

THE JOURNEYMAN BEEKEEPER

A Study Guide for the Intermediate-Level Master Beekeeper Examination

SOUTHEASTERN UNITED STATES

*Keyed to the 365-question Intermediate (Journeyman) examination
Twenty chapters · Study aids · Full examination coverage map*

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This document is a result of organizing and researching many online resources, combined with proven topics from Journeyman courses in South Carolina, as well as Journeyman level presentations made by me to local groups and at State conferences.

To assist in the creation of this Journeyman Beekeeper Certification Study Guide, A.I. has been used especially for organizing and amending the information presented. A word of warning, while A.I. is great at organizing and managing information, it can make mistakes, sometimes convincingly. The core information contained here has been passed through A.I. multiple times to confirm the validity of the information however it is up to the reader to double-check the facts contained here. Additionally, science changes. What was once an accepted fact becomes dated and replaced by newer scientific discoveries. Accepted treatments change; approved treatments are replaced or outlawed. Therefore, the reader, as a prospective Journeyman beekeeper, should always perform due diligence to ascertain the validity of any information contained here.

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**Edited and compiled by Larry Coble, Eastern Apicultural Society Master
Beekeeper**

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The Journeyman Beekeeper

A Study Guide for the Intermediate-Level Master Beekeeper Examination

Southeastern United States

How to Use This Study Guide

This guide was built to teach the content of the separate accompanying examination. The 365 questions on the Intermediate (Journeyman) examination for the Southeastern United States was read, sorted by subject, and assigned to a chapter. Where the examination tests a fact, this guide teaches the fact. Where the examination tests a judgment — and most of the harder items do — this guide teaches the reasoning that produces the judgment. Appendix D maps every examination question to the chapter that covers it, so you can verify for yourself that nothing on the test is unstudied.

A word about what the Journeyman level actually asks of you. The Certified level asks whether you can keep bees alive. The Journeyman level asks whether you can explain to somebody else why they should do what you are telling them to do. The examination reflects this: it is full of items where three of the four answers contain a true statement attached to a false explanation. You will not pass by recognizing vocabulary. You will pass by understanding mechanism.

The structure of each chapter

Each of the twenty chapters follows the same pattern:

- **Learning Objectives** — what you should be able to do when you finish the chapter.
- **The body of the chapter** — the teaching text, organized by subject.
- **Numbers to Memorize** — the figures that appear on examinations and that you should be able to produce without hesitation. These are collected again in Appendix B.
- **Key Terms** — vocabulary you should be able to define and use correctly.
- **Self-Check** — questions in the same formats the examination uses, with answers and brief explanations.
- **References for Further Study** — where to go next, separated into standard texts, regional extension sources, and primary literature.

How to study

Six suggestions, in the order they matter.

Read the chapter before you read the questions. The temptation with any question bank is to work the questions and look up what you missed. This produces a candidate who can answer those 365 questions and no others. The examination is a sample from a subject, not the subject itself.

Learn mechanisms, not conclusions. “Treat for mites in August” is a conclusion. “The bees reared in August and September become the long-lived winter bees, and mites feeding on them during development leave them short-lived and virus-damaged, so the colony dies in January having looked strong in September” is a mechanism. The mechanism generates the conclusion, and it also generates the answer to a question you have not seen before.

Keep the Southeast in front of you. A great deal of published beekeeping advice is written for a northern calendar and is simply wrong here. The most reliable way to miss questions on this examination is to answer them from a general text. Wherever this guide flags a regional difference, that difference is examinable.

Work the short-answer items in writing. The examination’s short-answer questions ask you to produce a structured answer under time pressure. That is a skill, and it does not develop from reading. When a Self-Check item asks for four factors, write down four factors before you look at the answer.

Learn to distinguish signs from diagnoses. A spotty brood pattern is a sign with at least nine causes. Fecal spotting is a sign, not a *Nosema* diagnosis. Deformed wings are a sign that points almost always at mites. Much of the applied-scenario section of the examination is testing whether you jump from sign to conclusion or work through the differential.

Check anything that can change. Pesticide labels, state apiary law, cottage food statutes, treatment authorizations and product registrations all change, sometimes within a single season. This guide states the position as of its writing and tells you where to check. An examiner will accept “I would check the current label” as part of an answer; an examiner will not accept a confidently recited label provision that was superseded two years ago.

A note on currency

This guide was written in 2026. Several matters have moved since the standard reference texts were published, and the guide flags them where they arise:

- The 2024–2025 year brought the highest colony losses recorded by the national survey (55.6 percent annual loss), and a USDA-ARS investigation of collapsing commercial operations implicated acute bee paralysis virus and deformed wing virus A and B vectored by *Varroa*, with an amitraz-resistance mutation found in every mite screened.
- The Honey Bee Health Coalition’s *Tools for Varroa Management* reached its 9th edition in 2026, with action thresholds of 1 percent early in the season and 2 percent from peak season on — lower than the “3 percent” still found in older texts.
- New *Varroa* treatments have been registered: an extended-release oxalic acid strip that spans brood cycles, and the first RNA-interference (dsRNA) varroacide (2025). Several current products may be used with honey supers on.
- Fumagillin (Fumagilin-B) remains on the US market for *Nosema* after a supply interruption in 2018, though its value against *Nosema ceranae* is debated.
- The yellow-legged hornet, *Vespa velutina*, was confirmed near Savannah, Georgia in August 2023 — the first live detection in the open United States. By August 2026 Georgia had destroyed 182 nests, and the hornet had been found in several South Carolina counties, including one near Charlotte.

- *Tropilaelaps* mites have moved westward out of Asia to southern Russia and the Caucasus. They have not been detected in the United States, but in July 2025 an infested swarm bound for New Jersey was intercepted at sea.

An examination written in one year and sat in another can lag on points like these. Know the current position and know the reasoning behind the older position; both are defensible in a written answer if you explain which you are giving.

A Note on Certification

The intermediate rank in most American master beekeeper programs is reached by a candidate who has kept bees for at least two years and has held the entry-level certification for at least one. In the Georgia Master Beekeeper Program, administered by the University of Georgia, the four ranks are Certified, Journeyman, Master and Master Craftsman, and the Journeyman rank requires a written examination including situational essay questions, a practical examination, and five public service credits documented in a portfolio.

The practical examination is worth thinking about while you study the written one, because the two reinforce each other. Candidates are typically asked to identify brood disorders from specimens or photographs, to distinguish honey bees from wasps, hornets and bee mimics, to read a pesticide label and determine whether a product may lawfully be applied under stated conditions, and to label the anatomical structures of a bee and the parts of a flower. Chapters 3, 4, 13 and 15 of this guide are written with that practical component in mind.

The public service requirement is not an afterthought. It is the program's statement about what the rank means: a Journeyman beekeeper is someone whose knowledge is useful to other people. Several items on this examination — the club talk about mite monitoring, the school group presentation, the advice to the over-enthusiastic first-year beekeeper, the conversation with the neighbor about the swimming pool — are testing exactly that capacity. Study them as communication problems, not only as technical ones.

Chapter 1: History of Bees and Man

Learning Objectives

When you have finished this chapter you should be able to:

- Trace the relationship between humans and honey bees from honey hunting through fixed-comb beekeeping to modern movable-frame practice.
 - Name the four nineteenth-century developments that together made modern commercial beekeeping possible, identify who was responsible for each and in what year, and state the specific problem each one solved.
 - Explain bee space and why Langstroth's recognition of it was the pivotal insight rather than merely a clever piece of joinery.
 - State when and how *Apis mellifera* came to North America, and explain why "honey bees are not native to North America" matters when you speak in public about pollinator decline.
 - Describe the origin and purpose of the Honey Bee Act of 1922 and explain what it did and did not accomplish.
 - Give a dated account of the major pest and disease arrivals in the United States during the twentieth and twenty-first centuries.
 - Explain the historical importance of the Southeast, and of Georgia in particular, to the American package bee and queen industry.
-

1.1 The Long Prehistory: Honey Hunting

The relationship between humans and honey bees is older than agriculture, older than pottery, and older than any written language. The evidence is pictorial before it is documentary. Rock paintings in eastern Spain, at Cuevas de la Araña near Valencia, show a human figure suspended on ropes or ladders reaching into a cliff-face cavity surrounded by flying insects, with a container in one hand. The painting is commonly estimated at about 8,000 years old (roughly 6000 BCE), though dating Levantine rock art is difficult and the figure is disputed. Comparable images occur in rock art across southern Africa, India and Australia.

What these images record is honey hunting, not beekeeping: the destructive harvest of wild nests. The colony is usually destroyed or crippled in the process. It is worth pausing on this, because the entire history of beekeeping technique can be read as a series of solutions to one problem — how to take the honey without destroying the colony or the comb.

Honey mattered to pre-agricultural people out of all proportion to its bulk. It was the only concentrated sweetener available in most of the world, it was calorically dense in a diet that was often not, it fermented readily into mead, and it had genuine antimicrobial value as a wound dressing. Beeswax mattered nearly as much: lighting, waterproofing, lost-wax metal casting, writing tablets, and later the candles that lit the churches of medieval Europe.

1.2 Fixed-Comb Beekeeping

The transition from hunting to husbandry happens when people stop finding nests and start providing cavities. Egypt provides the earliest clear documentary evidence: a relief from the sun temple of Nyuserre Ini at Abu Ghurab, dated to roughly 2400 BCE, shows workers apparently smoking cylindrical hives and processing honey. The Egyptians kept bees in horizontal cylinders of mud or clay, stacked in banks. Egypt also gives us the earliest documentary evidence of migratory beekeeping — hives moved to follow the bloom — but that evidence is much later than the Nyuserre relief: it comes from Greek papyri of the Ptolemaic period (the Zenon archive, third century BCE), in which hives are moved between districts; accounts of hives carried by boat along the Nile come from much later travelers. Keep the two dates apart; a common error is to push the moving of hives back into the Old Kingdom.

Throughout the Mediterranean, the Near East, Europe and Africa, various fixed-comb hives developed: clay cylinders, woven wicker or straw skeps, hollowed logs (gums), and bark cylinders. All of them share one defining characteristic. The bees attach their comb directly to the inside of the container, so the comb cannot be removed and replaced. The beekeeper can look at the entrance, heft the hive, and in some designs peer up from below, but cannot inspect the brood nest, cannot assess disease, cannot find the queen, cannot judge stores frame by frame, and above all cannot harvest without cutting comb away.

Fixed-comb beekeeping therefore imposed a characteristic set of practices:

- **Destructive harvest.** The traditional European method was to kill the colony, usually by sulfur fumigation over a pit, and cut out all the comb. The beekeeper chose which colonies to “take up” at the end of the season, typically the heaviest and the lightest, and overwintered the middle.
- **Crush-and-strain processing.** The comb was crushed and the honey drained or pressed out, destroying the wax structure. The wax was then rendered separately and was a significant part of the value of the crop.
- **Increase by swarming.** Because the beekeeper could not divide a colony, all increase came from catching swarms. Swarm management as we know it — prevention, artificial swarming, splitting — was impossible. The beekeeper’s relationship to swarming was to encourage it and to be present when it happened. Much of the folklore about bees, including the practice of ringing pans and the rhymes about the value of a swarm in May, belongs to this world.
- **No disease management.** Foulbrood was recognized in antiquity — Aristotle describes brood diseases in the *Historia Animalium* — but nothing could be done about it beyond destroying affected colonies.

One transitional design deserves mention because it appears in the examination literature: the movable-**comb** bar hive of Greece, sometimes called the Greek basket hive, in which bees built comb down from removable top bars. This allowed individual combs to be lifted out, and was described by European travelers to Greece in the seventeenth century. It is a genuine precursor to the movable-frame hive, and it is the direct ancestor of the modern top-bar hive. But it is not a frame: the comb is attached only at the top, it is fragile, it cannot be extracted centrifugally, and it cannot be moved between hives freely. The examination distinguishes this from Langstroth’s contribution, and you should too.

1.3 The Four Developments That Made Modern Beekeeping

Between 1851 and 1889, four innovations arrived that together converted beekeeping from a destructive harvest into a managed agricultural enterprise. This is one of the most reliably examined facts in the intermediate syllabus, and the examination asks not only for the four items but for what problem each solved. Learn them as a set.

1.3.1 The movable-frame hive and bee space — L. L. Langstroth, 1851–1852

The Reverend Lorenzo Lorraine Langstroth (1810–1895), a Congregational minister in Philadelphia and later Oxford, Ohio, recognized in 1851 that bees maintain a consistent gap — roughly a quarter to three-eighths of an inch — as a passageway through their nest, and that they treat any smaller gap as a crack to be sealed with propolis and any larger gap as void space to be filled with comb. He patented a hive built to that tolerance in 1852, and published Langstroth on the Hive and the Honey-Bee in 1853.

The importance of this is easy to understate. Others had built hives with frames before; the frames stuck fast because the builders had not identified the tolerance. Langstroth's insight was not a hive design but a measurement — a behavioral constant of the bees themselves — and every piece of standard equipment in use today is dimensioned around it.

The problem it solved: the comb could not be removed and replaced. With bee space, it could. This made possible colony inspection, disease detection, queen finding, deliberate requeening, splitting, equalizing, frame-by-frame assessment of stores, and the reuse of comb.

The practical consequences of bee space are still visible every time you open a hive, and the examination tests them. Burr and brace comb between boxes means the gap is too large. Heavy propolizing at a junction means the gap is too small. Mixing top-bee-space and bottom-bee-space equipment in one stack produces both problems simultaneously, because you end up with a double gap at one junction and none at the next. Warped, swollen or badly made equipment is a persistent source of the same trouble.

1.3.2 Comb foundation — Johannes Mehring, 1857

Mehring, a German cabinetmaker, produced the first practical wax foundation using a press that embossed the hexagonal cell base pattern onto a sheet of beeswax. Wired foundation and various machines followed.

The problem it solved: bees left to their own devices build comb where and how they choose, including a great deal of drone comb and comb that does not sit within a frame. Foundation gives the colony a starting midrib in the plane the beekeeper wants, and a cell size that biases the bees toward worker comb. It also gives the colony a head start, since the bees draw comb from a supplied base rather than building it from nothing.

1.3.3 The centrifugal honey extractor — Franz von Hruschka, 1865

Major Franz von Hruschka, an Austrian army officer living in Italy, is credited with the centrifugal extractor after — according to the story — watching his son swing a bucket containing a piece of comb.

The problem it solved: harvesting destroyed the comb. Centrifugal extraction removes honey while leaving the comb intact for reuse.

This is a far larger deal than it first appears, because of the cost of wax. A colony expends something on the order of six to eight pounds of honey, and by some accountings considerably more, to produce a pound of beeswax. Returning drawn comb to the colony after extraction rather than crushing it transforms the economics of honey production. It is the reason drawn comb is the single most valuable asset in a beekeeper's equipment shed, and the reason so much of pest management is really about protecting comb.

1.3.4 Systematic queen rearing by grafting — G. M. Doolittle, 1889

Gilbert M. Doolittle published Scientific Queen-Rearing in 1889, describing a repeatable system for producing queens on demand: artificial queen cell cups, transfer of young larvae into them by grafting, and the use of colonies conditioned to accept and finish cells.

The problem it solved: a beekeeper could not obtain a queen when one was needed and could not choose which colony's genetics to propagate. Doolittle's method made queens a scheduled product. From it follow deliberate stock selection, commercial queen production, package bees, requeening as routine management, and every breeding program since.

Examination note. A very common examination item offers Langstroth alongside three plausible distractors: the discovery that drones come from unfertilized eggs (that is Dzierzon, 1845), the invention of the extractor (Hruschka, 1865), and the Greek movable-comb bar hive. Know which is which.

1.4 Honey Bees in North America

Apis mellifera is not native to the Americas. There are roughly 4,000 native bee species in North America, and the honey bee is not among them. European colonists brought honey bees to the eastern seaboard in the 1620s — the usual date given is 1622, to the Virginia colony — and further introductions followed from various European sources over the next two and a half centuries, including Italian stock from 1859 and Carniolan and Caucasian stock later.

The bees spread ahead of settlement. Feral swarms moved west through the forests faster than European settlers did, and, according to Thomas Jefferson's Notes on the State of Virginia (1780s), Native Americans called the honey bee the "white man's fly" because its arrival foretold the arrival of colonists. The story is widely repeated; treat it as a colonial-era report, possibly embellished, rather than documented Native usage. By the time organized beekeeping reached a given territory, feral honey bees were frequently already there.

Two things follow that the examination cares about.

First, the ecological framing. When you speak to a school group or a garden club, honey bees are managed agricultural livestock introduced from Europe, not native wildlife. They are not an endangered species; managed colony numbers in the United States have been broadly stable because beekeepers replace their losses each year, at considerable cost. The genuine conservation concern attaches to native pollinators — bumble bees, solitary bees, specialist species with narrow host ranges — whose declines are a separate matter from managed honey bee colony losses, though the two interact through forage competition, pathogen spillover and

shared habitat loss. A beekeeper who conflates the two, or who tells an audience that honey bees are going extinct, will be corrected by someone in the room and will lose authority on the points that actually matter. Accuracy is the persuasive choice as well as the honest one.

Second, the feral population. The Southeast has a substantial feral honey bee population, and it is not merely picturesque. Feral colonies contribute drones to the matings of every open-mated queen in the area, they act as reservoirs of *Varroa* and of disease, and in Florida and parts of the Gulf states they may carry African-derived genetics. You cannot control what drones your queens meet, which is both a limit on your breeding and a reason to requeen captured swarms of unknown origin.

1.5 The Southeast and the Package Bee Industry

The Southeastern climate produces colonies that build early. Red maple pollen arrives in January in Florida and south Georgia and in February farther north, and colonies can be at strength for package and queen production while beekeepers in the upper Midwest are still wintered down. South Georgia in particular built a long-established package bee and queen industry on this advantage, shipping bees and queens throughout the country each spring, and it remains a national center of production.

This has two consequences for you. The convenient one is access: locally produced early queens, with short shipping and less thermal stress in transit, and a producer you can actually talk to. The inconvenient one is calendar shock. The same early spring that makes the industry possible means your colonies build and swarm well ahead of the national calendar printed in most general beekeeping books. This theme recurs throughout the guide and throughout the examination.

1.6 A Chronology of Arrivals

Much of the modern history of American beekeeping is a history of things arriving. The dates below appear repeatedly on examinations.

