Crop Profile for Honey in Virginia

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Fig. 1. A honey bee parasitized by a Varroa mite.
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General Production Information[1]

- Virginia was ranked 39th among honey-producing states in 2004.
- According to the Virginia Agricultural Statistics Service (VASS), 7,000 honeybee colonies produced 266,000 lbs. of honey worth $567,000 in 2004. However, the actual number of colonies is approximately 38,000 managed hives that produce over 1 million lbs. of honey annually.
- The average price per pound was $2.13 in 2004.
- The top five honey-producing counties in 2002 were Clarke, Rockingham, Henry, Loudoun, and Augusta.

HONEY BEE BIOLOGY [2]

Honey bees are social insects native to Europe and Asia that were first brought to the Americas in the 1600s. The typical honey bee colony has one queen, 20,000 to 80,000 female workers, and up to 5,000 male drones. The queen's primary responsibility is reproduction; her eggs will develop into workers, drones, or new queens depending on the time of year and the colony's strength. Workers have many responsibilities at different stages in their life cycle including brood rearing, queen care, comb building, nest construction, foraging, nest maintenance, honey production and storage, hive thermoregulation, and colony defense. Drones, which serve only for reproduction, die immediately after successfully copulating. Those that fail to mate are thrown out of the nest in the fall. The honey bee population is lowest in winter and peaks in late spring or early summer.

Cultural Practices

Honey bees are managed for their honey, secondary hive products (e.g., beeswax and propolis), bee stock, and crop pollination services. Beekeepers typically sell their honey to manufacturers in bulk or to individuals in smaller amounts. Honey is sold in four forms: extracted (liquid), comb honey, chunk honey, and crystallized (creamed) honey. Beeswax may be used in candles or sold as solid blocks to the cosmetic industry. Pollen, royal jelly, and propolis can be found in various health food products. Queens, bee packages, and nucleus colonies (nucs) are sold to supplement or start honey bee colonies.
Bee pollination of agricultural crops is valued between $8 and 10 billion per year and is 30 to 40 times greater than the value of honey and beeswax alone. Approximately 30% to 35% of food in the United States is directly or indirectly dependent on insect pollination. Strawberries, cucumbers, squash, pumpkins, watermelons, muskmelons, beans, blueberries, peas, and peppers all

require bee pollination to produce larger, more attractive fruit and vegetables. Good pollination also results in a higher crop yield where development is more synchronized; conversely, bad pollination leads to smaller yields of inferior fruit over an extended period. Annually, about 2 million colonies are contracted out for pollination in the United States. In Virginia, 12,000 to 15,000 colonies are used each year to pollinate crops, particularly apples, cucumbers, and melons. Rental fees are usually $30 to $45 per hive, with approximately one to three colonies needed per acre, depending on the crop. Precautions must be taken when transporting bees to avoid heat stress. Symptoms of heat stress include many dead bees on the bottom of the hive and workers crawling frantically while fanning their wings. When moving hives, the hive cover should be replaced with a screen cover to reduce heat buildup.

The ideal apiary location is protected from the wind, sloped so that water drains away from the hives, exposed to sun all day, accessible throughout the year, and is not highly visible so it will be left undisturbed. Also, it is very important to have a clean water source within a quarter mile of the bee yard. The hives should face south or southeast to encourage flight and be slightly elevated off the ground with a clear front entrance. The typical hive consists of a bottom board, two hive bodies (brood chambers), honey supers of various depths (full, medium, shallow, and comb honey) filled with wooden frames that hold comb, and a cover. Other hive components include an outer telescoping cover, inner cover, queen excluder, entrance reducer, and a hive stand. Personal beekeeping equipment consists of light-colored, smooth clothing; a veil; gloves; a smoker; and a hive tool.

Beekeepers fall into three categories based on the number of hives they keep: hobbyists (< 50), sideliners (50 to 500), and commercial beekeepers (> 500). General management activities occur at different times of year depending on location. They typically include disease and parasite control, swarm prevention, supering, honey collection and processing, colony splits, requeening, and colony winterization. In late winter and early spring, the apiarist's chief concern is ensuring colony survival. It is vital that the colony grows rapidly in the spring but does not swarm. In early to mid-summer, supers should be added to encourage excess honey production. Finally, in the late summer and early autumn beekeepers should replace the queen, if necessary; treat for mites and diseases; and help the colony prepare for winter.

Bee colonies should be checked three to five times during the spring. The first exam is made in early to mid-March and should focus on evaluating food stores, the queen's condition, and the colony's strength. The colony should be examined a second time in late March to inspect the brood, assess the queen, identify disease, and initiate swarm prevention. Starved brood may appear when there are not enough nurse bees to feed them. Larvae may be observed crawling out of their cells, or adult bees will be found in their cells with their tongues hanging out. Swarming is prevented either by reversing hive bodies twice (first in late March/early April and again in mid- to late April) or by using the Demaree method, which involves segregating the queen at the bottom of the hive in a brood chamber with empty comb. If the bees make swarm preparations, queen cells should be removed or destroyed, and the colony can be split or the Demaree method may be implemented. Bee colonies should not be disturbed during major nectar flows, except for quick inspections and to add honey supers. A queen excluder may be added to keep the queen from laying eggs in honey storage areas.

