the apiary out of the area.
4. Locate colonies a distance of 300 feet or more away from fields. Use wind breaks of vegetative growth to filter insecticide drifts.
5. Locate colonies upwind of field in direction of prevailing winds in the area.
6. Locate colonies so that flight path is not directly over fields that are sprayed frequently.
7. Move colonies two miles away from large fields that must be sprayed frequently.
8. You should be thoroughly familiar with all agricultural crops and pesticide use within flight range of your colonies.
9. Avoid hazards, anticipate problems, and cooperate with your neighbors.

TENNESSEE BEEMASTER PROGRAM

Publications Provided (UT/USDA)

TITLE	PUBLICATION #	AUTHOR (S)
Beekeeping in Tennessee	Pub 1745	Skinner et al.
Honey Bee Tracheal Mite	Pub 1359	Harry E. Williams
Honey Bees and Pesticides	Pub 1155	USDA
Tracheal Mites in Tennessee	SP409 A	John A. Skinner
Squash Pollination Guidelines	SP409 B	John A. Skinner
Tennessee BeeMaster Program	E&PP INFO 96	John A. Skinner
Crop Pollination	E&PP INFO 302	John A. Skinner
The Small Hive Beetle – A New Pest of Honeybees	SP 594	John A. Skinner
Using Terramycin for the Prevention of American Foulbrood	SP 596	John A. Skinner
Honey Bees in a Wall!! What Can Be Done??	Pub 1508	John A. Skinner
Varroa Mites in Tennessee	Pub 1511	John A. Skinner
Bee Aware: Africanized Honey Bee Facts	Pub 1513	John A. Skinner
Making a Pollination Contract	Pub 1516	John A. Skinner
Preparing for Honeybee Emergencies	Pub 1522	John A. Skinner
Swarming Honey Bees: What Should be Done	Pub 1524	John A. Skinner
ID & Control of Honey Bee Diseases	Pub 1112	USDA
Controlling the Greater Wax Moth	Pub 1111	USDA

4-H PUBLICATIONS		
The Family Tree of the Honey Bee	Unit 1 - Pub 711	Harry E. Williams
A Honey Bee Colony	Unit 2 - Pub 722	Harry E. Williams
Beekeeping Equipment	Unit 3 - Pub 744	Harry E. Williams
Seasonal Management of Honey Bees	Unit 4 - Pub 1070	Harry E. Williams
Processing and Packing Honey	Unit 5 - Pub 1074	Harry E. Williams
Nectar and Pollen Sources for Honey Bees	Unit 6 - Pub 1181	Harry E. Williams
Honey Bee Disease Pests, Poisoning and Regulation	Unit 7 - Pub 1217	Harry E. Williams