Year	Event
1622	<i>Apis mellifera</i> introduced to the Virginia colony from Europe
1851–52	Langstroth recognizes bee space; patents movable-frame hive
1857	Mehring produces comb foundation
1865	Hruschka invents the centrifugal extractor
1889	Doolittle publishes <i>Scientific Queen-Rearing</i>
1922	Honey Bee Act restricts importation of adult honey bees
1956–57	<i>A. m. scutellata</i> imported to Brazil; swarms escape in 1957
1984	Tracheal mite (<i>Acarapis woodi</i>) detected in the United States

Year	Event
1987	<i>Varroa</i> (then called <i>V. jacobsoni</i> , later <i>V. destructor</i>) detected in the United States
1990	Africanized honey bees reach southern Texas
1996	Small hive beetle specimen collected in South Carolina (recognized later)
1998	Small hive beetle identified in Florida; spreads rapidly through the Southeast
2001–2003	Established feral Africanized population confirmed in Florida
2006–07	Colony Collapse Disorder reported and named
2017	FDA veterinary oversight requirement applies to hive antibiotics
2018	US fumagillin supply interrupted when the manufacturer serving the US market closes; Fumagilin-B later returns to the US market
2023	Yellow-legged hornet (<i>Vespa velutina</i>) confirmed near Savannah, Georgia
2024–25	Record colony losses (55.6% annual); DWV-A, DWV-B and ABPV implicated, with amitraz-resistance mutation in all <i>Varroa</i> screened
2025	<i>Tropilaelaps</i> -infested <i>Apis dorsata</i> swarm intercepted at sea on a ship bound for New Jersey (July); EPA registers vadesca, the first RNA-interference varroacide (September)

The Honey Bee Act of 1922

The Act (7 U.S.C. §§ 281–286) restricted the **importation** of adult honey bees into the United States. Note the word: importation, not interstate movement. Interstate movement is regulated by the states, not by this Act.

The immediate impetus was the Isle of Wight disease episode in Britain, a catastrophic loss of colonies in the early twentieth century subsequently associated — though the attribution has been debated ever since — with the tracheal mite *Acarapis woodi*, which had been described in 1921. The United States moved to keep it out.

The Act is administered with USDA APHIS and has been amended over time to permit limited importation of bees and germplasm from designated countries and regions under specified conditions. Its record is mixed and worth stating honestly: it did not prevent the arrival of tracheal mite in 1984 or *Varroa* in 1987, both of which almost certainly came in through means the Act did not control. What it did do, and still does, is establish the principle of quarantine protection for the national bee population, and it is the reason a beekeeper cannot simply order

queens or packages from abroad. With *Tropilaelaps* moving westward out of Asia, that principle has fresh relevance.

1.7 The Modern Era: Losses, Causes and the Public Conversation

Colony Collapse Disorder, as defined during the 2007–2010 period, had a specific case definition: sudden loss of the adult bee population with very few dead bees in or near the hive, a laying queen and brood still present, and stores left unrobbed by pests for an unusually long period. No single cause was established. The consensus that emerged treats it as multifactorial, with *Varroa* and its viruses, nutrition, pesticide exposure and management stress interacting. Reported CCD incidence declined afterward, and the great majority of current colony loss does not meet the case definition. Use the term precisely; it is not a synonym for “my bees died.”

What has not gone away is the loss rate. The national US Beekeeping Survey (run first by the Bee Informed Partnership and now by Auburn University with Oregon State University and the Apiary Inspectors of America) has recorded annual colony losses averaging about **40 percent** since 2010–11 (a 14-year average of 41.4 percent), with winter losses averaging about 29 percent — losses absorbed by making splits and buying queens and packages. The 2024–2025 year was the worst on record: **55.6 percent** annual loss and **40.2 percent** winter loss, following 55.1 percent in 2023–24; losses eased to 39.9 percent in 2025–26. A USDA-ARS investigation of collapsing commercial operations (Lamas et al. 2026) found acute bee paralysis virus and deformed wing virus A and B at high levels, all vectored by *Varroa*, and the amitraz-resistance mutation in every mite screened. The practical guidance issued afterward is the guidance in this study guide: monitor, keep mite levels low, rotate genuinely different modes of action rather than leaning indefinitely on one, replace comb, isolate sick colonies, and use resistant stock.

The lesson of the history, taken as a whole, is that beekeeping technique has repeatedly solved the problem in front of it — how to harvest without destroying the comb, how to get a queen when you need one — and has repeatedly been handed a new problem from outside. The beekeeper’s job in each generation has been to learn the new problem quickly and accurately. That is what the Journeyman rank is for.

Numbers to Memorize

Item	Figure
Bee space	1/4 to 3/8 inch
Langstroth patent	1852 (insight 1851; book 1853)
Mehring, comb foundation	1857
Hruschka, centrifugal extractor	1865
Doolittle, <i>Scientific Queen-Rearing</i>	1889
Honey bees introduced to North America	1620s (Virginia, 1622)
Honey Bee Act	1922
African bees imported to Brazil / escaped	1956 / 1957

Item	Figure
Africanized bees reach Texas	1990
Tracheal mite detected in US	1984
<i>Varroa</i> detected in US	1987
Small hive beetle identified in Florida	1998 (1996 SC specimen recognized later)
Africanized population established in Florida	2001–2003
Yellow-legged hornet confirmed in Georgia	August 2023

Key Terms

Bee space — the gap of roughly 1/4 to 3/8 inch that bees maintain as a passageway; smaller gaps are propolized, larger gaps filled with comb.

Fixed-comb hive — a hive in which comb is attached to the container and cannot be removed intact; skeps, gums and clay cylinders.

Movable-comb bar hive — a hive with removable top bars but no full frames; the Greek precursor and the modern top-bar hive.

Honey hunting — the destructive harvest of wild nests, as distinct from beekeeping.

Skep — a woven straw or wicker fixed-comb hive of northern European tradition.

Gum — a hollowed log used as a fixed-comb hive, traditional in the American South.

Taking up — the traditional practice of killing a colony, usually by sulfur, to harvest its comb.

Colony Collapse Disorder (CCD) — a specific loss syndrome defined 2007–2010: rapid loss of adults, few dead bees present, queen and brood remaining, stores not robbed.

Self-Check

- (SA)** Name the four developments that together made modern commercial beekeeping possible and state what problem each solved.
- (MC)** Reverend Lorenzo Langstroth is remembered chiefly for: A) Establishing that drones develop from unfertilized eggs B) Inventing the centrifugal honey extractor C) Devising the movable-comb bar hive long used in Greece D) Recognizing and applying bee space, making the practical movable-frame hive possible
- (TF)** Honey bees are not native to North America; they were brought by European colonists in the seventeenth century, and the Southeast has both managed and feral populations descended from those and later introductions.
- (MC)** The Honey Bee Act of 1922: A) Restricted interstate movement of adult honey bees to slow American foulbrood B) Authorized federal quarantine of package bees from the tropics to

exclude African stock C) Restricted the importation of adult honey bees into the United States, initially to exclude tracheal mite following the Isle of Wight disease episode D) Established federal grading and labeling standards for honey in interstate commerce

5. (SA) A garden club asks you whether honey bees are going extinct. Draft a short, accurate reply.

Answers

1. (a) The movable-frame hive based on bee space, Langstroth, 1851–52 — solved the inability to inspect or manipulate a colony without destroying comb. (b) Comb foundation, Mehring, 1857 — solved the beekeeper’s lack of control over comb placement and cell type, and gave the colony a head start on building. (c) The centrifugal extractor, Hruschka, 1865 — solved the destruction of comb at harvest, allowing comb to be reused. (d) Systematic grafted queen rearing, Doolittle, 1889 — solved the inability to obtain a queen on demand or to choose which genetics to propagate, making stock selection, increase and routine requeening practical.

2. D. A is Dzierzon (1845); B is Hruschka (1865); C is the Greek bar hive, a precursor but not a frame hive.

3. True.

4. C. The Act governs importation, not interstate movement; interstate movement is a state matter. It did not ultimately exclude tracheal mite (1984) or *Varroa* (1987), but remains the legal basis for federal control of bee importation.

5. Honey bees are managed livestock, introduced from Europe in the 1620s, and are not at risk of extinction — managed colony numbers are held up by beekeepers replacing their losses each year, which is expensive but effective. The real story is a high annual loss rate driven principally by *Varroa* and the viruses it transmits, together with poor nutrition in simplified landscapes, pesticide exposure and disease. Separately, and importantly, a number of *native* pollinators — bumble bees and specialist solitary bees among them — are in genuine conservation trouble, and that is a different problem with different remedies, chiefly habitat and forage. Planting a succession of bloom and reducing pesticide use helps both.

References for Further Study

Standard texts - Crane, E. *The World History of Beekeeping and Honey Hunting*. Duckworth, 1999. The definitive work; exhaustive and highly readable. - Langstroth, L. L. *Langstroth on the Hive and the Honey-Bee*. 1853. Widely available in reprint and free online; still worth reading. - Graham, J. (ed.) *The Hive and the Honey Bee*. Dadant, 2015. See the historical chapters. - Root, A. I. *ABC and XYZ of Bee Culture*, 41st ed. A. I. Root Co.

Regional and extension - University of Georgia Honey Bee Program, Georgia Master Beekeeper Program materials: bees.caes.uga.edu - UF/IFAS EDIS ENY-114, *African Honey Bee: What You Need to Know*

Current status - Project Apis m., 2025 Colony Loss FAQ: projectapism.org/colony-loss-faq - Georgia Department of Agriculture, Yellow-Legged Hornet program: agr.georgia.gov/yellow-

legged-hornet - US Beekeeping Survey annual colony loss results (Auburn University, Oregon State University and Apiary Inspectors of America; formerly Bee Informed Partnership): apiaryinspectors.org

Primary literature - vanEngelsdorp, D. et al. “Colony Collapse Disorder: A Descriptive Study.” *PLoS ONE* 4:e6481 (2009). - vanEngelsdorp, D. & Meixner, M. D. “A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them.” *J. Invertebr. Pathol.* 103:S80–S95 (2010).

Chapter 2: Nomenclature

Learning Objectives

When you have finished this chapter you should be able to:

- Give the full taxonomic placement of the honey bee from kingdom to species and explain what each rank means.
 - Write a scientific name correctly, including the conventions for genus, species, subspecies and abbreviation.
 - Name the recognized species of the genus *Apis* and identify which of them matter to an American beekeeper and why.
 - Name the principal subspecies of *Apis mellifera* kept or encountered in the United States and give their common names.
 - Use the vocabulary of castes, developmental stages and colony states precisely.
 - Produce from memory the scientific names of the major pests and pathogens of honey bees and identify what kind of organism each is.
 - Explain why precise nomenclature is a practical matter and not merely an academic one.
-

2.1 Why Nomenclature Is on the Examination

It would be easy to treat this chapter as vocabulary drill. It is not, for three reasons.

The first is that common names are ambiguous and scientific names are not. “Sweat bee” covers several genera in at least two families. “Bee moth,” “wax worm” and “webworm” have all been used for *Galleria mellonella*. “Nosema” now refers to organisms some authorities place in the genus *Vairimorpha*. When you are filling in a sample submission form for a diagnostic laboratory, reporting a suspected exotic pest to a state agency, or reading a pesticide label to see whether your target organism is listed, the scientific name is the thing that does the work.

The second is that the name usually tells you what kind of organism you are dealing with, and therefore what will and will not work against it. A beekeeper who knows that *Nosema* is a microsporidian — a fungus-like intracellular parasite — will not expect an antibacterial antibiotic to help. A beekeeper who knows that *Ascosphaera apis* is a fungus and *Paenibacillus larvae* a spore-forming bacterium is already most of the way to understanding why one is managed by ventilation and hygienic stock and the other by fire.

The third is that the practical examination at this level typically asks candidates to distinguish honey bees from wasps, hornets and bee mimics, and to identify insects and disorders from specimens. That is applied taxonomy.

2.2 Binomial Nomenclature: The Conventions

The system is Linnaean, from Carl Linnaeus’s *Systema Naturae* (10th edition, 1758, the starting point for zoological nomenclature). The rules are administered by the International Commission on Zoological Nomenclature.

The form. Every species has a two-part name: the genus, capitalized, followed by the specific epithet, lowercase. Both are italicized (or underlined in handwriting). *Apis mellifera*.

Abbreviation. After the first full use in a piece of writing, the genus may be abbreviated to its initial: *A. mellifera*. Do not abbreviate the specific epithet. Within a document discussing several genera beginning with the same letter — *Apis* and *Aethina*, say — spell them out to avoid ambiguity.

Trinomials. A subspecies adds a third name, also lowercase and italicized: *Apis mellifera ligustica*. Honey bee subspecies are often called “races” or “stocks” in beekeeping usage. Strictly, a *subspecies* is a taxonomic category defined by morphology and geography; a *stock* or *line* is a commercial or breeding population that may or may not correspond to a subspecies. Russian bees, Buckfast bees and VSH lines are stocks, not subspecies.

Authority. Formal writing appends the describer and sometimes the date: *Apis mellifera* Linnaeus, 1758. Parentheses around the authority indicate that the species has been moved to a different genus since it was described — which is why you will see *Varroa destructor* Anderson & Trueman, 2000 without parentheses, and *Aethina tumida* Murray, 1867.

Higher ranks. Family, order and other ranks above genus are capitalized but **not** italicized: Hymenoptera, Apidae, Apinae. Family names end in **-idae**, subfamily names in **-inae**, and tribe names in **-ini**. Apidae, Apinae, Apini.

Common names. Entomological convention writes “honey bee” as two words, because the honey bee is a true bee; the two-word form signals a genuine member of the group named. Insects that are *not* what the name says are written as one word — dragonfly is not a fly, butterfly is not a fly. By the same rule, “bumble bee” is two words. You will see “honeybee” in print constantly, including in reputable sources, but two words is the form used by the Entomological Society of America and by most examination material.

2.3 The Taxonomic Placement of the Honey Bee

Rank	Taxon	What it tells you
Kingdom	Animalia	Multicellular, heterotrophic
Phylum	Arthropoda	Jointed appendages, exoskeleton of chitin, segmented body
Class	Insecta	Three body regions, six legs, typically two pairs of wings, one pair of antennae
Order	Hymenoptera	Membranous wings, fore and hind wings coupled by hamuli, ovipositor often modified; ants, bees, wasps, sawflies
Suborder	Apocrita	Constricted “wasp waist” between thorax and abdomen

Rank	Taxon	What it tells you
Superfamily	Apoidea	Bees and apoid wasps; pollen-collecting, branched (plumose) body hairs in bees
Family	Apidae	Includes honey bees, bumble bees, carpenter bees, stingless bees, orchid bees
Subfamily	Apinae	—
Tribe	Apini	The honey bees
Genus	<i>Apis</i>	Cavity- and open- nesting bees building vertical wax combs, perennial colonies, dance communication
Species	<i>Apis mellifera</i>	The western or European honey bee

A mnemonic many candidates use for the classical seven ranks is “King Philip Came Over For Good Soup” — Kingdom, Phylum, Class, Order, Family, Genus, Species.

Two notes on the name itself. *Apis* is Latin for bee. *Mellifera* means “honey-bearing,” from *mel* (honey) and *ferre* (to bear). Linnaeus first named it *Apis mellifera*, then changed it to *Apis mellifica* (“honey-making”) on the grounds that bees make honey rather than carry it. Under the rules of priority the original name stands, so *mellifera* is correct and *mellifica* is a junior synonym you will occasionally see in older literature.

Two characters distinguish bees from the apoid wasps they descend from, and both are examinable at the practical level: bees have **branched or plumose body hairs**, which trap pollen, and bees provision their young with **pollen and nectar** rather than with animal prey. Related distinguishing features of Hymenoptera generally include the **hamuli**, the row of tiny hooks on the leading edge of the hind wing that couple it to the forewing so the two function as a single airfoil.

2.4 The Genus *Apis*

There are eight to eleven recognized species in *Apis*, depending on the authority, and the count has moved as molecular work has split and merged taxa. The ones a Journeyman candidate should know:

Species	Common name	Note
<i>Apis mellifera</i>	Western or European honey bee	The managed species worldwide outside Asia
<i>Apis cerana</i>	Eastern or Asian hive bee	Cavity-nesting, managed in Asia; the original host of <i>Varroa</i>

Species	Common name	Note
<i>Apis dorsata</i>	Giant honey bee	Open-nesting, single large comb; host of <i>Tropilaelaps</i>
<i>Apis laboriosa</i>	Himalayan giant honey bee	Cliff-nesting; sometimes treated as a subspecies of <i>dorsata</i>
<i>Apis florea</i>	Red dwarf honey bee	Small open-nesting species
<i>Apis andreniformis</i>	Black dwarf honey bee	—
<i>Apis koschevnikovi</i> , <i>A. nigrocincta</i> , <i>A. nuluensis</i>	—	Southeast Asian cavity nesters

The examinable point about *Apis cerana* is coevolution. *Varroa* evolved as a parasite of *A. cerana*, in which it reproduces almost exclusively in drone brood and against which the host has effective grooming and hygienic defenses; the relationship is stable. When the mite host-shifted to *A. mellifera* — a bee with no evolutionary history with it — it gained access to worker brood as well, and the relationship became lethal. Every conversation about *Varroa* resistance is in some sense a conversation about whether *A. mellifera* can be brought, by selection, to where *A. cerana* already is. The same logic applies to *Tropilaelaps*, whose natural hosts are the giant honey bees of Asia.

2.5 Subspecies of *Apis mellifera*

About 30 subspecies of *A. mellifera* are recognized — a recent review counts 33, grouped into five evolutionary lineages (A, African; M, western and northern European; C, eastern European; O, Middle Eastern; and Y, Arabian/Ethiopian; Ilyasov et al. 2020) — native to Europe, Africa and western Asia. The count changes as new subspecies are described, which is why older texts give 24 to 29. Those that matter in the United States:

Subspecies	Common name	Characteristics
<i>A. m. ligustica</i>	Italian	Light/yellow banding, prolific, gentle, excellent comb builders, rear brood late into autumn, consume stores freely, less frugal. The historical mainstay of American beekeeping and well suited to the long Southeastern season.
<i>A. m. carnica</i>	Carniolan	Dark, very rapid spring build-up, frugal with stores, gentle, winters well on small clusters — and correspondingly more swarm-prone ,

Subspecies	Common name	Characteristics
		which in the Southeast's early spring demands close swarm management.
<i>A. m. caucasica</i>	Caucasian	Dark, gentle, long tongues, heavy propolizers.
<i>A. m. mellifera</i>	Dark European, German black bee	The original colonial introduction; dark, frugal, often more defensive and more prone to running on the comb.
<i>A. m. iberiensis</i>	Spanish/Iberian	—
<i>A. m. scutellata</i>	African (East African lowland)	The subspecies imported to Brazil in 1956; the African parent of Africanized populations. See Chapter 6.

Stocks that are not subspecies. Russian stock derives from *A. mellifera* populations in the Primorsky region of far-eastern Russia, which have coexisted with *Varroa* for far longer than western populations and carry resistance; it was imported by USDA in the 1990s. Buckfast is a composite line developed by Brother Adam at Buckfast Abbey. VSH (Varroa Sensitive Hygiene) lines are selected for a specific behavioral trait, not for ancestry. Minnesota Hygienic is selected for general hygienic behavior. Calling any of these a “race” is loose usage; calling them a stock or a line is correct.

2.6 The Vocabulary of Castes and Stages

Precision here matters because several examination items turn on it.