During the summer, one or two inspections should be made to assess honey production and prevent or control diseases and parasites. Summer is also a good time to evaluate the colony's overall performance, such as honey production, tendency to rear brood and adjust rearing to nectar flows, and gentleness. Honey supers can be removed and cleared of bees by shaking and brushing workers from the frames, or by using a bee repellent, bee escape, or bee-blower. Only frames on which at least three-quarters of the cells are capped should be removed to ensure the honey is ripe (< 18.6% moisture) and ready for extraction. Honey supers are initially placed in a warm room (~90°F) for one or two days to make the honey less viscous. Cell cappings are removed with an electric knife or an uncapping machine, and the honey is extracted via centrifugal force using a manual or electric extracting machine. Finally the honey is strained, allowed to settle, and bottled for sale or personal use. Tracheal and Varroa mites should be treated in late summer after honey stores have been removed.

Two inspections may be made in the fall to monitor and assist the bees in their preparation for winter survival. In order to successfully overwinter, a colony needs at least 30,000 bees to maintain warm cluster temperatures within the hive. Weaker, smaller colonies should be combined. The typical colony needs 50 to 60 pounds of honey and three to five frames of pollen stores to survive through the winter months. The colony may be supplemented with sugar water and pollen if not enough food has been stored. During the fall, it is also important to make sure the queen is healthy and the colony is free of diseases and parasites. Signs of a good queen are a solid brood pattern, similar-aged brood, and no symptoms of disease. Requeening is

necessary at least every two years. First, the old queen is removed, and then a new queen is introduced. Requeening is usually recommended during the early fall in Virginia. Colonies may also be treated for Nosema disease in October. Other management practices that help bees overwinter include reducing the lower hive entrance, adding an upper entrance, and placing a layer of absorbent material such as newspaper over the inner cover. If bees cannot maintain the high temperatures necessary for development, the brood will die. For this reason, hives should not be worked at any time during the year when weather is wet and below 60°F.

Worker Activities

Beekeepers typically wear a veil, long-sleeved shirt, shoes, gloves, or a protective suit to prevent bee stings. These items are not worn to prevent pesticide exposure, but they may help minimize dermal contact. Pesticides are usually administered to treat honey bee diseases or parasites in early spring, late summer, or early fall. Varroa mites are controlled in the late summer or early fall using pesticide strips (e.g., Apistan or Checkmite+ strips), which are hung in the brood chamber and pose little risk of pesticide exposure. However, strips must be removed after approximately 50 days and at least four weeks prior to honey production. Chemical-resistant gloves should be worn when handling the pest strips. Two other pesticides, ApiLife VAR and Sucrocide, are used to control Varroa mites with variable success. Although Sucrocide is harmless to human skin, goggles and waterproof gloves should be worn when applying ApiLife VAR. Small hive beetle adults may be controlled at any time during the year by placing Checkmite under a piece of plastic cardboard inside the hive. In addition, the soil surrounding the hives may be treated using Gardstar 40EC to control pupating hive beetles. Apiarists should follow label directions and wear chemical-resistant gloves, a long-sleeved shirt, pants, and waterproof shoes to avoid pesticide exposure. In the early spring or late fall, colonies may be treated with the antibiotics terramycin and fumagillin to control European foulbrood (EFB) and Nosema disease, respectively. Tracheal mites are controlled in the late summer or early fall using menthol contained in screen packets on frames at the top of the hive. There is little risk of exposure, but gloves should be worn as a precaution. Currently, tracheal mite treatments are only recommended if analyses indicate a mite problem.

Ethylene oxide was once used to fumigate equipment contaminated with American foulbrood (AFB) disease. However, this product is no longer registered because it poses a high risk of health hazards. At present, when AFB is detected a state bee inspector should be notified. The current practice is to remove and destroy any frames of comb with disease symptoms by burning or burying them and to treat the colony with terramycin. Samples of diseased larvae are tested for AFB resistance to terramycin, and, if found, tylosin is used to treat the colony. Colonies are only destroyed and burned in cases of heavy infestation and low bee populations.

SPECIAL USE LABELS

Section 18 Emergency Use Exemption and Special Local Need 24 (c) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/Special Local Need label. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need (SLN) labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. However, a fee must be paid annually by the registrant to keep the product registered for use in Virginia. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) and can be renewed annually. Several treatment products for Varroa mites are currently under Section 18 labels.

Insect Pests

ARTHROPOD PESTS

INSECTS

Ants and Yellow Jackets, Formicidae and Vespidae spp.

Although ants and yellow jackets are not usually serious pests of beehives, their presence may indicate colony weakness. Ants are very hard to control once they become established. However, they tend to bother apiarists more than the honey bees themselves.

MONITORING: No specific monitoring protocol is recommended.

CHEMICAL CONTROL: Pesticides should not be applied directly to the colony or hive equipment. If pesticides are necessary, apply them only when the bees are inactive since general insecticides will also kill honey bees.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Maintain colony strength, keep bottom boards raised off the ground, remove debris from around the bottom of the hive, use ant barriers around colonies, or place single colonies on stands surrounded by oil or sticky traps.

Bee Louse, *Braula coeca*

The bee louse is a wingless, ectoparasitic fly pest of adult bees. It is reddish brown and smaller than the head of a pin. Bee lice entered the United States by hitchhiking on imported queen bees. Worker bees usually harbor only one bee louse while queens can be found with several of these parasites attached. Bee lice feed by stealing nectar directly from the mouths of bees, particularly nurse bees, but they rarely parasitize drones. Female bee lice lay their eggs on honeycomb cappings from May through July. The fly larvae then hatch and tunnel through the comb while eating wax and pollen. This activity makes comb honey unsightly for sale to the public.

MONITORING: No specific monitoring protocol is recommended because the bee louse is rarely found in Virginia.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: No cultural controls are currently recommended.

Small Hive Beetle, *Aethina tumida*

The small hive beetle (SHB) is native to Africa. Both adults and larvae can be serious pests of honey bee colonies. Adults are reddish-brown or black, less than ¼-inch long, and live up to six months. Female beetles lay their eggs, which are smaller than those laid by queen bees, in crevices within a hive. Larvae damage the wax comb while feeding on honey and pollen. They also ruin honey by defecating within the food cells, causing the honey to ferment and smell like rotten oranges. Furthermore, the honey becomes thin and runs out of the combs. This, compounded by the repugnant smell, may cause bees to abandon the hive. Small hive beetles spend five to seven weeks pupating in the soil before emerging as adults.

MONITORING: Look for the symptoms noted above.

CHEMICAL CONTROL: Coumaphos and permethrin are used to control SHB. See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: Fungi and nematodes have been evaluated but are not available for commercial use.

CULTURAL CONTROL: Do not store honey for any length of time before extraction. Keep the comb in a location with less than 50% relative humidity to keep SHB eggs from hatching.

Wax Moth, *Galleria mellonella*

Lesser Wax Moth, *Achroia grisella*

Wax moths are serious pests of wax comb and cause over $5 million in damage annually. The lesser wax moth is not as important in Virginia although it does occur. These moths lay 300 to 600 eggs on or near wax combs each day. Caterpillars hatch three to five days later and tunnel through the wax combs, leaving webbing and debris behind. Immature wax moths feed on pollen, cast skins, and cocoons, but they do not usually attack new wax combs or foundation. Wax moths pupate outside of the comb and take from one to several months to complete development. These lepidopteran pests do not directly destroy bee colonies, but they can infest stored equipment and weaken colonies by forcing them to spend more time on comb maintenance. Strong bee colonies are better able to keep wax moths under control.

MONITORING: Signs of wax moth infestations include webbing, debris, pupal cocoons, and tunnels in the combs. Stored equipment that contains comb is most susceptible to wax moth infestations.

CHEMICAL CONTROL: Paradichlorobenzene (PDB) crystals will protect stored comb without honey. If any honey is present, it will be unsuitable for human consumption. Aluminum phosphide may also be used to fumigate hives and equipment. See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: *Bacillus thuringiensis* (Certan) was once used, but it is no longer available. Natural enemies include parasitic wasps, but they are ineffective.

CULTURAL CONTROL: Freezing temperatures kill all stages of wax moths, so store comb honey in the freezer and leave equipment in a dry, uninsulated room during the winter.

MITES

Tracheal Mites, *Acarapis woodi*

External Mites, *A. externus* and *A. dorsalis*

Tracheal mites are parasites of the respiratory system of adult bees. They were first discovered in Virginia in 1985, but these mites tend to be more severe in northern parts of the United States. They usually infest the respiratory tubes of the first thoracic segment, although they may invade the air sacs as well. Tracheal mites are transmitted by bee-to-bee contact and may also be introduced into colonies from package bees or new queens. Female mites lay their eggs in the tracheal tubes of honey bees where they complete development in as rapidly as two weeks. Mites feed by puncturing tracheal walls and ingesting the host's fluids. Infested bees become stressed and exhibit damaged flight muscles. Mite populations are highest and most destructive during the winter when heavy infestations can kill an entire bee colony. Honey production and winter survival are impacted when as few as one-third of the colony workers are parasitized. External mites (*A. externus* and *A. dorsalis*) are not considered an economic problem.

MONITORING: These mites are easier to detect during the fall and late winter. Collect sick bees from the hive entrance and store them in 70% ethanol until the tracheae can be examined under a microscope. Tracheal tubes infested with mites will usually have brown staining. Recent studies in Virginia indicate tracheal mites are not a problem. Colonies do not need treatment unless sampling indicates otherwise.

CHEMICAL CONTROL: If treatment is necessary, it is best to apply controls such as menthol in August or early September when winter bees are being reared. See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Use resistant honey bee varieties (e.g., New World Carniolan and Russian genotypes).

Varroa Mites, *Varroa destructor* (= *Varroa jacobsoni*)

Varroa mites are the most serious pests of honey bees in the world. They can completely wipe out a colony in two to four years. Varroa mites are found wherever bees occur, but they first appeared in Virginia in 1990. These ectoparasites feed primarily on the hemolymph of immature male bees but will also attack adults. Developing drones are ten times more attractive to Varroa mites than are the worker brood. Female mites infiltrate brood cells before they are capped and feed on the blood of immature bees. They lay eggs a day and a half after cells are capped and continue to produce new eggs every 30 hours. Immature mites develop on bee pupae and take about a week to mature. Mite feeding leads to shortened life span due to tissue damage; diminished productivity; pupal death; and malformed wings, legs, and abdomens. Varroa mites may also vector viral diseases such as deformed wing virus (DWV), chronic bee paralysis virus (CBPV), and acute bee paralysis (ABPV).