Castes. A honey bee colony has two female castes and one male sex. The **queen** is the reproductive female, diploid, developed from a fertilized egg fed royal jelly copiously throughout larval life. The **worker** is a functionally sterile female, diploid, from a fertilized egg switched after about three days to a mixture of jelly, honey and pollen. The **drone** is the male, **haploid**, developed from an unfertilized egg. Note that drone is not a caste in the same sense — caste properly describes the queen/worker division within the female sex — but common usage speaks of three castes and the examination generally follows common usage.

Haplodiploidy is the sex-determination system: males from unfertilized (haploid) eggs, females from fertilized (diploid) eggs. It is the reason the queen controls the sex of her offspring by controlling sperm release, the reason a drone has a grandfather but no father, and — through the complementary sex determiner locus — the reason inbreeding produces diploid drones that nurse bees remove, giving the “shot brood” or “pepperbox” pattern.

Developmental stages. Honey bees undergo **complete metamorphosis** (holometabolous development): **egg** > **larva** > **pupa** > **adult**. The larva passes through **five larval instars** (four

molts between them); after the cell is capped the last-instar larva spins a cocoon and becomes a **prepupa**, and a further molt produces the pupa. The adult emerging from the cell is said to **emerge** or **eclose** — it does not “hatch,” a word properly reserved for the egg hatching into a larva. The examination has been known to test that distinction.

Colony states. A **queenright** colony has a laying queen. A **queenless** colony does not. A **laying worker** colony has workers with activated ovaries producing unfertilized eggs. A **drone-laying queen** is a mated queen whose sperm is exhausted or who mated poorly, laying unfertilized eggs from a normal-looking laying pattern. **Supersedure** is the replacement of a failing queen by her colony without swarming. **Abscinding** is the abandonment of the nest by the whole colony, an escape response. **Swarming** is colony-level reproduction by division.

Other terms worth getting right. **Brood** means immature bees (egg, larva, pupa) collectively. **Beebread** is pollen stored in cells with honey and glandular secretions and fermented by lactic acid bacteria. **Nectar** is the plant secretion; **honey** is the ripened product. **Honeydew** is the excretion of sap-feeding insects, from which bees also make a honey. **Propolis** is plant resin worked with wax and enzymes. **Royal jelly** is the glandular secretion of nurse bees. **Phoretic** describes a mite riding on an adult bee; the modern literature increasingly prefers **dispersal phase**, since the mite is feeding rather than merely hitching a ride. **Corbicula** is the pollen basket on the hind tibia (plural *corbiculae*). **Festooning** is the chain-hanging behavior of wax-building bees.

2.7 Scientific Names of Pests, Parasites and Pathogens

This table is worth memorizing outright. The right-hand column is the part that pays.

Scientific name	Common name	Type of organism
<i>Varroa destructor</i>	Varroa mite	Mesostigmatid mite (Arachnida, Acari)
<i>Acarapis woodi</i>	Tracheal mite	Mite, internal in prothoracic tracheae
<i>Tropilaelaps mercedesae</i>	Tropilaelaps mite	Mite; exotic, not detected in the US
<i>Aethina tumida</i>	Small hive beetle	Beetle (Coleoptera: Nitidulidae), native to sub-Saharan Africa
<i>Galleria mellonella</i>	Greater wax moth	Moth (Lepidoptera: Pyralidae)
<i>Achroia grisella</i>	Lesser wax moth	Moth (Pyralidae)
<i>Paenibacillus larvae</i>	American foulbrood (AFB)	Spore-forming bacterium
<i>Melissococcus plutonius</i>	European foulbrood (EFB)	Bacterium, non-spore- forming
<i>Ascosphaera apis</i>	Chalkbrood	Fungus
<i>Aspergillus flavus</i> and relatives	Stonebrood	Fungus; also an opportunistic human pathogen

Scientific name	Common name	Type of organism
<i>Nosema apis</i> , <i>Nosema ceranae</i>	Nosema / nosemosis	Microsporidia (fungus-like intracellular parasites); some authorities now place them in <i>Vairimorpha</i>
<i>Solenopsis invicta</i>	Red imported fire ant	Ant (Hymenoptera: Formicidae)
<i>Vespa velutina</i>	Yellow-legged hornet	Hornet; detected Georgia 2023
<i>Vespa mandarinia</i>	Northern giant hornet	Hornet; Pacific Northwest incursion, declared eradicated 2024
<i>Apis mellifera scutellata</i>	African honey bee	Honey bee subspecies

Viruses are named in plain text without italics: deformed wing virus (DWV), acute bee paralysis virus (ABPV), chronic bee paralysis virus (CBPV), sacbrood virus (SBV), black queen cell virus (BQCV), Israeli acute paralysis virus (IAPV), Kashmir bee virus (KBV).

Two naming stories worth knowing. *Varroa destructor* was described only in 2000, by Anderson and Trueman, when molecular work showed that the mite parasitizing *A. mellifera* worldwide was a different species from *Varroa jacobsoni*. That older name goes back to Oudemans' 1904 description of a mite on the Asian honey bee, *Apis cerana*; it was later applied to the mite found on *A. mellifera*. Literature before 2000 calls it *V. jacobsoni*, and that is not an error on the author's part. Separately, the microsporidian genus *Nosema* has been the subject of a proposed transfer to *Vairimorpha*; you will see both *Nosema ceranae* and *Vairimorpha ceranae* in current literature. Examinations at this level generally still use *Nosema*, and it remains acceptable, but knowing why both appear is the sort of thing that marks a candidate who reads.

2.8 Plant Nomenclature

Bee botany uses the same system, and the examination expects the binomials of the major Southeastern honey plants. They are collected in Chapter 20, but note the convention here: cultivated plant varieties add a cultivar name in single quotes and roman type — *Vitex agnus-castus* 'Shoal Creek' — and a genus name used alone for a group of species takes *sp.* (one species, unspecified) or *spp.* (several species), neither italicized: *Aesculus* spp., *Helenium* spp., *Rubus* spp.

Note also that scientific names of plants change more often than beekeepers expect. Chinese tallow has moved from *Sapium sebiferum* to *Triadica sebifera*; both appear in the literature. Titi is *Cyrilla racemiflora*. Tupelo, in the sense that matters commercially, is *Nyssa ogeche*, the Ogeechee tupelo — not the black gum, *Nyssa sylvatica*, which is a different tree producing a different and far less valuable honey. That distinction has real money attached to it.

Numbers to Memorize

Item	Figure
Species in genus <i>Apis</i>	8–11, depending on authority
Recognized subspecies of <i>A. mellifera</i>	about 30 (33 in 5 lineages per Ilyasov et al. 2020)
Native bee species in North America	roughly 4,000
Bee families worldwide	7 (6 in North America)
Larval instars	5 (four larval molts, then the molt to pupa)
Starting point of zoological nomenclature	Linnaeus, <i>Systema Naturae</i> , 10th ed., 1758
<i>Varroa destructor</i> described as distinct species	2000 (Anderson & Trueman)

Key Terms

Binomial nomenclature — the two-part naming system: genus (capitalized) plus specific epithet (lowercase), both italicized.

Trinomial — a three-part name denoting a subspecies: *Apis mellifera ligustica*.

Haplodiploidy — sex determination in which males are haploid (from unfertilized eggs) and females diploid.

Holometabolous — undergoing complete metamorphosis: egg, larva, pupa, adult.

Eclose / emerge — of an adult, to leave the cell. Eggs *hatch*; adults *emerge*.

Queenright — having a laying queen present.

Phoretic (dispersal) phase — the period a *Varroa* mite spends on an adult bee rather than in a sealed cell.

Plumose hair — branched body hair, the character that distinguishes bees from apoid wasps.

Hamuli — the hooks coupling fore and hind wings in Hymenoptera.

Stock / line — a commercial or breeding population (Russian, Buckfast, VSH), as distinct from a subspecies.

Self-Check

- (SA)** Give the full taxonomic classification of the honey bee from kingdom to species.
- (MC)** Which is written correctly? A) *Apis Mellifera* B) *apis mellifera* C) *Apis mellifera* D) *Apis mellifera* (roman type, both capitalized)

3. **(SA)** State what kind of organism each of the following is, and one management consequence that follows from knowing it: *Paenibacillus larvae*, *Ascosphaera apis*, *Nosema ceranae*.
4. **(TF)** All drones produced by a single queen are genetically identical to one another because they develop from unfertilized eggs.
5. **(MC)** *Varroa destructor* originally evolved as a parasite of: A) *Apis mellifera* in Europe B) *Apis cerana* in Asia C) *Apis dorsata* in southern Asia D) *Bombus* species in the Americas
6. **(SA)** Distinguish the terms *subspecies* and *stock*, and give an example of each relevant to American beekeeping.

Answers

1. Kingdom Animalia; Phylum Arthropoda; Class Insecta; Order Hymenoptera; Suborder Apocrita; Superfamily Apoidea; Family Apidae; Subfamily Apinae; Tribe Apini; Genus *Apis*; Species *Apis mellifera*.
2. **C.** Genus capitalized, specific epithet lowercase, both italicized.
3. *Paenibacillus larvae* is a spore-forming bacterium; because the spores survive for decades in comb and woodenware and are not killed by any practical cleaning, antibiotics suppress signs without curing, and destruction or strictly regulated alternatives are the standard response. *Ascosphaera apis* is a fungus; it is favored by cool damp conditions and chilled brood, so the management response is siting, ventilation, colony strength and hygienic stock rather than a chemical. *Nosema ceranae* is a microsporidian — fungus-like, not bacterial — so antibacterial antibiotics do nothing; management rests on comb replacement and colony condition; fumagillin, the one drug marketed for *Nosema* in the US, is of doubtful value against *N. ceranae*.
4. **False.** Drones are haploid and carry only the queen's genes, but each unfertilized egg is a product of meiosis with recombination, so each drone carries a different random half of her genome. Drones from one queen are related by one half, not by one.
5. **B.** *Apis cerana*, in which it reproduces essentially only in drone brood and against which the host has effective defenses. The host shift to *A. mellifera*, which has no evolutionary history with it, gave the mite access to worker brood and made the relationship lethal.
6. A subspecies is a formal taxonomic category defined by morphology and geographic origin, written as a trinomial: *Apis mellifera ligustica*, the Italian honey bee. A stock or line is a commercial or breeding population selected for particular traits, which may cut across subspecies boundaries: Russian stock, Buckfast, or a VSH line selected for Varroa Sensitive Hygiene.

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Chapter 3: Anatomy and Physiology

Learning Objectives

When you have finished this chapter you should be able to:

- Name the three body regions of the adult honey bee and state which structures are attached to each, at the level of detail required for a practical identification exercise.
 - Give the developmental periods of queen, worker and drone from memory, and explain which figure governs swarm-season inspection intervals and why.
 - Explain caste determination and its consequences for queen rearing.
 - Describe the honey bee digestive tract and the role of the proventriculus, and name the enzymes added to nectar.
 - Describe the glandular systems of the worker and the timing of their development and regression.
 - Explain the tracheal respiratory system and why it matters diagnostically.
 - Describe honey bee vision, chemoreception and navigation, and the practical consequences of each.
 - Explain thermoregulation of the brood nest in both directions.
 - Describe the sting apparatus and the correct response to a sting.
 - Explain age polyethism, its flexibility, and how a beekeeper reads a colony through it.
 - State the seasonal difference in worker longevity and its physiological basis, and connect that to mite management.
-

3.1 The Three Body Regions

The adult honey bee, like all insects, has three body regions (“tagmata”): **head**, **thorax** and **abdomen**. Getting the assignment of structures right is not pedantry. It is what tells you that tracheal mite diagnosis requires dissecting the thorax rather than examining the abdomen, and that wax glands on the ventral abdomen explain why bees festoon and hang in chains while building comb.

3.1.1 The head

The head bears:

- **Compound eyes** — one on each side, made of many individual ommatidia (about 5,800 per eye in the worker, 4,900 in the queen and 11,000 in the drone, whose eyes meet at the top of the head; Streinzer et al. 2013). Used for pattern, motion and color vision.
- **Ocelli** — three simple eyes in a triangle on the top of the head. They do not form images; they detect light intensity and polarization and are important in timing flight at dawn and dusk and in flight stabilization.
- **Antennae** — the primary sensory organs, bearing enormous numbers of sensilla for smell, taste, touch, humidity, temperature and carbon dioxide. The antenna is elbowed,

with a long basal scape and a segmented flagellum. Workers and queens have 12 antennal segments; drones have 13.

- **Mandibles** — paired jaws used for comb working, manipulating wax and propolis, grooming, feeding larvae, chewing out of the cell, and in fighting. They are smooth-edged in *A. mellifera*, not toothed; the bee does not bite in the sense of cutting.
- **Proboscis** — a compound tongue-and-mouthpart structure formed chiefly of the **glossa** with the labial palps and galeae of the maxillae, assembled in use into a tube for drawing up liquids and disassembled at rest. Tongue length varies by subspecies and determines which flowers a bee can work.
- **Hypopharyngeal and mandibular glands** open in the head (see §3.4).

3.1.2 The thorax

The thorax is the locomotion center. It bears:

- **Two pairs of membranous wings.** The hind wing is coupled to the forewing in flight by a row of hooks, the **hamuli**, so the two act as one airfoil. In flight the wings do not simply flap; the wing beat is a rapid rotational motion driven indirectly by deformation of the thorax.
- **Three pairs of legs.** Each leg has the standard insect segments: coxa, trochanter, femur, tibia, tarsus (ending in a pretarsus with claws and an adhesive arolium). The legs carry several specialized structures:
 - **Antenna cleaner** on the foreleg: a notch in the basitarsus with a fringe of hairs, closed by a spur on the tibia, through which the antenna is drawn.
 - **Pollen rake and pollen press on the hind leg: the rake at the tip of the tibia, the press between the tibia and the first tarsal segment (basitarsus). The middle leg carries a tibial spur used to pry pollen loads from the corbicula.**
 - **Corbicula** (pollen basket) on the outer face of the **hind tibia**: a smooth concave surface fringed with long curved hairs into which the pollen load is packed. Present in workers, absent in queens and drones.
 - **Wax scales are removed from the wax mirrors by the hind legs and passed forward to the mouthparts. (The structure traditionally called the “wax shears” is in fact the pollen press.)**
- The **first thoracic spiracle** is the entry point for the tracheal mite, which is why diagnosis requires dissection of the thorax.

3.1.3 The abdomen

The abdomen contains:

- **Digestive tract** — crop, proventriculus, midgut (ventriculus), small intestine, rectum.
- **Malpighian tubules** — the excretory organs, which empty into the gut.
- **Wax glands** — four pairs of glands on the **ventral (underside)** surface of abdominal sterna 4 through 7 in the worker, secreting wax scales into wax mirrors.
- **Nasonov gland** — on the dorsal surface between the last tergites, exposed by flexing the abdomen; releases the orientation pheromone.
- **Sting apparatus** — at the tip, in females only.

- **Reproductive organs** — in the queen, the ovaries (which in a laying queen fill much of the abdomen) and the spermatheca; in the drone, testes, seminal vesicles and the endophallus.
- **Dorsal vessel (heart)** — an open circulatory system pumping hemolymph forward; hemolymph does **not** carry oxygen.
- **Fat body** — a tissue of great importance, dealt with in §3.9.

3.2 Development

3.2.1 The three developmental timetables

	Egg	Larva	Capped (prepupa + pupa)	Total to emergence
Queen	3 days	about 5½ days	about 7½ days	16 days
Worker	3 days	about 6 days	about 12 days	21 days
Drone	3 days	about 6½ days	about 14½ days	24 days

Memorize **16, 21, 24**. The egg stage is three days in all three castes.

Several derived numbers matter as much as the totals:

- **Queen cells are capped at about day 8** from the egg. A primary swarm typically issues at or shortly after the first queen cells are capped. Therefore a **7-day inspection interval** during swarm season is the standard way to intercept the sequence — you cannot go longer without risking a colony that caps cells and departs between visits. This is the single most useful application of the developmental numbers and is a recurring examination item.
- **Worker brood is capped at about day 9**, drone brood at about day 10.
- **Drone brood remains capped roughly 2 to 3 days longer than worker brood**, which is why *Varroa* foundresses entering drone cells produce more mature daughters, and why drone brood trapping works.
- A complete brood break requires roughly **three weeks** so that all sealed brood emerges and none is newly capped.
- **Drones reach sexual maturity at roughly 12 to 16 days** after emergence.

3.2.2 Caste determination

A fertilized egg can become either a queen or a worker. The difference is **nutritional, not genetic**.

A larva reared in a queen cell is fed royal jelly copiously and continuously throughout larval life, with a higher proportion of mandibular gland secretion and higher sugar content. A larva reared in a worker cell receives glandular jelly for roughly the first three days and is then switched to a mixture of jelly, honey and pollen in smaller quantity.

The consequences of this are entirely practical:

- A colony can convert a young worker larva into an emergency queen. This is what makes the walk-away split, the test frame and emergency requeening possible.
- **Larval age at grafting is the most important single variable in queen quality.** Queens started from larvae older than about three days are smaller, carry fewer ovarioles and smaller spermathecae, and are more often superseded. The grafting target is the youngest larva that can be handled, ideally under 24 hours from hatching.
- When you leave a queenless split to rear its own queen, you must verify that larvae under about three days old — ideally eggs and just-hatched larvae — are present. A split given only older larvae will produce a poor queen.

Drone determination is different and is not nutritional: it is **haplodiploid**. The queen assesses cell width with her forelegs before laying and releases stored sperm for worker-sized cells but withholds it for the wider drone cells. This explains why a queen with an exhausted spermatheca becomes a drone layer, and why old, damaged or enlarged comb accumulates drone brood.

3.2.3 Laying rate and what limits it

A good queen at the peak of the season can lay **1,500 to 2,000 eggs per day**, which can exceed her own body weight daily. In practice she rarely does, and the limits are not usually her:

- the number of empty, cleaned and polished cells available,
- the number of nurse bees available to feed larvae,
- incoming pollen and nectar,
- the colony's ability to hold the brood area at temperature.

This is worth dwelling on because it underlies one of the most frequently examined diagnostic errors in beekeeping. **A restricted or spotty brood pattern is not automatically a queen problem.** A honey-bound or pollen-bound brood nest, too few nurse bees, or a colony too small to cover its comb will all restrict laying with a perfectly sound queen present. Requeening in those circumstances replaces a good queen and leaves the real problem running.

3.3 The Digestive System

Nectar enters the mouth, passes down the esophagus through the thorax, and is stored in the **crop**, or honey stomach, in the abdomen. The crop is a transport organ, not a digestive one.

Between the crop and the midgut sits the **proventriculus**, a valve with four muscular lips bearing spines. Its function is to filter solid particles — pollen grains, yeast cells, spores — out of the crop contents and pass them on to the midgut for digestion, while leaving the nectar in the crop available to be regurgitated. This single structure is what makes nectar transport possible at all; without it a forager would digest her load on the way home.

Beyond the proventriculus lies the **midgut** (ventriculus), the site of digestion and absorption and the tissue infected by *Nosema*. The **Malpighian tubules** empty at the midgut–hindgut junction and handle nitrogenous excretion. The **hindgut** ends in the **rectum**, which is distensible and serves as a storage organ during winter confinement, allowing bees to retain waste until a cleansing flight is possible.

3.3.1 Enzymes and the making of honey

Two enzymes from the worker's **hypopharyngeal glands** matter here, and both are examinable:

- **Invertase** (also called sucrase or alpha-glucosidase) hydrolyses sucrose into glucose and fructose. This is the chemical change that distinguishes honey from concentrated nectar.
- **Glucose oxidase** acts on glucose to produce gluconic acid and **hydrogen peroxide**. The gluconic acid is the major contributor to honey's low pH; the hydrogen peroxide is responsible for much of honey's natural antibacterial activity.

Diastase (amylase), which breaks down starch, is also added and is used as a quality index. All of these enzymes are heat-labile, which is the biological reason overheating degrades honey quality and why enzyme activity is measured in commercial quality specifications.

Nectar becomes honey by a combination of processes: addition of enzymes; repeated manipulation and transfer among bees, which exposes thin films to hive air; and evaporation driven by fanning, until moisture falls to roughly 17–18.6 percent. Capping is the colony's own signal that the honey is ripe, though not a guarantee against fermentation. In the humid Southeast ripening takes longer, and unripe honey is a recurring cause of fermented product — see Chapter 8.

3.4 The Glandular Systems

The worker honey bee is, among other things, a walking set of glands, and they develop and regress on a schedule that drives the division of labor.

Gland	Location	Product / function	Peak age
Hypopharyngeal	Head	Brood food (royal jelly component); invertase, glucose oxidase, diastase in foragers	about 6–15 days
Mandibular	Head	Component of royal jelly in nurses; in the queen, queen mandibular pheromone (QMP); in older workers 2-heptanone (weak alarm/repellent role; anesthetizes small pests such as wax moth larvae)	Varies
Wax	Ventral abdomen, sterna 4–7	Beeswax scales	about 12–18 days
Nasonov	Dorsal abdomen, between terminal tergites	Orientation pheromone	Foragers and orienting bees
Koschevnikov gland and	At the base of the sting	Worker sting alarm pheromone (isopentyl acetate the principal component, with	Guards onward

Gland	Location	Product / function	Peak age
sting-sheath glandular areas		many others); in the queen, the Koschevnikov gland contributes to the queen's attractive signal	
Arnhart (tarsal)	Feet	Footprint pheromone	—
Salivary (labial)	Head/thorax	Saliva, dissolving sugars, wax softening	—

Two things about this table are examinable.

The wax glands are functional in comparatively young bees, roughly the second and third weeks of adult life, and regress well before a bee becomes a forager. A commonly offered false statement is that wax glands are at their most productive in older foragers; they are not.

The hypopharyngeal glands can be reactivated. A colony that loses its nurse bees can push foragers back into brood-food production, and a colony that loses its foragers can push young bees into foraging prematurely. This flexibility is what allows colonies to recover from disruption. It also explains why a package made up largely of older bees rears brood poorly at first but adjusts, and why a colony that loses its field force to a pesticide kill recovers slowly, having pressed short-lived young bees into foraging early.

3.4.1 The cost of wax

Wax is expensive. Commonly cited figures run from about **6 to 8 pounds of honey per pound of wax**, and considerably higher figures are defensible depending on how the metabolic cost of holding the comb-building cluster at temperature is accounted for. The uncertainty in the published numbers does not affect the management conclusion:

- Colonies draw comb freely on a flow and grudgingly or not at all during dearth.
- Drawn comb is the most valuable asset in a beekeeper's equipment shed, and a beekeeper who has drawn comb begins each spring with a substantial head start.
- Protecting comb from wax moth, small hive beetle, mice and careless handling is worth real effort.

3.5 Pheromones

Pheromones are chemical signals between individuals of the same species. A colony is coordinated by them, and a working beekeeper reads several every time a hive is opened.

Queen mandibular pheromone (QMP) is produced by the queen's mandibular glands and distributed through the colony by contact and food sharing (trophallaxis). Its functions include inhibiting queen rearing, inhibiting worker ovary development, attracting workers to form a retinue, stabilizing the swarm cluster and attracting drones during mating flights. The examinable mechanism is this: **the amount of pheromone each bee receives depends on how many bees are sharing it.** A crowded colony distributes the same output among more bees, each receives less, the inhibition weakens, and queen cells are started. That is the link between congestion and swarming, and it is also the lever the beekeeper pulls — relieving congestion raises the per-bee share.

An aging queen produces less, which is the mechanism of supersedure.

Nasonov pheromone is released from the dorsal abdominal gland when the bee flexes her abdomen upward and fans, exposing a pale membrane. It is an orientation signal: come here. You see it at the entrance after a move, when a swarm is settling into a new cavity, when bees are reorienting, and at a water source. Recognizing the posture — abdomen raised, tip exposed, fanning — is a genuinely useful field skill. When you hive a swarm and see bees fanning Nasonov at the entrance of the new box, the queen is inside and the swarm is going in.

Alarm pheromone is released from glands at the base of the sting — mainly the **Koschevnikov gland** and glandular areas of the sting sheath — the principal component being isopentyl acetate, which smells distinctly of banana. The mandibular glands of older workers produce 2-heptanone, long taught as a second alarm substance; its alarm role is now considered much weaker than that of the sting pheromone, and it acts as an anesthetic on small intruders such as wax moth larvae and *Varroa* (Papachristoforou et al. 2012). Alarm pheromone recruits defenders and marks a target. Its practical implications: a crushed bee marks you; a sting marks the spot and invites more stings there; banana-scented sunscreen or lip balm is a poor choice in an apiary; and a whiff of banana while you are working tells you to use smoke and to close up.

Brood pheromone (brood ester pheromone and related compounds) signals the presence and quantity of larvae, influences foraging effort and pollen collection, and suppresses worker ovary development. This is why giving a laying-worker colony repeated frames of open brood can suppress the layers.

Footprint pheromone from the tarsal glands is deposited as bees walk, marks the entrance and, from the queen, contributes to the suppression of queen cell construction along the bottom bars.

3.5.1 Why smoke works

Two mechanisms operate together. Smoke **masks alarm pheromone**, interfering with the recruitment of defenders. And smoke **triggers a feeding response**: the bees engorge on honey, which makes them both less inclined to sting and physically less able to flex the abdomen to do so.

The technique matters. Cool white smoke, applied lightly at the entrance and under the cover, then given a moment to work, is far more effective than a heavy blast. Hot or excessive smoke drives bees off the combs, taints honey, and can provoke rather than calm a colony. In the Southeast, dry pine straw, pine needles and burlap are standard fuels — and a smoldering smoker set down on dry pine straw is a serious wildfire hazard (see Chapter 19 on safety).

3.6 Respiration

Honey bees do not have lungs and their blood does not carry oxygen. Air enters through **spiracles** — paired openings along the thorax and abdomen — and travels through a branching system of **tracheae** and **air sacs** directly to the tissues, where gas exchange occurs. Hemolymph carries nutrients, hormones and immune cells, but **not** oxygen; there is no respiratory pigment.

Three practical consequences:

- **Tracheal mites** (*Acarapis woodi*) colonize the prothoracic tracheae, entering through the first thoracic spiracle of young adults. Because they are inside the respiratory system, they impair the bee effectively and cannot be seen without dissection or laboratory work.
- **Carbon dioxide anesthetizes bees quickly and reversibly**, which is why CO₂ is used for handling queens and in instrumental insemination.
- **Bees suffocate rapidly in a closed container without ventilation.** This is a real hazard when moving colonies, and it is why confining colonies during a pesticide application must be done with screens that preserve full ventilation, briefly, and preferably in cool weather.

3.7 The Senses and Navigation

3.7.1 Vision

Honey bees see **ultraviolet, blue and green**, and are essentially **blind to red**. Their visible spectrum is shifted toward shorter wavelengths relative to ours. Consequences:

- Many bee-pollinated flowers carry **ultraviolet nectar guides** invisible to us.
- Red flowers — trumpet creeper, cardinal flower — are generally hummingbird plants rather than bee plants. A question offering “bees see deep red, which is why red flowers are heavily worked” is testing this.
- Bees detect the **polarization pattern of the sky**, which allows them to navigate when the sun is obscured by cloud, and which is read chiefly through the specialized **dorsal rim area** of the compound eye, with the ocelli also contributing.
- Bees have excellent **motion detection** and a high flicker-fusion rate, which is why rapid movement near a colony provokes a response while slow, steady movement does not.

3.7.2 Chemoreception

Smell is dominant. The antennae carry very large numbers of olfactory sensilla, and the bee’s discrimination of floral odors is acute. Taste receptors occur on the mouthparts, antennae and tarsi.

Colony odor is the basis of nestmate recognition. Guard bees distinguish nestmates from intruders primarily by a **learned chemical signature carried on the cuticle**, strongly influenced by the comb and by the colony’s forage — not by sight, wingbeat sound or body size. Because the signature is learned and partly environmental, colonies kept on shared comb and fed alike accept one another more readily. That is the mechanism behind the **newspaper combine**: separating two colonies for a day or two while they chew through allows their odors to merge before the bees meet.

It is also why **drifting** increases when hives look and smell alike and stand in long identical rows.

3.7.3 Navigation and foraging range

Bees navigate by the sun's azimuth, by polarized light, by landmark memory and by an internal sense of elapsed flight distance (optic flow). Foragers navigate to the **precise location** of their hive entrance.

Normal foraging range is commonly **1 to 2 miles**, extending to **4 or 5 miles and beyond** when necessary. A two-mile radius covers roughly 8,000 acres. Three consequences:

- You cannot confine bees to a target crop.
- Pesticide exposure can originate well off your own property; siting must consider the surrounding landscape across several square miles, not the fence line.
- A colony must be moved **less than about 3 feet or more than about 3 miles**, because an intermediate move leaves foragers returning to an empty site where they are lost. To move an intermediate distance: relocate more than three miles away for two to three weeks and then bring the colony back to the new site; or move a few feet per day; or move it directly and obstruct the entrance with leafy branches to force reorientation, accepting some forager loss. A useful trick when moving within a yard is to place a nucleus or a swarm trap at the old location to collect the returning foragers.

3.8 Thermoregulation

The brood nest is held at approximately **93 to 96 °F (about 34 to 35 °C)** — close to 95 °F. The tolerance is narrow, and brood chilled during a long inspection on a cool day can be damaged or killed.

Heating. Bees warm brood by contracting their flight muscles without moving the wings, generating heat metabolically. Individual bees press their thoraces against cappings to warm specific pupae. The cluster in cold weather contracts, with a dense insulating mantle and a looser heat-producing core, and the whole cluster moves through the comb to follow its stores.

Cooling. When the temperature rises, the colony uses three mechanisms, and the examination expects all three:

1. **Evaporative cooling** — workers collect water, spread it in thin films on comb surfaces and cell rims, and fan vigorously to evaporate it.
2. **Fanning** — bees at the entrance and within the hive fan to move air through, in coordinated streams with bees facing one way at one side of the entrance and the other way at the other.
3. **Bearding** — surplus bees move outside and cluster on the front of the hive, reducing the metabolic heat load inside.

Bearding on the front of a hive on a humid Southeastern evening is normal thermoregulatory behavior and requires nothing beyond confirming adequate shade, ventilation and water. It is not a sign of swarming. Swarming occurs on warm mid-days, is preceded by queen cells in the brood nest, and involves a mass departure rather than a static cluster. Persistent daytime bearding may indicate the colony needs more room or better ventilation.

The practical corollary of evaporative cooling is that **a reliable nearby water source is essential in the Southeast** — and it is needed year round, not only in hot weather. In cold weather bees need water to dilute granulated stores in order to make brood food, and they will

fly for it on the first mild days of late winter at temperatures that make the trip costly. Establish the source before the bees find your neighbor's swimming pool; water foragers are strongly faithful to an established source and recruit others to it, so dislodging an established habit is far harder than preventing one.

3.9 The Fat Body, and Why Winter Bees Are Different

The **fat body** is a tissue lying beneath the abdominal cuticle, analogous in function to the vertebrate liver and adipose tissue combined. It stores lipid, glycogen and protein (notably **vitellogenin**), synthesizes and detoxifies, and is central to immune function and to longevity.

This tissue explains the most consequential seasonal fact in beekeeping.

Summer bees reared during a flow, working hard, wear out in about **four to six weeks**.

Winter bees — reared beginning in August–September, depending on location, as brood rearing declines and autumn pollen is abundant — have large fat bodies, high vitellogenin titers and greatly extended longevity, living for **months**. They are the same genotype in a different physiological state; there is no separate class of winter egg and no genetically distinct winter line.

The quality of that winter cohort determines whether a colony survives to spring. And *Varroa* damages the winter bee in two ways. Mites on adult bees feed mainly on fat body tissue, while mites reproducing on pupae feed mainly on hemolymph (Chapter 16, §16.1). Either way, mite feeding and virus transmission during the autumn cohort's development shorten the lives of the bees that make a winter bee a winter bee.

This is the biological reason that **late-summer mite control is the single most important timing decision in colony management**, and the reason a colony can look populous and productive in September and be dead in January. It also explains why the late-summer *Varroa* count is treated as decisive and why the late-summer threshold is kept low: the damage is done to a cohort whose failure will not be visible for months. Chapter 16 develops this fully; it is introduced here because it is a physiological fact before it is a management rule.

3.10 The Sting Apparatus

The sting is a **modified ovipositor**, which is why only females possess it. Workers have a **barbed** sting; queens have a smoother, curved sting with reduced barbs; **drones have none**.

The barbs catch in elastic mammalian skin, so a worker stinging a mammal cannot withdraw and tears loose the sting together with the venom sac, associated muscles and a ganglion, which kills her. Against the exoskeleton of another insect — a robbing bee, a wasp, a small hive beetle — the barbs do not catch, and a worker can sting repeatedly without harm to herself. The queen's sting is used principally against rival queens.

The detached sting **continues to pump venom** for some time after separation, which is the reason behind the modern first-aid advice.

Sting removal: speed matters more than method. The traditional instruction never to pinch the sting, on the grounds that squeezing the sac injects more venom, is not supported by measurement. Controlled work (Visscher, Vetter & Camazine, *Lancet*, 1996) compared wheel

size after stings removed at different intervals and by different methods, and found that **elapsed time governed the dose delivered while method did not significantly affect it**. Scraping the sting out sideways with a hive tool or fingernail remains convenient; the point is not to hesitate while you find something to scrape with. Get it out at once, by whatever means is quickest.

3.10.1 Reactions to stings

A **normal local reaction** produces pain, redness and swelling **at and continuous with** the sting site. A **large local reaction** may involve substantial swelling extending over a joint and lasting several days; it is uncomfortable and alarming but is not anaphylaxis.

A **systemic allergic reaction** is defined by signs appearing **away from the sting site**: generalized hives, flushing, facial or throat swelling, difficulty breathing or swallowing, wheeze, abdominal cramping, dizziness, or collapse. The distinguishing question is always *are the symptoms away from the sting?*

Any systemic reaction warrants **immediate intramuscular epinephrine** into the outer thigh if an auto-injector is available, an immediate call to emergency services, and transport to hospital for observation even if symptoms improve, because reactions can recur hours later. Keep the person lying down with legs elevated unless breathing difficulty makes sitting necessary; do not have them stand or walk. Be prepared to give a second dose after roughly five to fifteen minutes if there is no improvement. Antihistamines are an adjunct and are **not** a substitute for epinephrine. Refer the person to an allergist afterward.

Mass envenomation — hundreds of stings — is dangerous to anyone regardless of allergy status. It is a **toxic**, not allergic, phenomenon: venom in quantity can produce rhabdomyolysis, hemolysis, kidney injury and cardiovascular strain, developing over hours to days. Tolerance to ordinary stings confers no protection. Anyone who takes a very large number of stings should be evaluated in hospital even if they feel well.

3.11 Age Polyethism: The Division of Labor

A worker bee's tasks change with age, driven by the maturation and regression of her glands. The typical progression:

Approximate age	Task
Days 1–3	Cell cleaning and polishing
Days 3–12	Brood feeding (nurse work); hypopharyngeal glands mature
Days 12–18	Wax production, comb building, receiving and storing nectar, capping, undertaking, hive cleaning
Days 18–21	Guarding; orientation flights
Day about 21 to death	Foraging

Memorize the sequence: **cleaning › nursing › wax and food handling › guarding › foraging**.

The sequence is **flexible, not fixed**. If a colony loses its foragers, young bees mature early to replace them. If it loses its nurses, foragers can revert and reactivate their brood food glands. This plasticity is what a beekeeper reads:

- A **package** contains bees of mixed and largely older ages and no brood; it cannot draw comb well immediately and must be fed steadily until it is established.
- A **split made up largely of foragers** rears brood poorly at first.
- A colony that has lost its field force to a **pesticide kill** pushes young bees into foraging prematurely, producing short-lived workers and a slow recovery that outlasts the visible incident.

3.11.1 Drones

Drones are reproductive specialists. They do not forage, make wax, build comb, feed brood or defend the colony, though they contribute somewhat to thermoregulation. They reach sexual maturity at roughly 12 to 16 days after emergence, fly on warm afternoons to drone congregation areas, and **die in the act of mating**.

The beekeeper's instinct to regard drones as parasites is misplaced: a healthy colony in spring and summer rears drones, and a colony that is not rearing drones during the season is telling you something. The qualification is that drone brood is preferentially infested by *Varroa*, which the beekeeper can exploit through drone brood trapping (Chapter 16).

In most of the country, workers **evict drones** in late summer or autumn as the flow ends, denying them food and driving them out so that the colony does not carry non-productive bees through winter. In south Florida, where brood rearing and forage can continue nearly year round, colonies commonly keep drones much later or throughout the year, so drones in a Florida colony in December are not the anomaly they would be in Tennessee. Conversely, **an abrupt eviction of drones during a summer dearth anywhere in the Southeast is a useful signal** that forage has failed and that feeding may be needed.

3.12 Colony Population Through the Year

A strong Southeastern colony runs roughly **40,000 to 60,000 bees or more** at the peak of the spring flow in April and May, falling to perhaps **10,000 to 20,000** at midwinter. The difference is driven by the cycle of brood rearing, which expands with day length, temperature and incoming pollen and nectar, and contracts after the main flow and again as autumn forage declines.

The Southeastern curve has a distinctive shape worth holding in your head, because it explains most of the region's management calendar: an **early and steep** spring build-up beginning with red maple pollen in January or February; a peak in April and May; a marked decline through the **July and August dearth**; a modest autumn recovery on goldenrod and aster; and a shallow winter trough with **only a brief or absent broodless period**.