MONITORING: Identify mites on adults by using the shaking/washing method or the ether/sugar roll method. Capped pupae, especially drones, can be examined using a cappings scratcher. A screenboard with white sticky paper on the bottom board can also be used for quantitative measurements. Spotty brood patterns may indicate a Varroa mite infestation, particularly if associated with DWV.

CHEMICAL CONTROL: Coumaphos, fluvalinate, formic acid, sucrose octanoate, and ApiLife VAR are all used to treat Varroa mites. See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: Entomopathogenic fungi (e.g., *Metarhizium anisopliae*) are being studied but are not yet commercially available.

CULTURAL CONTROL: Cull mites with screened-bottom boards and trap mites in drone combs. Resistant bee stocks are under development and include Russian bees and hygienic lines with the SMR (suppressed mite reproduction) trait.

CHEMICAL ARTHROPOD CONTROL

- **aluminum phosphide** (*Phosfume*, *Gastoxin*) For fumigation of diseased beehives and beekeeping equipment. Kills bees and greater wax moths. **RESTRICTED-USE PESTICIDE.**
- **coumaphos** (*Checkmite+ Strips*) – Organophosphate. For control of fluvalinate-resistant Varroa mites, use one strip per five combs placed close to the bee cluster. Apply in spring two months before adding honey supers or in the fall after removing the honey supers. **DO NOT** use during surplus honey flow, and remove honey supers before treating. Supers can be replaced after a 14-day withholding period. For SHB, cut a strip in half, staple it to a piece of plastic corrugated cardboard, and place on the bottom board of the hive. Leave strips in for 42 – 45 days. **SECTION 18 EXEMPTION.**
- **fluvalinate** (*Apistan* Strips) – Pyrethroid. For control of Varroa mites in beehives, hang two strips in the brood chamber during the spring or fall for 42 – 56 days. **DO NOT** use within four weeks of marketable honey flow. Remove honey before treatment and allow two weeks to pass after strip removal before replacing the supers.
- **formic acid** (*Mite Away II*) – For control of tracheal and Varroa mites, use one treatment pad for 21 days when temperatures are 50°F – 79°F. Remove all honey supers before treatment and do not use during nectar flow.
- **menthol** (*Mite-A-Thol*) – Treat tracheal mites in overwintering hives during the early spring or fall when there is no surplus honey flow and daytime temperatures are at least 60°F – 80°F,. Put 1.8 oz. of product in a 7-inch-square plastic screen on the top frames or on the bottom board. Replace packs as necessary, but remove packets 10 – 12 weeks after initial treatment. Remove packs at least one month before surplus honey flow.
- **paradichlorobenzene** (*Para-Moth*) – For empty, stored combs, use at a rate of 3 oz. per five hive bodies. Hive bodies

with combs are stacked on a closed bottom-board and a cover is placed on top. Place product on a piece of paper or cardboard at the top of the frames to control adult and immature greater wax moths. Does not kill eggs. Reapply after two to three weeks if crystals are gone. Air out honey supers for at least two weeks before introducing live bees. Do not use on stored frames of honey.

- **permethrin** (*Gardstar* 40EC) – Pyrethroid. For control of SHB outside of hive **ONLY**. Highly toxic to bees if applied incorrectly. Use at a rate of 5 ml per gallon of water for six hives. Use a sprinkle can to drench the soil 18 – 24 inches in front of each beehive once bees are inactive during the late evening. Reapply after 30 – 45 days.
- **sucrose octanoate** (*Sucrocide*) – For control of Varroa mites, spray bees on comb directly with a *Sucrocide* solution at a rate of 1.5 oz. per frame of bees. Administer three applications (one every 7 – 10 days). *Sucrocide* is as effective as *Checkmite* and *Apistan* in controlling Varroa mites in late fall. More research is needed to assess its effectiveness at other times when the brood population is higher. Although inexpensive, *Sucrocide* is harder to apply because each frame must be sprayed individually. It is harmless to human skin, but goggles and waterproof gloves are necessary when applying. **SECTION 3 PESTICIDE.**
- **thymol + eucalyptus oil + L-menthol** (*Api-Life VAR*) – For control of Varroa mites, break one tablet into quarters, enclose them in pieces of 8-mesh screen, and place on the top corners of the hive body. Reapply two additional times (after removing the old tablet pieces) at 7- to 10-day intervals. Leave the last tablet on for 12 days, and then remove all material. Remove honey supers 30 days before treating, and do not use within five months of surplus honey flow. Do not use when temperatures are above 90°F. Compared to *Checkmite* and *Apistan*, this product is more expensive, harder to administer, not as effective, and possibly harmful brood production. **SECTION 18 EXEMPTION.**

Vertebrates

Mice

Mice make nests in hives and destroy combs during the fall and winter months. Rodents build their nests in corners away from the bee cluster so they do not get stung. Their urine is partially repellent to bees and will not be cleaned out by them in the spring. Mouse problems in beehives are most likely to occur in apiaries located near woodlots or in fields.

MONITORING: No specific monitoring protocols are recommended.

CHEMICAL CONTROL: Chemical control is unnecessary if cultural controls are followed.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: For beehives in use: reduce the lower hive entrance in early fall, chase away mice already in the hive, destroy nests, and replace chewed frames because bees will replace destroyed worker cells with drone cells. For beehives in storage: cover the top and bottom of combs with a pile of supers and a queen excluder, wire screen, or telescoping lid.

Skunks, Raccoons, and Opossums

Skunks, raccoons, and opossums feed at beehive entrances at night (when bees are less likely to sting) primarily during the spring, but also during summer and fall. They scratch at the entrance, and when bees come to defend the colony, the invaders eat the bees. These mammals have been known to feed for an hour or more. This feeding activity causes bee colonies to become more defensive and aggressive.

MONITORING: Bee parts will be visible on the ground near the entrance. Also, the grass and hive will appear disturbed.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Keep strong colonies, use screens or queen excluders at the front of the hive, add an upper entrance, install a fence around the bee yard, keep colonies on stands, or move bees to a new location. A piece of chicken wire can be stapled to the bottom board and stretched in front of the hive to discourage skunks and other animals.

Bears

Bears eat bees, brood, and honey. They destroy hives and are very hard to control.

MONITORING: No specific monitoring protocol is recommended.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Select the apiary site carefully to avoid bear home ranges and pathways, forest edges, and ravines. Game wardens will capture nuisance bears and release them elsewhere, when possible. Install a baited, electric fence around the bee-yard. Establish the apiary away from trees, which would allow bears to climb and drop inside the fence.

Birds, Amphibians, and Reptiles

Insectivorous birds, blue jays in particular, eat honey bees as they are entering or leaving the hive. They can be a severe problem in queen-rearing operations. Amphibians and reptiles will also eat honey bees, but they are not serious pests.

MONITORING: No specific monitoring protocol is recommended.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: No cultural controls are currently recommended.

Diseases

BACTERIAL DISEASES

American Foulbrood, *Paenibacillus larvae*

American foulbrood disease is the most serious honey bee disease in America. AFB spores are spread to young larvae (less than two days old) while being fed by nurse bees. Immature bees die from this bacterial disease in the late larval or pupal stage and decay in their cells. AFB is also spread by housekeeper bees and by apiarists using contaminated equipment. Honey can become contaminated as well. Once a colony grows weak from AFB, robber bees may infiltrate the hive, steal infected honey, and bring it back to their own brood, thus spreading the disease. AFB spores remain viable indefinitely.

MONITORING: Dead bees change color from tan to dark brown and become “ropey” (stretch out 1 inch or more when pulled out of the cell with a toothpick). Prepupae form “scales” in their cells that are hard to remove. Pupae may be found with extruded tongues. Cell cappings may appear sunken and dark in color, with multiple perforations and a

characteristic odor similar to animal-based glue. There may also be a spotty brood pattern of infected and uninfected cells. Positive identification of AFB can be made with the VITA diagnostic kit, which uses AFB-specific antibodies.

CHEMICAL CONTROL: Terramycin is sometimes used to prevent or control the disease in colonies, although no antibiotics are able to completely control AFB. Tylosin may control AFB infections in colonies if AFB is terramycin resistant. The fumigant ethylene oxide is no longer available to treat infected equipment. See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Maintain good management and sanitation practices. If AFB is identified in a colony, all infected combs should be removed and destroyed by burning. The colony should be treated with terramycin (or tylosin, if AFB is terramycin resistant). The bees in an infected colony can also be shaken into clean equipment with frames of foundation. They should also be treated with terramycin. Very heavily diseased colonies with small bee populations are best destroyed and burned. After working with an infected colony, clean hive tools with 10% bleach solution and a wire brush. Clean any contaminated clothing or gloves. Close off infected hives after killing the bees if you cannot destroy them immediately. Healthy bees should not be exposed to AFB-infected honey or allowed to rob diseased colonies. Humans may safely eat honey from diseased hives. Hive bodies, covers, and bottom boards from infected hives should be disinfected by scorching before reuse. All cases of AFB must be reported to the Virginia state apiarist or one of the state bee inspectors.

European Foulbrood, *Melissococcus pluton*

Along with sacbrood, Nosema, and chalkbrood, European foulbrood is a stress disease of honey bees aggravated by conditions such as cool temperatures, moisture, and food shortages. It is caused by nonspore-forming bacteria that are transferred throughout the colony via housekeeper bees as they remove dead larvae. It is also spread by beekeepers using contaminated equipment and robber bees. Young larvae ingest EFB bacteria and die within four days of egg hatch. EFB is most common with increased brood rearing in the spring. The severity of the disease may vary from one hive to the next. EFB can seriously retard colony growth, although the infection usually goes away on its own, especially as summer begins. Strong honey flows help honey bees overcome EFB.

MONITORING: Unlike with AFB, larvae killed by EFB usually die in the coiled stage and do not become "ropey." Also, the larvae change from yellow to brown, with a silvery cross-pattern caused by tracheal discoloration. Decomposed larvae form a rubbery scale that is easily detached. Positive identification of EFB can be made with a VITA diagnostic kit, which uses EFB-specific antibodies.