Numbers to Memorize

Item	Figure
Development, egg to emergence	Queen 16 d, worker 21 d, drone 24 d
Egg stage	3 days, all castes
Queen cell capped	about day 8 from egg
Worker / drone brood capped	about day 9 / about day 10
Swarm-season inspection interval	7 days
Brood nest temperature	93–96 °F (34–35 °C), about 95 °F
Peak laying rate	1,500–2,000 eggs/day
Summer worker lifespan	4–6 weeks
Winter bee lifespan	several months
Wax gland activity	about 12–18 days of adult life
Honey per pound of wax	about 6–8 lb, commonly cited; often more
Drone sexual maturity	12–16 days after emergence
Normal foraging range	1–2 miles; up to 4–5+
Colony move rule	less than 3 ft or more than 3 miles
Peak colony population (SE spring)	40,000–60,000+
Midwinter population	10,000–20,000
Antennal segments	12 (queen, worker), 13 (drone)
Wax gland pairs	4 pairs, sterna 4–7
Ocelli	3

Key Terms

Proventriculus — the valve between crop and midgut that filters particles out of crop contents, making nectar transport possible.

Corbicula — the pollen basket on the outer hind tibia of the worker.

Hamuli — hooks coupling hind wing to forewing.

Age polyethism — the age-related progression of worker tasks.

Fat body — abdominal tissue central to nutrient storage, detoxification, immunity and longevity; the tissue *Varroa* feed on while riding adult bees (mites reproducing on pupae feed mainly on hemolymph).

Vitellogenin — a storage protein central to winter bee longevity and immune function.

Trophallaxis — mouth-to-mouth transfer of food, and the route by which queen pheromone is distributed.

Queen mandibular pheromone (QMP) — inhibits queen rearing and worker ovary development; diluted by crowding.

Nasonov pheromone — orientation signal released with abdomen raised and fanning.

Bearding — normal thermoregulatory clustering outside the hive in hot weather.

Eclosion — emergence of the adult from the cell.

Self-Check

- 1. (SA)** Give the days from egg to emergence for queen, worker and drone, and state which figure is most useful for scheduling swarm-season inspections and why.
- 2. (MC)** The honey stomach (crop) is separated from the true digestive stomach by which structure? A) The proventriculus, filtering pollen and particles out of crop contents while nectar can still be regurgitated B) The Malpighian tubules, which remove water from nectar C) The rectum, which stores nectar during the return flight D) The pylorus, which begins digestion of nectar
- 3. (SA)** Name the three body regions of the adult honey bee and state which structures are attached to each.
- 4. (TF)** Worker bees produce beeswax from glands on the underside of the abdomen, the glands being most productive in older foragers, and comb is drawn about as readily during a dearth as during a flow because wax costs the colony very little honey.
- 5. (MC)** Honey bee vision differs from human vision in that bees: A) Cannot detect movement B) See only black and white C) See a wider range including deep red D) See ultraviolet, blue and green but are essentially blind to red, and detect sky polarization
- 6. (SA)** Describe how a colony cools itself when the temperature in a Georgia apiary reaches 98 °F in July.
- 7. (MC)** The average life expectancy of a worker bee differs greatly by season because: A) Winter bees never leave the hive and so cannot be counted B) Summer workers reared in a flow wear out in 4–6 weeks, whereas autumn-reared bees have larger fat bodies and higher reserves and live for months C) Winter bees are a genetically distinct line D) The queen lays a larger class of egg in autumn
- 8. (SA)** Explain what determines whether a fertilized egg becomes a queen or a worker, and give two practical consequences.

Answers

- 1.** Queen 16, worker 21, drone 24. The queen figure matters most: queen cells are capped about day 8 from the egg and a primary swarm normally issues at or shortly after capping, so an inspection interval of about 7 days is needed to intercept the sequence. In the Southeast that interval must begin in late February or early March, far earlier than in northern states.
- 2. A.**
- 3.** Head — antennae, compound eyes, three ocelli, mandibles, proboscis, and the openings of the hypopharyngeal and mandibular glands. Thorax — two pairs of wings and three pairs of legs, including the corbicula on the hind tibia; first thoracic spiracle (entry point of the tracheal mite). Abdomen — digestive and reproductive organs, Malpighian tubules, wax glands on the ventral

surface (worker), Nasonov gland on the dorsal surface, the sting apparatus, dorsal vessel and fat body.

4. False on two counts. The wax glands are functional in comparatively young bees (roughly the second and third weeks of adult life) and regress before a bee becomes a forager. And wax is expensive — about 6 to 8 pounds of honey per pound of wax is the usual figure, and higher is defensible — which is why colonies draw comb freely on a flow and grudgingly or not at all in a dearth, and why drawn comb is a beekeeper's most valuable equipment.

5. D.

6. Workers collect water and spread it in thin films on comb surfaces and cell rims, then fan vigorously to evaporate it, cooling the nest by evaporation. Bees also fan at the entrance to move air through the hive. Surplus bees move outside and cluster on the front — bearding — reducing the metabolic heat load inside. The practical implications are that a reliable nearby water source is essential, that shade and ventilation reduce the workload, and that bearding on a hot evening is normal rather than a sign of swarming.

7. B.

8. Nutrition during the larval stage: a larva fed royal jelly copiously throughout larval development in a queen cell becomes a queen, while a larva switched after about three days to jelly, honey and pollen in a worker cell becomes a worker. The genetics are the same. Consequences: (a) a colony can convert a young worker larva into an emergency queen, which is what makes walk-away splits and test frames work; (b) larval age at grafting is the most important variable in queen quality, so the target is a larva under 24 hours old, and a beekeeper leaving a split to requeen itself must verify that eggs or very young larvae are present.

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Chapter 4: Bees and Their Relatives

Learning Objectives

When you have finished this chapter you should be able to:

- Distinguish a bee from a wasp, a hornet and a bee-mimicking fly in the field and from a specimen.
 - Name the bee families, describe the characteristics of each, and give representative genera occurring in the Southeast.
 - Describe the principal native pollinators of the Southeast and the crops for which they matter.
 - State the criteria for eusociality and place honey bees, bumble bees and solitary bees along the social spectrum.
 - Explain buzz pollination, which plants require it, and why honey bees, although less efficient per flower, are still the main rented pollinator of blueberries and are used together with bumble bees and native bees.
 - Describe the relationship between managed honey bees and native pollinator conservation honestly and accurately.
 - Identify the wasps and hornets of beekeeping concern in the Southeast, including *Vespa velutina*.
-

4.1 Why This Chapter Exists

The practical component of most intermediate certifications asks candidates to distinguish honey bees from wasps, hornets and non-bee insects, generally to a ninety percent standard. There are three reasons this matters beyond the examination.

The first is public service. A Journeyman beekeeper takes swarm calls, and a great many of those calls are about yellowjackets in a wall, a carpenter bee at a deck rail, or a hover fly at a picnic. Being able to say confidently and quickly what an insect is — and what it is not — is one of the more useful things you will do for your community, and it saves a great many bee colonies from being destroyed under a mistaken identity.

The second is biosecurity. The yellow-legged hornet arrived in Georgia in 2023 and the response depends on beekeepers and members of the public correctly identifying and reporting it. An exotic pest is usually first seen by somebody who was not looking for it.

The third is intellectual honesty in public. Honey bees are one species among roughly 4,000 in North America, and the popular conflation of “save the bees” with honey bee colony losses obscures a genuine conservation problem affecting species that nobody is managing or replacing. A beekeeper who can talk accurately about native bees is far more credible when talking about honey bees.

4.2 Telling Bees from Wasps from Flies

4.2.1 Bees versus wasps

Both are Hymenoptera; bees are, in evolutionary terms, a lineage of wasps that took up vegetarianism. The distinguishing features:

Character	Bee	Wasp
Body hair	Branched (plumose) , often dense	Sparse, simple, unbranched
Larval provisioning	Pollen and nectar	Animal prey (or, in some, provisioned by adults)
Hind legs	Often modified for pollen carriage (corbicula, scopa)	Not modified for pollen
Body shape	Generally stouter, waist less pronounced	Typically slender, waist markedly narrow
Legs in flight	Tucked	Often dangling (in many wasps)
Coloration	Often brown, black, metallic; some banded	Frequently bright yellow and black, sharply patterned, often shiny

The single most reliable character is **branched body hair**, visible with a hand lens. It is the defining bee adaptation: pollen adheres to branched hair, and everything else about bee biology follows from the decision to feed their young on pollen.

Two other features worth knowing: bees have **13 antennal segments in males and 12 in females**; and a wasp's smooth, shiny body reflects its lack of pollen-trapping hair.

4.2.2 Bee mimics: the flies

Many flies (order Diptera) mimic bees and wasps, gaining protection from predators that avoid stinging insects. The family Syrphidae — hover flies or flower flies — contains a great many convincing mimics, and the drone fly *Eristalis tenax* is a classic honey bee mimic that turns up constantly in identification exercises. Bee flies (Bombyliidae) mimic bumble bees.

Flies are easy once you know where to look:

Character	Bee (Hymenoptera)	Fly (Diptera)
Wings	Two pairs (four wings), hind coupled to fore by hamuli	One pair ; hind wings reduced to halteres , small knobbed balancing organs
Eyes	Smaller relative to head, separated in females	Very large , often meeting or nearly meeting on top of the head

Character	Bee (Hymenoptera)	Fly (Diptera)
Antennae	Long, elbowed, obviously segmented	Short, stubby, often bristle-like
Mouthparts	Chewing mandibles plus proboscis	Sponging or piercing; no mandibles
Sting	Present in females	Absent
Flight	Direct, purposeful	Often hovering, darting, able to fly backwards

Two wings, huge eyes, stubby antennae is the diagnostic trio. Say it to yourself; it will get you through most identification exercises.

4.2.3 The honey bee specifically

Compared with a bumble bee: smaller, slimmer, less densely furry, with distinct amber-and-brown or black abdominal banding rather than dense yellow and black pile. Compared with a yellowjacket: hairier, duller, browner, with less contrast; the yellowjacket's abdomen is smooth and boldly patterned and its waist is pinched. Compared with a honey bee mimic hover fly: two wings versus four.

Honey bee **swarms** — a clustered mass, often on a branch, in spring — are honey bees. A **paper nest**, whether the football-shaped grey envelope of a bald-faced hornet or the open umbrella comb of a paper wasp, is never honey bees. Honey bees build **wax comb**, always, and their nests are in cavities.

4.3 The Bee Families

There are seven families of bees worldwide, six of which occur in North America.

Andrenidae — mining bees. Ground-nesting solitary bees, many with velvety facial hair patches (the “foveae”). *Andrena* is a large genus with many spring-flying species, often the first bees out in late winter in the Southeast. Many are oligolectic — specialists on a narrow range of host plants. Stings are feeble.

Apidae — the largest and most diverse family. Contains honey bees (*Apis*), bumble bees (*Bombus*), carpenter bees (*Xylocopa*, *Ceratina*), squash bees (*Eucera*, formerly *Peponapis*), long-horned bees (*Melissodes*), digger bees (*Anthophora*, *Habropoda*), cuckoo bees (*Nomada*, *Triepeolus*), stingless bees (*Melipona*, *Trigona* — tropical) and orchid bees. The corbiculate bees — honey bees, bumble bees, stingless bees and orchid bees — share the pollen basket.

Colletidae — plasterer or polyester bees. Line their nest cells with a cellophane-like waterproof secretion applied with a short bilobed tongue. *Colletes* and the small, nearly hairless yellow-faced bees *Hylaeus*, which carry pollen internally in the crop rather than externally.

Halictidae — sweat bees. Named from their attraction to perspiration. Many are brilliantly metallic green or blue (*Agapostemon*, *Augochlora*, *Augochlorella*), others dark and small (*Lasioglossum*, *Halictus*). The family is a treasure for anyone interested in social evolution, because it contains solitary, communal, semi-social and eusocial species, sometimes within a single species depending on latitude.

Megachilidae — leafcutter and mason bees. The distinguishing feature is that they carry pollen on a **scopa on the underside of the abdomen** rather than on the legs, which makes them easy to recognize in the field — a bee with a bright pollen-laden belly. Includes *Megachile* (leafcutters, which cut neat circles from leaves to line cells), *Osmia* (mason bees, using mud), *Anthidium* (carder bees, using plant fibers) and the introduced *Megachile rotundata*, the alfalfa leafcutting bee, managed commercially.

Melittidae — a small family of mining bees, several of which collect floral oils in addition to pollen and nectar.

Stenotritidae — Australian only; fast-flying mining bees. Not in North America.

4.4 Native Bees of the Southeast

North America has roughly 4,000 native bee species. The great majority are **solitary**: a single female builds, provisions and seals her own nest with no worker caste and no cooperation. Roughly **70 percent nest in the ground**; most of the remainder nest in cavities — hollow stems, beetle burrows in wood, snail shells. A small number, principally the bumble bees, are truly social.

Species and groups a Southeastern beekeeper should be able to name:

Bumble bees (*Bombus*). Annual eusocial colonies founded each spring by an overwintered mated queen, growing to a few dozen to a few hundred workers, producing new queens and males in late season, and dying out in autumn with only the new queens surviving. Nests are in cavities, often abandoned rodent burrows or grass tussocks. Bumble bees fly at lower temperatures and in poorer light than honey bees, have longer tongues, and perform **buzz pollination**. Southeastern species include *B. impatiens* (the common eastern bumble bee, also the species reared commercially), *B. griseocollis*, *B. bimaculatus*, *B. pensylvanicus* (the American bumble bee, in decline) and *B. fervidus*. *B. affinis*, the rusty patched bumble bee, is federally listed as endangered — the first bee so listed in the continental United States — though its range is chiefly north of the Southeast.

Southeastern blueberry bee (*Habropoda laboriosa*). A solitary, ground-nesting spring specialist of enormous importance to rabbiteye blueberry. It buzz-pollinates, flies early and in cool weather, and a single female is credited with pollinating a very large number of blueberry flowers in her short life. Its flight period is tightly synchronized with blueberry bloom.

Squash bees (*Eucera (Peponapis) pruinosa* and relatives). Specialists on cucurbits. They fly before dawn, when squash and pumpkin flowers open, and are typically finished for the day before honey bees get going. Males sleep in closed flowers. In many cucurbit fields they do a substantial share of the pollination unrecognized.

Carpenter bees (*Xylocopa virginica*). The large bee that bores perfectly round half-inch holes in fascia boards, decks and barn siding, and that homeowners call about constantly. Distinguished from a bumble bee by the **shiny, hairless black abdomen** — bumble bee abdomens are furry. Males have a pale face patch and cannot sting; they hover aggressively and harmlessly. Carpenter bees are frequent **nectar robbers**, slitting the base of long corollas to reach nectar without contacting anthers, which reduces their pollination value on some crops.

Mason bees (*Osmia*). Cavity nesters using mud partitions; efficient orchard pollinators, and the species most often reared in “bee hotels.”

Sweat bees (*Halictidae*). Ubiquitous, often metallic, generalist visitors to a very wide range of bloom.

Cuckoo bees (*Nomada*, *Triepeolus*, *Sphecodes*, and *Bombus* subgenus *Psithyrus*). Brood parasites that lay in the nests of other bees. Mostly hairless, wasp-like, often red and black, and frequently mistaken for wasps.

4.5 Eusociality

The four criteria for **eusociality**, the highest grade of social organization:

1. **Cooperative brood care** — individuals care for offspring that are not their own.
2. **Overlapping generations** within the colony, so that offspring assist parents.
3. **Reproductive division of labor** — a caste that reproduces and a caste that largely does not.
4. (Often added, and the criterion that makes honey bees distinctive) **A morphologically distinct, irreversible worker caste.**

On these criteria:

- **Honey bees** are eusocial in the fullest sense — often called **highly eusocial** or *advanced* eusocial. Queen and worker differ morphologically, the difference is fixed at development, colonies are perennial, and reproduction occurs by colony fission (swarming) rather than by solitary founding.
- **Bumble bees** are eusocial but **primitively** so: queens and workers differ in size but not in fundamental morphology, a worker can in principle lay, and colonies are annual and founded by a lone queen.
- **Many halictids** are facultatively social, and some switch between solitary and social depending on season and latitude — which is what makes them so valuable for studying how eusociality evolves.
- **Most bees are solitary.** No worker caste, no cooperative brood care, no overlap of generations in the nest.

Between solitary and eusocial sit several intermediate grades that the Journeyman syllabus sometimes asks about: **communal** (several females share a nest entrance but each provisions her own cells), **quasi-social** (shared nest, cooperative brood care, but all females reproduce) and **semi-social** (shared nest, cooperative brood care, and a reproductive division of labor, but no overlap of generations).

The honey bee’s eusociality is why we can speak of the colony as a **superorganism** — a unit on which selection acts, in which the individual bee is more nearly analogous to a cell than to an organism. That framing is developed in Chapter 19.

4.5.1 Polyandry

A honey bee queen mates with a dozen to twenty or more drones and stores their sperm for life. This **extreme polyandry** is unusual and is an adaptation rather than an accident. Its

consequence is that the workers in a colony are a mixture of **full sisters within each patriline and half sisters across patrilines**.

The benefits of that genetic diversity are measurable: colonies with genetically diverse worker populations regulate brood nest temperature more precisely, resist disease better, forage more effectively and are more productive than genetically uniform colonies (Mattila & Seeley, *Science*, 2007). For the beekeeper the practical consequence is that a colony's observable traits are a blend of many fathers, so a single daughter queen from an excellent mother will not reliably reproduce the mother colony's performance.

4.6 Buzz Pollination and Crops Where Honey Bees Fall Short

Some flowers hold their pollen in **poricidal anthers** — tubular anthers that release pollen only through a small terminal pore. Pollen is not freely available to a visiting bee; it must be shaken out. Bumble bees and many solitary bees do this by grasping the anther and vibrating their flight muscles at high frequency without moving the wings, producing an audible buzz that fires the pollen out in a cloud. This is **sonication**, or buzz pollination.

Honey bees do not buzz-pollinate. They can collect pollen that has already been released and they do contribute to pollination of these crops, but visit for visit they are less effective than the sonicating bees.

Crops that benefit from buzz pollination include **blueberry** (notably rabbiteye blueberry, a major Georgia crop), **cranberry**, **tomato** and **eggplant**, all with poricidal anthers, and **kiwifruit**, whose pollen is also released more readily by sonication (Cooley & Vallejo-Marín 2021). Tomatoes grown under glass are pollinated commercially by *Bombus impatiens* colonies for exactly this reason; honey bees do a poor job. Blueberries are the instructive exception: honey bees are less efficient per flower than the southeastern blueberry bee or bumble bees, yet because they can be supplied in large numbers they remain the main **managed** pollinator rented for commercial blueberry fields. (Peppers are not a buzz-pollinated crop; they are largely self-pollinating.)

The practical upshot for a beekeeper offering pollination services in the Southeast: rabbiteye blueberry growers typically combine high honey bee stocking rates with managed or native bumble bees and with habitat that supports the southeastern blueberry bee. Be able to say where honey bees excel and where they are part of a mix. It is the honest answer and it is the one a knowledgeable grower will respect.

4.7 Wasps and Hornets of Beekeeping Concern

Yellowjackets (*Vespula* spp.). Ground- or cavity-nesting social wasps with annual colonies that peak in late summer and autumn — precisely when Southeastern colonies are stressed by dearth. They rob hives and prey on bees at the entrance. Management: reduce entrances so the colony can defend them, keep colonies strong, remove nearby nests where that is safe and lawful, and set baited traps **away from** the hives rather than beside them. Do not spray insecticide at a hive entrance; it kills bees and contaminates the colony.

Bald-faced hornet (*Dolichovespula maculata*). Despite the name, a large black-and-white yellowjacket relative. Builds the familiar grey football-shaped aerial paper nest. Predatory on bees at the entrance but rarely a serious colony threat.

European hornet (*Vespa crabro*). Introduced, large, brown and yellow; will take bees at the entrance and is notable for flying at night, occasionally coming to lights.

Paper wasps (*Polistes* spp.). Open umbrella-shaped combs under eaves and inside hive covers and telescoping lids. More nuisance than threat.

Yellow-legged hornet (*Vespa velutina*). This is the one to know. Native to Southeast Asia, invasive in Europe since 2004, and confirmed near **Savannah, Georgia in August 2023** — the first live detection in the open United States. The Georgia Department of Agriculture, USDA APHIS and the University of Georgia are conducting trapping, tracking and nest eradication, with periodic public updates: by mid-August 2026 Georgia had found and destroyed **182 nests** (5 in 2023, 47 in 2024, 63 in 2025 and 67 so far in 2026). The hornet has also reached **South Carolina** — queens and an embryo nest in Beaufort County in spring 2024, later finds in Jasper, Colleton and Hampton counties, and in December 2025 a nest in **York County**, near Charlotte, the first in South Carolina outside the Lowcountry. Clemson University’s Department of Plant Industry leads the South Carolina response. Officials still frame the work as eradication, though some beekeepers doubt it remains achievable.

V. velutina is a serious predator of honey bees. It hawks foragers in front of the hive entrance — a behavior sometimes called “hawking,” in which hornets hover and seize returning bees in flight — and can severely suppress a colony’s foraging. European experience is that it reduces colony productivity substantially and can destroy weak colonies.

Identification: dark body with a velvety appearance, a distinct orange-yellow band toward the rear of the abdomen, an orange-yellow face, and — the field mark that gives it its name — **legs that are conspicuously yellow at the ends**. Colonies start in spring as small **primary nests** in sheltered, often low sites (sheds, eaves, shrubs) and later move to large egg-shaped **secondary nests**, usually built high in trees.

What to do: photograph it if you can do so safely, and report it. In Georgia, reports go to the Georgia Department of Agriculture through its online reporting form or to yellow.legged.hornet@agr.georgia.gov; in South Carolina, to Clemson’s Department of Plant Industry through its online reporting tool. Do not attempt to destroy a nest yourself. Native wasps look superficially similar, so a photograph is worth far more than a description.

Northern giant hornet (*Vespa mandarinia*). The large hornet detected in Washington State and British Columbia from 2019, notable for the “slaughter phase” in which a group of hornets destroys an entire colony. Eradication in the United States was declared in December 2024. It has never been found in the Southeast, but the public will ask you about it, and the answer is: that is a different insect, it was on the other side of the country, and it has been eradicated.

4.8 Managed Bees and Native Pollinator Conservation

The relationship deserves an honest account, and the examination rewards one.

Honey bees are **managed livestock**. They are not native, they are not endangered, and managed colony numbers are held up by beekeepers replacing their losses annually. Native bees are **wildlife**, unmanaged and unreplaced, and several groups are in documented decline from habitat loss, agricultural intensification, pesticide exposure, pathogen spillover and climate change.

The two interact in ways that are real but often overstated in both directions:

- **Forage competition.** Very high honey bee densities can reduce resource availability for native bees, and the effect has been demonstrated in some natural landscapes. It is a legitimate consideration when siting large apiaries in protected natural areas; it is not a reason to stop keeping bees on agricultural land.
- **Pathogen spillover.** Several viruses, notably deformed wing virus, and *Nosema ceranae* can move between managed honey bees and wild bumble bees through shared flowers. Keeping managed colonies healthy is a conservation act as well as a business one.
- **Shared solutions.** Almost everything that helps native pollinators — diverse forage across the season, reduced and better-timed pesticide use, nesting habitat, unmowed margins — helps honey bees as well.

When you speak in public, the accurate message is stronger than the alarming one: beekeepers absorb high annual losses driven chiefly by *Varroa* and its viruses, poor nutrition in simplified landscapes and pesticide exposure; separately, native pollinators face a genuine conservation problem; and the remedies overlap substantially. That is more interesting than “the bees are dying,” and nobody in the audience can correct you.

Numbers to Memorize

Item	Figure
Bee families worldwide / in North America	7 / 6
Native bee species in North America	about 4,000
Proportion of native bees nesting in ground	about 70%
Criteria for eusociality	3 core (+1 often added)
Honey bee queen matings	a dozen to 20+ drones
<i>Vespa velutina</i> confirmed in Georgia	August 2023 (South Carolina spring 2024)
<i>Vespa mandarinia</i> US eradication declared	December 2024
Wings: bee vs fly	4 (2 pairs) vs 2 (1 pair) + halteres

Key Terms

Plumose hair — branched body hair; the defining bee character.

Scopa — a brush of pollen-carrying hairs; on the hind legs in most bees, on the **underside of the abdomen** in Megachilidae.

Corbicula — the pollen basket of the corbiculate bees (honey, bumble, stingless, orchid).

Halteres — the reduced hind wings of flies, used as balancing organs; the giveaway that a “bee” is a fly.

Eusocial — cooperative brood care, overlapping generations, reproductive division of labor (plus, in the highly eusocial, a morphologically distinct worker caste).

Buzz pollination (sonication) — vibrating the flight muscles to shake pollen from poricidal anthers; performed by bumble bees and many solitary bees, not by honey bees.

Poricidal anther — an anther releasing pollen only through a terminal pore.

Oligolectic / polylectic — specializing on a narrow range of host plants / generalist.

Nectar robbing — taking nectar through a hole cut at the base of the corolla without contacting the anthers.

Pathogen spillover — transmission of pathogens from managed bees to wild populations, or the reverse.

Self-Check

- 1. (SA)** Give three characters that distinguish a hover fly mimicking a honey bee from a real honey bee.
- 2. (MC)** Honey bees are relatively poor pollinators of rabbiteye blueberry and tomato principally because: A) Those flowers offer pollen but very little nectar B) The nectar is held in spurs too deep for the honey bee tongue C) Those flowers hold pollen in poricidal anthers released best by buzz pollination, which bumble bees perform and honey bees do not D) Those flowers shed pollen before honey bees fly
- 3. (SA)** State the criteria for eusociality, and place honey bees, bumble bees and a mining bee in the genus *Andrena* along the social spectrum.
- 4. (MC)** A large black bee with a shiny, hairless abdomen is boring a round hole in a deck rail. It is: A) A bumble bee B) A carpenter bee, *Xylocopa virginica* C) A queen honey bee that has absconded D) A bald-faced hornet
- 5. (SA)** A member of the public sends you a photograph of a dark hornet with an orange-yellow band near the tip of the abdomen and conspicuously yellow leg ends, taken in coastal Georgia. What is your response?
- 6. (TF)** Because a queen mates with many drones, the workers in a single colony are all unrelated to one another.

Answers

- 1.** A fly has **one pair of wings** with the hind wings reduced to knobbed halteres, whereas a bee has two pairs coupled by hamuli; a fly's **eyes are very large**, often meeting or nearly meeting on top of the head; and a fly's **antennae are short and stubby or bristle-like**, whereas a bee's are long, obviously segmented and elbowed. A fly also has no sting and no chewing mandibles, and typically hovers and darts rather than flying directly.
 - 2. C.** Honey bees remain the main rented pollinator, but they are less efficient per flower; rabbiteye growers in Georgia typically combine high honey bee stocking with bumble bees and habitat supporting the southeastern blueberry bee, *Habropoda laboriosa*.
 - 3.** Cooperative brood care, overlapping generations within the colony, and reproductive division of labor; to which is often added a morphologically distinct and irreversible worker caste. Honey bees are highly eusocial on all four, with perennial colonies reproducing by fission. Bumble bees are primitively eusocial: annual colonies founded by a lone overwintered queen, with queens and workers differing in size but not fundamentally in morphology. *Andrena* is solitary — each female builds and provisions her own nest with no worker caste and no cooperative brood care.
 - 4. B.** The shiny hairless abdomen is the key; bumble bee abdomens are densely furry. Males have a pale face patch and cannot sting.
 - 5.** It is consistent with the yellow-legged hornet, *Vespa velutina*, confirmed near Savannah in August 2023 and the subject of an active eradication program. Thank them, ask for the location and date, tell them not to approach or attempt to destroy any nest, and report it to the Georgia Department of Agriculture through its online reporting form or yellow.legged.hornet@agr.georgia.gov. Note that several native wasps look superficially similar, so the photograph is essential for confirmation.
 - 6. False.** Workers are a mixture of full sisters within each patriline and half sisters across patrilines. That genetic diversity is adaptive: it improves thermoregulation, disease resistance and productivity.
-

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Chapter 5: Honey Bee Nutrition

Learning Objectives

When you have finished this chapter you should be able to:

- State the nutritional roles of nectar and pollen precisely, and explain why the distinction drives every feeding decision.
 - Describe beebread and explain how it is preserved.
 - Explain why pollen diversity matters to colony health and what a beekeeper can practically do about forage.
 - Distinguish a pollen dearth from a pollen-bound brood nest and explain why the two require opposite interventions.
 - Prepare and use 1:1 and 2:1 syrup correctly, and state which sugars are and are not acceptable.
 - Name at least four methods of feeding syrup and give an advantage or drawback of each.
 - Distinguish stimulative from emergency feeding.
 - State when a Southeastern colony is most likely to need a pollen substitute, and state the limitations of substitutes and the specific Southeastern risk they carry.
 - Recognize the signs of starvation and respond correctly.
 - Explain why water is a year-round requirement and how to manage a water source.
 - Explain the adulteration problem created by feeding while supers are on.
-

5.1 The Two Halves of the Diet

Everything in honey bee nutrition follows from one distinction, and the examination tests it directly:

- **Nectar, stored as honey, supplies carbohydrate** — the energy for flight, for heat production, and for all colony work.
- **Pollen, stored as beebread, supplies protein, lipids, vitamins and minerals** — the building materials for brood rearing, glandular development and the fat body.

Nectar contains traces of amino acids and minerals, and pollen contains some sugars, but for management purposes the division is clean and it is absolute in one direction: **a colony with abundant honey and no pollen cannot rear brood, and feeding sugar syrup will not correct a protein shortage.** Conversely, a colony with beebread but no honey will starve.

The practical demand this makes of you is that you assess **both** on every inspection. Beginners routinely look at honey and never look at beebread. In the Southeastern summer dearth, both can be short at once.

5.1.1 What the colony does with each

Nectar is received by house bees from returning foragers, passed among bees, dosed with **invertase** and **glucose oxidase** from the hypopharyngeal glands, and spread in thin films and

fanned until the moisture falls to roughly 18 percent. Then it is capped. Honey fuels flight, heat production and comb building.

Pollen is packed into cells around the brood nest, mixed with honey and glandular secretions, and colonized by lactic acid bacteria that ferment it. **Nurse bees eat beebread** and convert its protein into brood food from their hypopharyngeal and mandibular glands. It is worth being clear about this chain: pollen is not fed directly to young larvae. Nurse bees eat it, and what the larva receives is glandular jelly. Only in the later larval stages does a worker larva receive a mixture containing honey and pollen directly.

5.1.2 Beebread and its preservation

A commonly examined false statement holds that packing pollen into cells preserves it by **raising** the pH. The pH moves in the opposite direction. Lactic acid bacteria ferment the packed pollen and **acidify** it, and that lowered pH — together with added sugar, reduced oxygen in a packed cell and enzymes from the bees — is what preserves the store and suppresses spoilage organisms.

The practical corollary is important for anyone trapping pollen: **trapped pollen has none of that protection**. Pollen taken out of the hive carries substantial moisture and a natural microbial load, and in warm humid weather it will mold or ferment within hours. Traps must be emptied at least daily and the pollen dried or frozen at once (Chapter 11).

5.2 Pollen Diversity and Forage

Pollens differ in crude protein content — commonly from under 15 percent to over 30 percent — and, more importantly, in **amino acid balance**. Bees require ten essential amino acids, and a pollen deficient in any one limits the value of the rest. They also require sterols, which they cannot synthesize, and which come from pollen.

A mixed diet is far more likely to supply the full requirement than any single source. Colonies on diverse forage show better immune function, better brood production and better survival than colonies restricted to a single pollen, even a nutritionally good one (Di Pasquale et al., 2013).

What a beekeeper can actually do about this:

- **Site selection matters more than planting.** A colony forages over several square miles; a beekeeper's own acre of wildflowers is a supplement, not a solution. Choosing a site whose surrounding landscape offers a succession of bloom is the single most effective intervention.
- **Plant or encourage bee forage** where you can: clovers, vitex, partridge pea, native asters and goldenrods, hollies, and pollinator hedgerows. Vitex is particularly valuable in the Southeast because it blooms through early summer, covering part of the dearth.
- **Delay or reduce mowing** of clover and flowering ground cover. This is one of the few forage levers under direct human control, and it extends to persuading a cooperative landowner, roadside manager or golf course to mow later.
- **Cooperate with landowners** on cover crops and field margins. Crimson clover sown as a cover crop blooms around April; white clover on lawns and roadsides runs into early summer.

Be honest about the limits when you are asked. Planting a pollinator garden is worth doing, and it will not by itself feed a colony.

5.3 The Critical Diagnostic: Dearth Versus Bound

The best single indicator that a colony is short of protein is **little or no stored beebread in the brood area, with brood rearing contracted despite warm weather and a laying queen present**.

Set that against its mirror image. A **pollen-bound** brood nest has combs packed solid with beebread so that the queen has nowhere to lay. A **honey-bound** brood nest has the same problem with incoming nectar. Both reduce brood. Both can look like a failing queen. And they call for **opposite** interventions:

Condition	What you see	What to do
Pollen dearth	Cells empty and available; little beebread; brood contracted	Feed pollen substitute; consider moving to better forage
Pollen-bound	Combs packed with beebread; queen restricted	Give laying space; move or remove packed frames
Honey-bound	Brood nest backfilled with nectar; queen restricted	Give storage space above ; open the brood nest with empty drawn comb
Failing queen	Spotty pattern, drone brood in worker cells, supersedure cells	Requeen — but only after excluding the above and excluding mites and disease

A honey-bound brood nest during the gallberry flow in coastal Georgia is a classic and very common Southeastern situation: the colony is doing well, there is nowhere to put the crop, and the nest is backfilled. The remedy is to give storage space above immediately, preferably as **drawn comb**, since foundation is slower to take up, and to open the brood nest by inserting empty drawn frames or moving nectar-filled frames up into a super. Left alone, this colony swarms.

5.4 Feeding Sugar Syrup

5.4.1 Concentrations

Syrup	Ratio (sugar:water, by weight)	Approximate use
1:1	equal parts	Approximates nectar; stimulative — encourages brood rearing and comb

Syrup	Ratio (sugar:water, by weight)	Approximate use
2:1	two parts sugar to one water	building. Spring feeding, packages, splits, drawing foundation. Storage — more carbohydrate per unit of water, less evaporation required. Autumn feeding to build winter stores.

Volume-based measures are close enough in practice; beekeepers routinely mix by volume and the difference is immaterial.

5.4.2 What sugar to use

Use: plain white granulated **cane or beet sugar**, or a good **bee-grade high fructose corn syrup** or invert syrup that has been properly stored and handled.

Do not use:

- **Brown sugar, molasses, raw or turbinado sugar.** The retained plant solids are indigestible to bees and cause dysentery, particularly during winter confinement. The idea that the “trace minerals” are beneficial is exactly backwards.
- **Powdered/confectioner’s sugar as feed.** It contains anticaking starch. It is used for dusting, not feeding.
- **Honey of unknown origin, including store-bought honey.** This is a recognized route for introducing **American foulbrood spores**, which survive in honey indefinitely and may have originated anywhere. Feeding back honey from your own colonies of known health is a different matter, but you must be certain of the source colony’s status. This is one of the most consistently repeated biosecurity rules in beekeeping and one of the most frequently broken.
- **Badly stored HFCS.** High fructose corn syrup held warm in bulk accumulates **hydroxymethylfurfural (HMF)**, which is toxic to bees. The same chemistry is why you should **not boil syrup** or attempt to acid-invert it: heating sugar solutions generates HMF.

To make syrup, dissolve sugar in hot — not boiling — water and let it cool. For 2:1, warm water is genuinely necessary to get the sugar into solution.

5.4.3 Methods of feeding

Method	Advantage	Drawback
Entrance (Boardman) feeder	Simple; level visible without opening the hive	Sits at the entrance where it readily provokes robbing ; heats in the sun. Poorly suited to the Southeast.

Method	Advantage	Drawback
Division board / frame feeder	Large volume, inside the hive, cannot be robbed	Requires opening the hive to refill; drowns bees without a ladder or floats
Hive-top feeder	Large volume, refilled with minimal disturbance, well protected from robbing	Adds height and weight
Inverted pail or jar over inner cover hole	Cheap and effective; rate controlled by hole size	Limited capacity; needs an empty box around it
Open / barrel feeding away from the apiary	Fast for many colonies	Feeds unevenly, favoring the strongest ; spreads disease between colonies and apiaries; can set off apiary-wide robbing; draws bees from neighboring apiaries
Fondant, sugar cakes, dry sugar (mountain camp)	Works in cold weather when bees cannot process syrup; emergency feed placed directly over the cluster	Not a substitute for adequate stores; does not stimulate

In the Southeast, robbing risk dominates the choice. **Internal feeders are strongly preferred during the dearth, and open feeding is generally discouraged** for small and sideline operations.

5.4.4 Stimulative versus emergency feeding

Stimulative feeding gives **thin (1:1) syrup** to push brood rearing and comb building ahead of a flow or a pollination contract. It simulates an incoming flow.

Emergency feeding gives a colony close to starvation **heavy syrup or solid feed placed above the cluster**.

Confusing the two produces two common errors: feeding thin syrup to a starving winter colony, which the bees cannot ripen and which adds moisture they must then remove; and stimulating brood rearing at a time when the colony cannot support the brood it produces.

5.4.5 When bees stop taking syrup

A colony being fed 2:1 in October that stops taking it has usually hit the **temperature limit**: below which the bees may not take and ripen liquid feed. Cold syrup left standing in a feeder ferments. The management lesson is to complete liquid feeding early enough in the autumn and then rely on **fondant or dry sugar** for winter emergencies. The Southeastern window is longer than the northern one, but it still closes. On the other side of winter, during spring build-up, the bees may readily take syrup at low temperatures. Note their interest, stores, and status of build-up and feed accordingly.