CHEMICAL CONTROL: Treat with the antibiotics terramycin or tylosin. See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: To treat light infections, reduce stress; with moderate cases, reduce stress and possibly requeen; and for severe infections, treat with terramycin and requeen. Honey bees vary in resistance to EFB; thus, requeening helps by changing stock.

FUNGAL DISEASES

Chalkbrood, *Ascosphaera apis*

Chalkbrood is a fungal disease that infects three- to four-day-old larvae in stressed bee colonies. It is most common in the spring or any time there is heavy precipitation during cool weather. Nurse bees spread the fungal spores while feeding immature bees. The spores germinate in the gut of the larva and mycelia grow, causing the larva to appear

white, chalky, and mummified. Larvae usually die in an upright, stretched-out position. Worker bees may then uncap the dead bee larvae. Chalkbrood does not usually destroy a colony, but it may result in fewer bees or less honey at peak times. Spores can persist for years in infected beehives.

MONITORING: Look for symptoms described above.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Treat by reducing stress or by requeening. Honey bees show differences in susceptibility to chalkbrood. No other effective treatments are available.

Stonebrood, *Aspergillus flavus, A. fumigatus*

Stonebrood is caused by two types of fungi. It may be misidentified as chalkbrood, although the mummies differ in appearance. As with other brood diseases, stonebrood is thought to be transmitted via infected food from nurse bees. Stonebrood affects larvae, pupae, and adult bees, causing them to become hard and covered with powdery greenish spores, especially around the head.

MONITORING: Stonebrood is extremely rare. Mummies are yellowish green or grayish green in color.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: None. Bees remove diseased brood and recover quickly on their own.

PROTOZOAN PESTS

Nosema, *Nosema apis*

Nosema is a very common honey bee disease. As many as 70% of the colonies in Virginia may be infected. This disease typically becomes problematic in late winter, early spring, or during cool, wet weather. Adult bees consume infective spores, which then germinate in the midgut and invade the epithelial cells. The digestive system is disturbed, leading to malnutrition and a shortened life span. Other symptoms may include severe dysentery (defecation within the hive); weak, crawling bees; and poor buildup in the spring. Occasionally, many dead and dying bees are visible near the hive entrance. Nosema is spread in contaminated feces, honey, and combs. It also spreads via hive robbing, contaminated equipment, and infected package bees. In severe cases, Nosema disease may lead to queen supersedure (natural queen replacement).

MONITORING: Nosema disease is identified by analyzing abdominal contents. Infected mid-guts will appear white and bloated and Nosema spores will be apparent during the microscopic examination of homogenized gut tissue.

CHEMICAL CONTROL: Use fumagillin (Fumidil-B) during an active infection or preventively during the fall. See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Keep bees healthy and use good management techniques to reduce stress. Use clean equipment to avoid spreading Nosema among colonies.

CHEMICAL DISEASE CONTROL

- **fumagillin** (*Fumadil-B*, *Fumagillin-B*) – For control of Nosema, mix 1 tsp. per gallon of syrup and feed at a rate of 2 gallons of syrup per colony during the fall or spring. Use at least 30 days before spring honey flow and any time after fall honey flow is finished.

- **resmethrin** – Pyrethroid. To kill colonies with heavy AFB infestations, apply inside the hive. Burn dead bees and infected equipment at least 12 hours after pesticide application.

- **terramycin** (*TM-50D*, *TM-100D*, *TM-25*, *Tetra-B Mix*) – For control of EFB and to prevent AFB, sprinkle dust mixed with powdered sugar over frames or mixed with shortening and sugar to make extender patties. Apply three times (once per week) using one patty per colony. DO NOT use within four weeks of marketable honey flow. AFB resistance to terramycin has been reported.

- **tylosin** (*Tylan*) – Apply as a dust at a rate of 200 mg in 20 g of confectioner's sugar three times (once per week) to the top bars of frames. Do not use before or during honey flows.

VIRAL DISEASES

Sacbrood Virus

Sacbrood is a stress disease caused by a virus. The disease is most likely to occur in spring and early summer during stressful conditions such as cool temperatures, excess moisture, and malnutrition. Sacbrood tends to disappear after conditions improve and especially after the main nectar flow. It has been identified in healthy larvae and adults as well as in sick bees. However, two-day-old larvae are more susceptible to this disease. Immature bees turn from yellow-gray to black, with the head blackening first. The dark cappings of the brood cells appear punctured or partially removed. Larvae die in an upright position after their cells have been sealed. Dead larvae resemble fluid-filled sacs and can be removed from the cell intact. Like EFB, the decomposed larval scale is easily removed from the cell.

MONITORING: Look for the symptoms described above.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: The only treatments for sacbrood are reducing stress and improving living conditions.

Bee Paralysis Viruses

Chronic bee paralysis virus and acute bee paralysis virus are spread by Varroa mites. These diseases may also be passed on contagiously in the hive. Paralysis viruses make bees unable to fly and cause them to shake uncontrollably. Affected individuals lose their hair and become dark and shiny like robber bees. Sick bees are usually seen crawling up and falling down from the front of the hive.

MONITORING: Look for the symptoms mentioned above.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Requeen using a different honey bee strain. Add a frame of sealed brood from a healthy

colony. Control Varroa mites, which vector these viruses.