5.4.6 The adulteration rule

Do not feed sugar syrup while honey supers intended for sale are on the colony.

The bees will store it, you will extract it, and selling the result as honey is **adulteration**. Honey is defined as the natural product produced by bees from nectar or honeydew; a product containing stored sugar syrup is not honey, and labeling it as such is misbranding.

The practical rule is to remove supers intended for harvest before feeding. If an emergency requires feeding during a flow, keep the resulting stores out of the harvested crop — mark the frames and leave them on the colony.

5.5 Pollen Substitutes and Supplements

A **pollen supplement** contains some real pollen; a **pollen substitute** contains none, being built from soy flour, brewer's yeast, whey, egg products and similar protein sources. In practice the terms are used loosely.

5.5.1 When a Southeastern colony needs one

- **During the July and August dearth**, when little pollen is coming in but the colony is still rearing brood.
- **In late autumn if the goldenrod and aster bloom fails**, since the autumn pollen supply determines the quality of the winter bee cohort — and the quality of that cohort determines survival.
- **In late winter**, to stimulate early build-up ahead of the spring flow or ahead of a pollination contract.

5.5.2 Limitations

No substitute fully matches diverse natural pollen. Substitutes vary in amino acid profile and lack the **sterols** and the micronutrient diversity of real pollen, so extended reliance on substitute alone produces declining brood rearing. A colony with abundant natural pollen coming in will frequently ignore a patty altogether, which is itself useful information.

5.5.3 The Southeastern risk: small hive beetle

This is the region-specific point and it is examined directly. **Protein patties are prime breeding substrate for small hive beetle larvae.** An oversized patty on a colony without the population to cover and patrol it becomes a beetle nursery, and you will return to a slimed, fermenting mess.

The rules that follow:

- **Size the patty to a few days' consumption**, not a month's.
- Place it **directly on the top bars over the cluster**, and **remove the paper backing** (beetle larvae breed readily in the space between paper and patty).
- Give protein only to colonies with **enough adult bees to patrol it**. For a weak colony or a small nucleus, use small pieces with caution due to SHB.
- Check it at every visit and remove any remnant that the bees are not working.

Every supplemental feeding decision in the Southeast has to be evaluated against beetle pressure. That is one of the sharpest practical differences between Southeastern and northern beekeeping.

5.6 Starvation

5.6.1 Recognizing it

- Very light hive weight on hefting.
- No capped or uncapped stores visible in the combs.
- Brood being removed or cannibalized.
- **Dead bees head-first in empty cells** — they died reaching for the last food.
- Lethargic or trembling bees.
- A small, tight cluster with no reserves adjacent.
- In warm weather, a colony that has become aggressive or has begun robbing.

5.6.2 Responding

Feed at once. A starving colony can die within a day or two, so speed matters more than method. Syrup if the weather permits the bees to take and process it; **fondant, sugar cakes or dry sugar placed directly above the cluster** in cold weather; or a frame of capped honey from a colony of **known good health** placed adjacent to the cluster.

In the Southeast, starvation occurs most often during the **midsummer dearth** and in **late winter**, when brood rearing has resumed and consumption has risen sharply while forage has not yet arrived.

5.6.3 Isolation starvation

A particular and frequently examined case: a colony found in winter with **plenty of capped honey on the outer frames** but the cluster sitting on empty comb. The stores are present but out of reach; the cluster consumed what was around it and could not cross cold comb to the rest.

The immediate action is to **move frames of capped honey next to the cluster** if the weather allows a brief manipulation, or to **place fondant or dry sugar directly above the cluster**. Warm thin syrup in a hive-top feeder is the wrong answer: it adds moisture and may not be taken at all.

But the immediate action is only half the response. **Ask why the cluster was too small to bridge to its stores.** A colony that dwindled to a cluster too small to move through its own hive in January was very often damaged by *Varroa* and deformed wing virus in the previous autumn. Look for deformed wings on the dead bees and for **white mite fecal deposits on the upper inner walls of vacated brood cells**; if you find them, the management change is to complete mite control before the winter bees are reared, not to feed more next year.

5.7 Water

Water is a **year-round requirement**, not a hot-weather one. This is examined as a true/false item and candidates get it wrong.

In hot weather bees use water for **evaporative cooling**. In cool weather they need it to **dilute stored honey**, which has often granulated, in order to make brood food. Colonies fly for water on the first mild days of late winter, sometimes at temperatures that make the trip costly — which means the source matters most in the season when its necessity is least obvious. In the Southeast, where brood rearing frequently continues through the winter, demand is close to continuous.

Establish the source first. Water foragers are strongly faithful to an established source and recruit others to it. Once bees have fixed on a neighbor's swimming pool, a pet's water bowl or a birdbath, simply offering an alternative rarely breaks the habit. This is the lesson: put an attractive water source in the apiary **before** the bees find something objectionable, keep it running through the season, and expect that dislodging an established habit will take far more effort than preventing one.

A good apiary water source is close to the hives, in sun, reliably wet, and provides **landing surfaces** so bees do not drown: gravel, corks, floating wood, a wet board, a slowly dripping hose onto a rough surface, or a poultry waterer with pebbles.

5.8 Honeydew

Honeydew is the sugary excretion of sap-feeding insects — aphids, scales, adelgids — collected by bees and ripened into a honey. Honeydew honey is **darker, higher in mineral content and less digestible** than floral honey.

The classic concern is that it makes a **poor winter store** where confinement is long, because the indigestible residue accumulates in the rectum and produces dysentery before the bees can take a cleansing flight. Central European beekeepers routinely remove honeydew stores before winter for this reason.

The Southeastern qualification is worth knowing: the risk depends on **how long bees are confined**, and mild Southeastern winters allow frequent cleansing flights. Honeydew is therefore much less of a concern in Georgia than in Bavaria. The examination has been known to offer the northern rule without the regional qualification.

Numbers to Memorize

Item	Figure
1:1 syrup	stimulative; spring, packages, comb building
2:1 syrup	storage; autumn winter stores
Temperature below which bees stop taking syrup	roughly mid-50s °F

Item	Figure
Essential amino acids required by bees	10
Crude protein range of pollens	roughly 15–30%+
Honey moisture at capping	about 17–18.6%
Winter store target, SE piedmont	commonly 40–60 lb; less in coastal plain
Trapped pollen: time to spoilage in warm weather	hours

Key Terms

Beebread — pollen stored in cells with honey and glandular secretions, preserved by lactic acid fermentation that **lowers** pH.

Pollen substitute / supplement — protein feed containing no pollen / containing some pollen.

Stimulative feeding — thin (1:1) syrup to encourage brood rearing and comb building.

Emergency feeding — heavy syrup or solid feed to a colony near starvation.

Pollen-bound / honey-bound — brood nest filled with beebread or nectar, restricting the queen's laying.

Isolation starvation — death of a cluster that has consumed the stores around it and cannot cross cold comb to the remainder.

HMF (hydroxymethylfurfural) — a degradation product of sugars formed by heat and storage, toxic to bees and used as a honey quality index.

Honeydew — sugary excretion of sap-feeding insects; darker, mineral-rich, less digestible.

Open feeding — communal feeding away from the hives; discouraged for disease spread, uneven distribution and robbing.

Self-Check

- (MC)** Which statement correctly describes the nutritional roles of nectar and pollen? A) Nectar supplies carbohydrate for flight; pollen is eaten by foragers while brood is reared on gland secretions alone B) Nectar supplies carbohydrate and a little protein; pollen is fed mainly to drone and queen larvae C) Nectar, stored as honey, supplies carbohydrate for energy; pollen, stored as beebread, supplies protein, lipids, vitamins and minerals for brood rearing D) Nectar supplies carbohydrate and vitamins; pollen supplies protein alone
- (TF)** Beebread is preserved by a process that raises the pH of the stored mass well above that of fresh pollen.
- (SA)** Name four methods of feeding sugar syrup and give one advantage or drawback of each.

4. **(MC)** Feeding a pollen substitute patty to a Southeastern colony carries a particular risk northern beekeepers face less acutely: A) Patties draw wax moth larvae into the brood nest B) Patties are prime breeding substrate for small hive beetle larvae, so they should be sized for a few days and given only to colonies able to patrol them C) Patties drive brood rearing that lifts the colony's mite load D) Patties take up moisture and sour, causing dysentery
5. **(SA)** List the signs that a colony is starving and state what to do immediately.
6. **(TF)** Providing water in the apiary is a hot-weather requirement rather than a year-round one.
7. **(SA)** A colony in coastal Georgia has filled its brood nest with nectar during the gallberry flow and the queen has little room to lay. What is happening, and what do you do?

Answers

1. C.

2. **False.** Lactic acid bacteria ferment the packed pollen and **acidify** it; the lowered pH, with added sugar and reduced oxygen, preserves it. Trapped pollen has none of that protection and must be dried or frozen within hours in warm weather.

3. Any four: *Entrance (Boardman)* — simple and the level is visible, but provokes robbing and heats in sun; poorly suited to the Southeast. *Division board / frame feeder* — large volume inside the hive, safe from robbing, but requires opening to refill and drowns bees without a ladder. *Hive-top feeder* — large volume, minimal disturbance, well protected, but adds height and weight. *Inverted pail or jar over the inner cover* — cheap, rate controlled by hole size, but limited capacity and needs an empty box. *Open feeding* — fast for many colonies, but feeds unevenly favoring the strongest, spreads disease and can set off apiary-wide robbing.

4. B.

5. Very light weight on hefting; no capped or uncapped stores in the combs; brood being removed or cannibalized; dead bees head-first in empty cells; lethargic or trembling bees; a small tight cluster with no reserves nearby; in warm weather, sudden aggression or robbing. Feed immediately — syrup if the weather permits processing, fondant, sugar cakes or dry sugar directly above the cluster in cold weather, or a frame of capped honey from a colony of known good health placed next to the cluster. Speed matters more than method.

6. **False.** Water is needed in cold weather too, to dilute granulated stores for brood food. Colonies fly for water on the first mild days of late winter. In the Southeast, where brood rearing often continues through winter, the demand is close to continuous — and the source should be established before the bees find a neighbor's pool, since water foragers are faithful to an established source.

7. The colony is becoming **honey-bound**: incoming nectar is being stored in the brood nest because there is insufficient storage space above, restricting the queen and potentially triggering swarming. Give storage space above the brood nest immediately, using drawn comb if available since foundation is slower to take up; open the brood nest by inserting empty drawn frames within it or by moving nectar-filled frames up into a super; verify that any queen excluder is not impeding movement; and check ventilation. Distinguish this from a pollen-bound nest (combs packed with beebread, same remedy of providing laying space) and from a failing queen.

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Chapter 6: Africanized Bees

Learning Objectives

When you have finished this chapter you should be able to:

- Give an accurate account of how African honey bees came to the Americas and how the Africanized population spread to and through the United States.
 - State when Africanized bees became established in Florida and where they now occur.
 - Explain why Africanized bees cannot be reliably identified by appearance or by a single behavioral observation, and state what confirmation actually requires.
 - Describe the behavioral differences that make African-derived colonies a public safety concern.
 - Explain requeening as the primary management tool, including how long the change takes and why.
 - Describe the regulatory framework, in particular Florida's registration and Best Management Requirements.
 - Handle a swarm call, a structural removal and an unusually defensive colony safely in an area where African genetics may be present.
 - Explain mass envenomation and why it is dangerous irrespective of allergy.
-

6.1 The Origin of the Problem

In 1956, Dr. Warwick Kerr, a Brazilian geneticist, imported queens of *Apis mellifera scutellata* — the East African lowland honey bee — from southern Africa to Brazil. The purpose was straightforward and reasonable: European honey bee stock performed poorly in tropical Brazil, where it had been introduced from temperate Europe and was never well adapted, and *scutellata* was a tropically adapted bee with excellent foraging vigor and rapid build-up. The plan was a breeding program to combine African productivity with European temperament.

In **1957**, twenty-six swarms escaped from the quarantine apiary at Rio Claro when queen excluders were removed from hive entrances. Those escaped colonies, hybridizing with the resident European-derived population, founded what became known as the **Africanized honey bee**.

The resulting population spread through South and Central America at a rate of roughly 200 to 300 miles per year, reaching **southern Texas in 1990**. It subsequently expanded through parts of the Southwest — Arizona, New Mexico, southern California, Nevada — and eastward along the Gulf.

In Florida, Africanized bees were intercepted at ports on several occasions during the 1980s and 1990s, and each interception was dealt with. An **established feral population was in place around Tampa by about 2003, after the first colonies were documented near the Port of Tampa in 2001**. They are now considered established in Florida and present in parts of the Gulf states. The northward and eastward limits of the population are set principally by winter severity, because a colony with African genetics stores less honey, maintains a smaller cluster and rears brood more continuously, which is a poor strategy where winters are long.

6.1.1 Terminology

The terms in use are **Africanized honey bee (AHB)**, **African honey bee (AHB)** and **African-derived**. Florida's extension and regulatory material has moved toward "African honey bee" on the grounds that the Florida population is genetically dominated by African ancestry rather than being an even hybrid. "Killer bee" is a media term with no technical content; avoid it in anything you write or say publicly, because it does real damage to public understanding and to beekeepers' credibility.

The important conceptual point is that this is **not a distinct species and not a sharp category**. It is a continuum of ancestry in a population, and a given colony can carry anything from a trace to a preponderance of African genetics. That is why identification is difficult.

6.2 Identification

Africanized bees cannot be reliably distinguished by appearance or by any single behavioral observation. Confirmation requires morphometric or molecular laboratory analysis.

This is one of the most reliably examined facts in the subject, and it is worth understanding why each of the plausible shortcuts fails.

Color fails. Africanized bees are not darker than all European stock. *A. m. scutellata* is a yellowish bee, and European stocks range from the very dark *A. m. mellifera* to the light *A. m. ligustica*. There is no color that identifies ancestry.

Size fails. Africanized workers are on average slightly smaller than European workers, and their cells are on average slightly smaller. But the ranges overlap so substantially that a side-by-side comparison of individual bees is worthless. Averages of many measurements, taken carefully, can distinguish populations; individual bees cannot.

A single behavioral episode fails. Any colony can be defensive on a given day. Dearth, queenlessness, cool or threatening weather, late-afternoon inspection, rough handling, hot or insufficient smoke, recent robbing, or a skunk visiting nightly will all make a gentle European colony behave badly (Chapter 19). Concluding "Africanized" from one bad inspection is an error, and a costly one if it leads you to destroy a sound colony.

What does work:

- **FABIS** (Fast Africanized Bee Identification System) — a rapid morphometric screen based on forewing length and other measurements, used as a first-pass sorting tool.
- **USDA-ID / standard morphometrics** — a fuller multivariate morphometric analysis of a sample of workers.
- **Molecular methods** — mitochondrial DNA analysis identifies the maternal line, and nuclear markers or whole-genome approaches assess overall ancestry. Mitochondrial analysis alone tells you the queen's maternal lineage, not the colony's total ancestry, which matters because a European queen mated to African drones produces African-influenced workers with European mitochondria.

Samples go to the state agency or an approved laboratory. In Florida that is the Florida Department of Agriculture and Consumer Services, Division of Plant Industry.

6.2.1 What to do without a laboratory

For practical purposes in the field, the working rule is behavioral and precautionary rather than diagnostic: **a colony in an affected region that is persistently and extremely defensive should be requeened with known gentle European stock, irrespective of whether its ancestry is ever confirmed.** Requeening is the right response to dangerous defensiveness whatever its genetic cause. The laboratory identification matters for regulatory reporting and for regional surveillance, not usually for your management decision.

6.3 Behavioral Differences

The differences are quantitative — more, faster, longer — rather than qualitative. African-derived colonies:

Defensive behavior - Respond to **smaller disturbances**, including vibration and movement at greater distances from the hive. - Send **far more bees** to respond — on the order of ten times as many in comparative tests. - **Pursue** intruders much farther, commonly a quarter mile or more, compared with tens of yards for European stock. - Remain **agitated much longer** after a disturbance, for hours rather than minutes.

Reproduction and movement - **Swarm far more frequently**, several times a year in favorable conditions, which is the principal mechanism of geographic spread. - **Abscond readily** in response to disturbance, dearth or pest pressure. - **Build up very rapidly**, exploiting brief resource pulses.

Nesting - Occupy a **wider range of cavities**, including much smaller ones: water meter boxes, irrigation valve boxes, tires, overturned buckets, cavities near or at ground level, and open sites. - Consequently nest in places where people encounter them: utility boxes, playground equipment, sheds, and wall voids in occupied buildings.

Other - Store **less surplus honey**, investing instead in brood and swarming. - Are more susceptible to some management stresses and less amenable to conventional migratory beekeeping.

The **public safety** issue arises from the combination of the nesting behavior and the defensive behavior: a colony in a water meter box near a sidewalk, responding to a lawnmower fifty feet away by launching a large, persistent, pursuing defensive response, is a genuine hazard to people and to tethered or penned animals, who cannot escape.

6.4 Requeening: The Primary Management Tool

The primary management tool available to a beekeeper is requeening with a mated queen of known gentle European stock.

The reasoning is genetic and it is worth being able to state cleanly. The workers currently in the colony carry the genetics of the old queen and of the drones she mated with. **Their behavior cannot be changed.** Introducing a new queen changes the genetics of all *future* workers, so the colony's temperament shifts as the existing population is replaced by her daughters.

How long does it take? Worker lifespan in the active season is roughly four to six weeks, so the change becomes apparent over about **six weeks** and is essentially complete after **two brood cycles**. During that interval the colony must still be handled with full precautions.

Practical points on requeening a dangerously defensive colony:

- Finding and removing the old queen may require assistance, full protective equipment, and cool early-morning timing.
- Moving the colony to a remote location before working it is often the safest course.
- Do not let the colony rear its own replacement: an emergency queen from that colony carries the same maternal genetics and will mate with the same local drones.
- Follow the standard requeening sequence (Chapter 14): remove the old queen, wait a few hours, destroy any started cells, introduce the new queen caged, and **check again for queen cells about a week later**. That follow-up check is the step most often skipped and the most common reason requeening fails.

6.4.1 The broader control

Beyond the individual colony, the control strategy is **maintained, managed, requeened colonies**. A landscape with a healthy population of managed European colonies contributing drones, and with beekeepers promptly requeening anything that turns defensive, is a landscape in which European genetics are continually reinforced. Unmanaged equipment, abandoned hives, unqueened captured swarms and feral colonies in structures all work the other way. This is the logic behind Florida's regulatory approach.

6.5 Regulation

Apiary regulation in the United States is a **state** function (Chapter 9), and Africanized bee policy varies accordingly.

Florida is the state a Southeastern candidate must know. Florida:

- **Requires registration** of all honey bee colonies with the Florida Department of Agriculture and Consumer Services, Division of Plant Industry.
- Requires beekeepers to comply with the state's **Best Management Requirements for Maintaining European Honey Bee Colonies**, which include maintaining colonies with European stock, requeening colonies showing excessive defensiveness, keeping colonies in managed apiaries, and not allowing unmanaged equipment to become feral nest sites.
- Provides identification and response services through DPI, and public guidance through UF/IFAS.