Deformed Wing Virus

Deformed wing virus is associated with heavy Varroa mite infestations. DWV was once thought to be caused directly by mite feeding. However, Varroa mites actually carry viruses that cause wing deformities. Viruses have also been isolated from pollen, honey stores, comb, and healthy-looking bees. DWV cause bees to grow ragged wings that are incapable of flight. Deformed bees either die off naturally or are actively removed from the colony.

MONITORING: Look for the symptoms mentioned above.

CHEMICAL CONTROL: No chemical controls are currently recommended.

BIOLOGICAL CONTROL: No biological controls are currently recommended.

CULTURAL CONTROL: Control Varroa mites to minimize the spread of DWV.

PESTICIDE IMPACTS ON HONEY BEES

Pesticides are the greatest abiotic threat to bees. Several million colonies have been destroyed by insecticides and miticides in the last 50 years. Certain chemicals are more or less toxic to honey bees depending on the type of formulation. Dusts are most dangerous due to their long residual activity and because they cling to bees' hairs. Granular compounds are least harmful, while wettable powders and emulsifiable concentrates are moderately or highly hazardous. Microencapsulated formulations are dangerous because they can be carried back to the hive, stored with food reserves, and spread to the entire colony. Suspect pesticide poisoning when the following symptoms appear: older forager bees die suddenly; many dead bees are in front of the hive; bees are shaking, paralyzed, or unable to fly; individuals are regurgitating onto themselves; or bees exhibit other unusual behavior. Bees are most likely to be poisoned indirectly when they visit pesticide-treated blooming crops (e.g., sweet corn), blooming weeds growing in or adjacent to pesticide-treated crop fields (e.g., alfalfa), blooming groundcover plants in orchards, or pesticide-contaminated water sources. To help bees avoid insecticide poisoning, implement the following tactics:

- Maintain a clean water supply for bees.
- Establish the apiary away from where pesticides are sprayed or may drift.
- Move colonies if adjacent fields are to be sprayed. If hives cannot be moved, cover them with wet burlap for no longer than two days. Spray covered hives with water and keep them wet.
- If involved in commercial pollination, do not let farmers spray when bees are active.
- Notify local beekeepers 48 hours before prior to spraying pesticides.
- Use bee-friendly chemicals with the shortest residual period in the least toxic formulation, if possible.
- Control weeds in crop fields.
- Mow blooming groundcover plants in orchards before prior to spraying pesticides.
- Spray in the evening or early morning when bees are not active.

DO NOT:

- Apply pesticides directly to hives.
- Apply pesticides to crops when bees are foraging actively.
- Allow pesticide tank rinsate to accumulate because bees may use it for a water source.
- Apply highly toxic pesticides to crops in bloom or flowering weeds.
- Allow pesticides to drift.

RELATIVE TOXICITY OF PESTICIDES TO HONEY BEES [3]

GROUP 1. HIGHLY TOXIC: Severe losses may be expected if these pesticides are used when bees are present at treatment time or within a day after.			
Acramite (bifenazate)	Capture (bifenthrin)	Famphos (famphur)	Nexter (pyridaben)
Actara, Platinum (thiamethoxam)	Carzol (formetanate)	Ficam (bendiocarb)	Orthene (acephate)
Admire, Provado (imidacloprid)	Cidial (phenthoate)	Folimat (omethoate)	Parathion
Advantage (carbosulfan)	Commodore, Warrior (lambda-cyhalothrin)	Fipronil	Pay Off (flucythrinate)
Afugan (pyrazophos)	Cygon, De-fend, Rebelate (dimethoate)	Furadan F (carbofuran)	Phosdrin (mevinphos)
Ambush, Gardstar, Pounce (permethrin)	Cythion (malathion)	Fury (zeta-cypermethrin)	Proaxis (gamma-cyhalothrin)
Ammo, Cymbush (cypermethrin)	Danitol (fenpropathrin)	Gardona (tetrachlorvinphos)	Synthrin (resmethrin)
Arsenicals	Dasanit (fensulfothion)	Guthion (azinphos-methyl)	Sevin (carbaryl)
Asana (esfenvalerate)	DDVP, Vapona (dichlorvos)	Imidan (phosmet)	Sumithion (fenitrothion)
Avaunt (indoxacarb)	Dibrom (naled)	Lannate D, Nudrin (methomyl)	Supracide (methidathion)
Avid (avermectin)	Spectracide (diazinon)	BHC (lindane)	Swat (bonyl)
Azodrin (monocrotophos)	Dimecron (phosphamidon)	Matacil (aminocarb)	Temik (aldicarb)
Baygon (propoxur)	Dursban, Eradex, Lorsban (chlorpyrifos)	Mesurol (methiocarb)	TEPP
Baytex (fenthion)	Ectrin, Pydrin (fenvalerate)	Methyl parathion	Zectran (mexacarbate)
Baythroid (cyfluthrin)	EPN	Monitor, Tameron (methamidophos)	Zephyr (abamectin)
Bidrin (dicrotophos)	Ethyl guthion (azinphos-ethyl)	Nemacur P (phenamiphos)	

GROUP 2. MODERATELY TOXIC: These can be used around bees if dosage, timing, and method of application are correct, but should not be applied directly on bees in the field or at the colonies			
Abate (temophos)	Ciodrin (crotoxyphos)	Korlan (ronnel)	Rhonthane (RDE)
Agritox (trichloronate)	Counter (terbufos)	Larvin (thiocarb)	SpinTor, Conserve SC, Entrust (Spinosad)
Agridip, Asunthol (coumaphos)	Decis (deltamethrin)	Metasystox (demeton-s-methyl)	Systox (demeton)
Assail (acetamiprid)	Di-Syston (disulfoton)	Metasystox R (oxydemeton-methyl)	Thimet (phorate)

Banol (carbanolate)	Dyfonate (fonofos)	Mocap (ethoprop)	Thionex (endosulfan)
Bolstar (sulprofos)	endrin	Oil Sprays (superior type)	Trithion (carbophenothion)
Carzol (formetanate)	Esteem (pyriproxyfen)	Pirimor (pirimicarb)	Vydate (oxamyl)
Chlordane	Ethodan (ethion)	Pyramat	
GROUP 3. RELATIVELY NONTOXIC: These can be used around bees with a minimum risk of injury			
Acaraben (chlorobenzilate)	Dessin (dinobuton)	Kryocide (cryolite)	Pyrethrum
Acarol (bromopropylate)	Dimilin (diflubenzuron)	Mavrik, Spur (fluvalinate)	Rotenone
Agri-Mek (avermectin)	Dinocap (karathane)	Marlate (methoxychlor)	Ryania
Allethrin	Dylox (trichlorfon)	Morestan (oxythioquinox)	sabadilla
Altosid (methoprene)	Ethrel (ethephon)	Murvesco (fenson)	Saphos (menazon)
Amitraz	Esteem (pyriproxyfen)	Neotran	Savey (hexythiazox)
Apollo (clofentezine)	Fujimite (fenpyroximate)	Nicotine	Surround (kaolin)
Aza-direct, Neemix (azadirachtin)	Fulfill (pymetrozine)	Omite (propargite)	Tetram
Accoate, Biotrol, Dipel (*Bacillus thuringiensis*)	Heliothis polydrosis virus	Ovotran (ovex)	Trigard (cyromazine)
Calypso (thiacloprid)	Intrepid (methoxyfenozide)	Pentac (dienochlor)	Vendex (fenbutatin oxide)
Chloroparacide (chlorbenside)	Isomate	Plictran, Mitacid (cyhexatin)	Zeal (etoxazole)
Confirm (tebufenozide)	Joust (chinomethionate)	Pynamin (pyrethrin)	
Cyd-X (CM granulovirus)	Kelthane (dicofol)	Pyrellin (rotenone/pyrethrin)	
FUNGICIDES: Generally, fungicides are safe to use around honey bees.			
Afugan (pyrazophos)	Copper oxychloride sulfate	Ferbam	Plantvax (oxycarboxin)
Arasan (thiram)	Copper sulfate	Karathane	Polyram (metriam)
Benlate (benomyl)	Kocide (cupric hydroxide)	Maneb	Sulfur
Bordeaux mixture	Cyprix, Syllit (dodine)	Mancozeb	Vitavax (carboxin)

Bravo (chlorothalonil)	Dithane D-14 (nabam)	Morocide (binapaeryl)	Zerlate (Ziram)
Captan	Du-Ter (fentin hydroxide)	Mylone (dazomet)	Zineb
Copper oxides	Dyrene (anilazine)	Phygon (dichlone)	
HERBICIDES, DEFOLIANTS, AND DESSICANTS:			
Atrex (atrazine)	2,4-D	Herbisan (EXD)	Princep (simazine)
Alanap (naptalam)	Daconate (MSMA)	Hyvar (bromacil)	Probe (methazole)
Amiben (chloramben)	Dalapon	IPC (propham)	Ramrod (propachlor)
Amitrol	2,4-DB	Karmex (diuron)	Ronstar (oxadiazon)
Ammate	2,4-DP (dichlorprop)	Kerb (proamide)	Sencor (metribuzin)
Balan (benefin)	Diquat	Lasso (alachlor)	Sinbar (terbacil)
Banvel (dicamba)	DSMA	Lorox (linuron)	Surflan (oryzalin)
Betanal AM (bentanex)	Endothal	MCPA	Sutan (butylate)
Bladex (cyanazine)	Eptam	Paarlan (isopropalin)	Tordon (picloram)
Cacodylic acid	Folex (desmedipham)	Prowl (pendimethalin)	Treflan (trifluralin)
Caparol (prometryn)	Glyphosate	Phenmedipham (Betanal)	
Cotoran (fluometuron)	Gramoxone (paraquat)	Pramitol (prometone)	

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3. Fell, R.D. 2006. "Regulations and Basic Information: Protecting Honey Bees." 2006 Virginia Pest Management Guide. http://www.ext.vt.edu/pubs/pmg/fc1.pdf

On-Line Resources

Virginia Agricultural Statistics Service
http://www.nass.usda.gov/va

Virginia Tech Pesticide Programs
http://www.vtpp.ext.vt.edu

Virginia 2006 Pest Management Guides
http://www.ext.vt.edu/pubs/pmg/

Virginia State Beekeepers' Association
http://www.virginiabeekeepers.org