Other Southeastern states differ, and requirements change. Georgia, South Carolina, North Carolina, Alabama, Mississippi and Tennessee each have their own apiary law. **Check your own state's current requirements**, and if you move colonies, check the destination state's entry requirements — some include African honey bee provisions.

One further point: **Africanized bees do not respect state lines, and neither does the regulatory obligation to behave responsibly**. A beekeeper in south Georgia who captures

swarms of unknown origin and leaves them unrequened in a residential area is creating a problem regardless of what the statute says.

6.6 Practical Safety in an Affected Region

Apiary siting. Away from the public, from roads and footpaths, and from tethered or penned animals, which cannot flee. Use fencing and flyway barriers. Post the apiary if appropriate. Do not keep colonies where a defensive episode would put a neighbor, a child or a livestock animal at risk.

Protective equipment. Full protection — suit, veil, gloves, ankles and wrists sealed — is appropriate when working colonies of unknown temperament in an affected region. Chapter 19 makes the case that more equipment is not always better; that argument does not apply here.

Working practice. Have an escape route. Do not work alone. Carry a phone with signal. Know where the nearest emergency services are. Have a plan for what to do if a colony proves unmanageable: leave, close up, come back with help.

Swarm calls. A clustered swarm is usually docile, having engorged before departure and having no nest or brood to defend, and this is true of African-derived swarms as well — but they are considerably less tolerant than European swarms, and a swarm that has been clustered for several days and has begun drawing comb is more defensive in any case. Hive a captured swarm **apart from your apiary**, observe its temperament and health, monitor for *Varroa*, and **requeen it with known stock** before integrating it. In an affected region, temperament observation is a public safety matter, not merely a preference.

Structural removals. These require an assessment of temperament before you open anything, a plan for occupant and neighbor safety during the work, and a written agreement covering scope, repair responsibility, liability and insurance (Chapter 9). A beekeeper without insurance and without construction competence should refer the job rather than accept it.

Never leave unmanaged equipment — stacked boxes with comb, abandoned hives, unbaited swarm traps left unchecked — in populated areas. It is a nest site invitation.

6.7 Mass Envenomation

The public safety hazard from African-derived bees is not principally allergic; it is **toxic**.

Bee venom in large quantity is dangerous to anyone, regardless of allergy status. Massive envenomation — hundreds of stings — can produce **rhabdomyolysis** (muscle breakdown), **hemolysis** (red cell breakdown), consequent **kidney injury**, liver injury and cardiovascular strain. The clinical course can develop over hours to days, so a person who feels well immediately afterward is not necessarily out of danger.

A beekeeper who has become tolerant of ordinary stings has no protection against this. Tolerance is an immunological phenomenon; toxicity is a dose phenomenon.

Anyone who receives a large number of stings should be taken to hospital for evaluation and observation, even if they feel well. The risk is greatest with highly defensive colonies, in confined spaces where escape is difficult, and for people or animals who cannot get away.

This is distinct from **anaphylaxis**, which is an allergic reaction to a small dose in a sensitized individual and which is managed with immediate intramuscular epinephrine (Chapter 19). Both can occur; they are different problems.

6.7.1 If you are being attacked

The guidance given by public agencies in affected regions:

- **Run.** Get away in a straight line, as fast as you can, and keep going — African-derived bees pursue a quarter mile or more.
- **Cover your face and head** with your shirt or whatever is available; protect eyes, nose and mouth.
- **Get indoors or into a vehicle.** A few bees will follow you in; that is far better than the alternative.
- **Do not swat**, and do not stand still.
- **Do not jump into water.** The colony will wait above the surface.
- Call 911 and tell the dispatcher it is a bee attack.

6.8 Talking About It

You will be asked about Africanized bees by neighbors, by reporters, by school groups and by new beekeepers. Three things are worth saying, and one is worth not saying.

Say that they are honey bees, not a different species, and that the difference is in degree of defensiveness, swarming and nesting behavior, not in venom potency — a single sting from an African-derived bee is the same as any other sting.

Say that the danger is real and specific: the response is large, fast and persistent, and the nesting behavior puts colonies where people meet them.

Say that managed, requeened colonies are part of the solution rather than part of the problem, and that beekeepers are the people most likely to find and address a problem colony.

Do not say “killer bees,” and do not repeat exaggerated claims. The subject is alarming enough accurately described, and accuracy is what makes you worth listening to.

Numbers to Memorize

Item	Figure
<i>A. m. scutellata</i> imported to Brazil	1956
Swarms escaped at Rio Claro	1957 (26 swarms)
Rate of spread through the Americas	about 200–300 miles/year
Reached southern Texas	1990
Established feral population confirmed in Florida	2001–2003
Time for requeening to change colony temperament	about 6 weeks (two brood cycles)

Item	Figure
Pursuit distance, African-derived	quarter mile or more
Defensive response magnitude	roughly 10× more bees than European stock

Key Terms

Africanized / African honey bee (AHB) — honey bees descended from the *A. m. scutellata* stock accidentally released in Brazil in 1957, hybridized with European-derived populations.

FABIS — Fast Africanized Bee Identification System, a rapid morphometric screen.

Morphometrics — multivariate measurement of body structures used to assign population ancestry.

Best Management Requirements — Florida’s mandatory practices for maintaining European honey bee colonies.

Abandoning — abandonment of the nest by the whole colony; markedly more frequent in African-derived stock.

Mass envenomation — toxic effects of a very large number of stings, independent of allergy.

Rhabdomyolysis — breakdown of skeletal muscle, releasing myoglobin and threatening the kidneys; a feature of massive envenomation.

Self-Check

- (SA)** Summarize how Africanized honey bees came to be in the United States and state approximately when they became established in Florida.
- (MC)** Which statement about identifying Africanized honey bees is correct? A) They can be reliably identified by color, being darker than any European stock B) They are noticeably larger, so side-by-side comparison suffices C) They can be identified by consistently smaller comb cell diameter D) They cannot be reliably distinguished by appearance or by a single behavioral observation; confirmation requires morphometric or molecular laboratory analysis
- (SA)** Describe the behavioral differences that make African-derived colonies a public safety concern, and state the primary management tool available to a beekeeper.
- (TF)** Florida requires beekeepers to register their colonies with the state and to follow the state’s Best Management Requirements for maintaining European honey bee colonies, which include requeening colonies that show excessive defensiveness.
- (SA)** Explain why requeening is the recommended response to a dangerously defensive colony, and how long the change takes to become apparent.
- (MC)** Mass stinging incidents involving hundreds of stings are dangerous even to people with no bee allergy because: A) The venom is toxic in quantity, and massive envenomation can produce muscle and red cell breakdown, kidney injury and cardiovascular strain B) The venom

load overwhelms the liver's clearance of histamine C) The stings carry hive bacteria deep into tissue, causing widespread infection D) The number of stings sensitizes the victim during the attack itself

7. (SA) You capture a swarm of unknown origin in April in south Georgia. What is the prudent practice?

Answers

1. *Apis mellifera scutellata* was imported to Brazil in 1956 for a breeding program aimed at improving tropical performance, and 26 swarms escaped in 1957. The resulting population, hybridized with resident European stock, spread through South and Central America at roughly 200–300 miles per year and reached southern Texas in 1990, subsequently expanding through parts of the Southwest and Gulf states. Africanized bees were intercepted at Florida ports several times in the 1980s and 1990s, and an established feral population was in place around Tampa by about 2003, after the first colonies were documented near the Port of Tampa in 2001.

2. D. Africanized bees are slightly smaller on average and their cells slightly smaller, but the ranges overlap so far that individual comparison is worthless; behavior varies with weather, colony state and disturbance, so a single defensive episode proves nothing. Samples go to the state agency or an approved laboratory.

3. They respond defensively to smaller disturbances, send far more bees to respond, pursue intruders much farther — a quarter mile or more — and remain agitated for hours rather than minutes. They also swarm and abscond far more readily, nest in a much wider range of cavities including small ones at or near ground level where people encounter them, and build up quickly. The primary management tool is **requeening with mated queens of known gentle European stock**; the broader control is maintaining and requeening managed colonies rather than allowing feral and unmanaged colonies to persist. Practical precautions: site apiaries away from the public and from tethered animals, use flyway barriers and fencing, work colonies in full protective equipment, and never leave unmanaged equipment or unrequened captured swarms in populated areas.

4. True.

5. The workers present in the colony carry the genetics of the old queen and of the drones she mated with, and their behavior cannot be changed. Introducing a queen of known gentle stock changes the genetics of all future workers, so temperament shifts as the existing population is replaced by her daughters. Because worker lifespan in the active season is roughly four to six weeks, the change becomes apparent over about six weeks and is essentially complete after two brood cycles. The colony must be handled with full precautions in the interim, and finding and removing the old queen may require assistance, full protective equipment, cool early-morning timing, or moving the colony to a remote location first.

6. A. It is a toxic rather than an allergic phenomenon; a beekeeper tolerant of ordinary stings has no protection. Anyone receiving a large number of stings should be evaluated in hospital even if they feel well, because the course can develop over hours to days.

7. Hive it on foundation or clean comb rather than on comb of unknown history, keep it **apart from your apiary** while you observe it for disease, temperament and queen performance, monitor for *Varroa*, and then integrate it. In an area where African-derived genetics may be

present, temperament observation is a public safety matter, and requeening a captured swarm with known gentle stock is common and prudent practice.

References for Further Study

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Chapter 7: Equipment and Apiary Siting

Learning Objectives

When you have finished this chapter you should be able to:

- State the dimension of bee space and diagnose equipment problems from what the bees build.
 - Describe the components of a standard Langstroth hive and the function of each.
 - State the approximate full weights of deep and medium boxes and explain the case for standardizing on mediums or eight-frame equipment in the Southeast.
 - Compare wax and plastic foundation and state when comb will and will not be drawn.
 - Explain the nine-frame spacing practice and its one important limitation.
 - Select an apiary site for the humid Southeast, accounting for sun, drainage, access, water, wind, beetle pressure and neighbors.
 - Protect hives from imported fire ants and explain why hive stands matter.
 - Explain what a screened bottom board does and, more importantly, what it does not do.
 - Use entrance reducers and robbing screens correctly through the season.
 - Store drawn comb safely through a Southeastern winter.
 - Prepare an apiary for a hurricane.
 - Describe the beekeeper's essential kit for an apiary visit, and keep useful records.
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7.1 Bee Space

Bee space is approximately 1/4 to 3/8 inch. Bees leave a gap of that dimension open as a passageway. A **smaller** gap they fill with **propolis**. A **larger** gap they fill with **burr or brace comb**.

Langstroth's recognition of this narrow tolerance in 1851 is what makes a frame removable, and every dimension in standard equipment derives from it. The practical diagnostics follow directly and you use them constantly:

What you find	What it means
Burr comb between boxes, or bridging frames to the box below	The gap is too large
Heavy propolizing at a junction, frames glued hard	The gap is too small
Both problems in the same stack	You have mixed top-bee-space and bottom-bee-space equipment
Comb built in the space under the inner cover	Too much space above the top bars

Top versus bottom bee space. In a top-bee-space hive the gap sits above the top bars and the frames hang flush with the bottom of the box; in a bottom-bee-space hive the gap is below the frames and the top bars sit flush with the box rim. Both work. Mixing them in one stack produces a double gap at one junction and none at the next, and therefore both problems at

once. Most American equipment is bottom-bee-space; orientation varies with the hive type and the manufacturer, so check which yours is. Know which yours is and buy consistently.

Warped, swollen, home-made or badly weathered equipment is a persistent source of the same trouble, which is one of several arguments for keeping woodenware painted and in good order.

7.2 The Standard Hive

From the ground up:

Hive stand. Raises the hive off the ground. In the Southeast this is not optional; see §7.7.

Bottom board. Solid or screened. The solid board is the traditional item; the screened bottom board is discussed in §7.8.

Entrance reducer. A wooden or metal cleat narrowing the entrance. See §7.9.

Brood boxes (hive bodies). Where the queen lays and brood is reared. Commonly one or two deeps, or two to three mediums.

Queen excluder. Optional; see §7.4.

Honey supers. Boxes for surplus storage, usually mediums or shallows.

Inner cover. Provides bee space beneath the outer cover, a handhold for prying, and a ventilation and feeding port. Removing it in winter costs the colony an air gap; leaving it means condensation forms on it, which is why an absorbent or insulated inner cover, or a small upper vent, is worthwhile even in a mild Southeastern winter.

Outer cover. Telescoping (overlapping the box sides, usually metal-clad) or migratory (flush, easier to stack and transport).

Frames and foundation. Wooden or plastic frames carrying wax or plastic foundation, or foundationless with a comb guide.

Optional components worth knowing:

Slatted rack. A frame of wooden slats placed between the bottom board and the lowest brood box, providing extra space beneath the brood nest. It gives bees a place to cluster off the brood combs in hot weather, which reduces bearding; it buffers the brood nest from drafts and from cold air entering at the entrance, which allows the queen to use the lower portion of the bottom frames; and it relieves congestion below the brood nest. The thermal and space benefits are well established in practical experience. A frequently repeated claim that it reduces swarming is more anecdotal, and you should present it as such. In the hot Southeast the ventilation and clustering benefits are the main reason for use.

Follower board. A solid board replacing one or two frames, used to reduce the effective volume of a box so a small colony covers all its comb — genuinely valuable in the Southeast for nucs and splits, because undefended comb is what small hive beetle exploits.

Robbing screen. A screen fitted over the entrance that displaces the actual opening, so that resident bees learn the route while robbers, which orient to the scent at the face of the screen, do not find it.

7.3 Box Sizes and Weight

Box	Depth	Full weight of capped honey, 10-frame
Deep	9 5/8 in	roughly 80–90 lb
Medium (“Illinois”)	6 5/8 in	roughly 50–60 lb
Shallow	5 11/16 in	roughly 35–40 lb

Eight-frame equipment runs roughly 20 percent lighter than the equivalent ten-frame box.

Many Southeastern beekeepers standardize on **all-medium** equipment, or on **eight-frame** equipment, and you should be able to give the reasons:

- A medium is manageable by one person; a full deep is not, for many people.
- **Interchangeability** simplifies everything. Any frame fits any box. You can move a frame of brood into a super, make up a nuc from any box on the place, and keep one size of spare frame.
- Repeated lifting of deeps is the leading cause of **back injury** in beekeeping.
- In the Southeast this is compounded by **heat**: lifting 90-pound boxes in a full suit in July is genuinely hazardous, and heat illness is a real occupational risk (Chapter 19).

The trade-offs: more boxes to handle for the same volume; slightly more brood-nest interruption at box junctions; and more woodenware to buy, paint and store.

7.4 Queen Excluders

A queen excluder placed between the brood chamber and the honey supers **prevents the queen and most drones from passing**, keeping brood out of the supers. It is a tool with a trade-off, not a requirement.

Against: it can reduce worker traffic into the supers, particularly a damaged or dirty excluder, and particularly when the super above contains only foundation. Drones that get above it die at it. Some beekeepers call it a “honey excluder” for this reason.

Mitigations: bees pass more readily through a clean, undamaged excluder, and much more readily when the super above already contains drawn comb or some stored honey. Adding an **upper entrance** during the flow both relieves the traffic problem and lets trapped drones out.

Note also: an excluder is **not** a small hive beetle barrier — beetles pass it freely — and no state requires its use. Remove it before winter so the cluster can move upward freely.

7.5 Foundation and Comb

Wax foundation is drawn more readily by the bees and is required for comb honey production. It is fragile, needs wiring or support pins in deep frames, and sags in heat. Commercial wax foundation is made from recycled wax and can carry miticide residues (Chapter 11), which matters for comb honey and for anyone selling wax products.

Plastic foundation (and one-piece plastic frames) is durable, holds up to extraction, and does not sag. It is drawn best by a strong colony in a flow, and an additional coat of beeswax markedly

improves acceptance. Given to a weak colony or offered during a dearth, it is frequently ignored, chewed, or built past with cross comb.

Foundationless frames with a comb guide work, and produce natural cell size and a higher proportion of drone comb. They require level hives, careful handling and patience.

The most common beginner problem, and a recurring examination theme, is **giving foundation to a colony that lacks the population or the flow to draw it**. The result is partly drawn, cross-built or chewed comb. In the Southeast the reliable comb-drawing window is the spring flow from about late March through May; outside it, drawing comb generally requires feeding.

7.5.1 Nine frames in a ten-frame super

Spacing nine frames evenly in a ten-frame honey super produces **thicker combs that are easier to uncap** and that yield slightly more honey per frame. It is standard practice and it works.

The important limitation: **do this only with drawn comb**. Bees build deeper cells at wider spacing, but they need an accurate reference surface to build **straight**, and drawn comb provides that while foundation does not. Foundation spaced wide produces wavy, cross-built comb that is difficult to extract and awkward to handle.

The rule: **draw comb at the full frame complement, then reduce the spacing afterward**, keeping the frames evenly positioned with spacers or a follower board.

7.6 Siting an Apiary in the Humid Southeast

The considerations, roughly in order of importance:

Morning sun with afternoon shade. Morning sun gets bees flying early. Afternoon shade in a Southeastern summer reduces heat stress and bearding. Deep full-day shade is a mistake: it favors small hive beetle and keeps the site damp.

Well-drained ground above flood level. Matters for colony health, for your access after heavy rain, and critically in the coastal plain, where low ground floods. Colonies that survive a hurricane's wind are frequently lost afterward to standing water.

Air drainage. Avoid frost pockets and stagnant hollows; a site with some air movement dries faster and is healthier.

Vehicle access. You will carry 60-pound boxes. You will want to bring a truck to the hives in October. A site you cannot drive to in wet weather is a site you will not visit when you should.

Water. A reliable source close by, established before the bees find your neighbor's pool (Chapter 5).

Wind protection. A windbreak on the prevailing winter wind side; do not place hives where winter wind blows straight into the entrances.

Separation from neighbors, roads and animals. Distance, screening, and flyway barriers (Chapter 9).

Forage. Evaluate the surrounding landscape across a two-mile radius, not the fence line. In a pine-dominated Southeastern landscape, look at the **understory**, not the canopy: the pines themselves yield no nectar and only low-value pollen, while managed, burned, open pine flatwoods with a gallberry understory can be excellent.

Beetle pressure. Heavily shaded, damp sites carry greater small hive beetle pressure; sites with morning sun and well-drained soil carry less. This must be balanced against summer heat, and the usual compromise is morning sun with dappled or afternoon shade on well-drained ground.

Predators. Bears in the mountains, skunks anywhere, fire ants everywhere in the lower Southeast.

Hive orientation. Entrances facing east or southeast get early sun. Varying orientation across the yard reduces drifting.

Spacing and layout. Which brings us to the most underrated item on the list.

7.6.1 Apiary layout and drifting

Drifting — bees returning to the wrong hive — is increased by placing hives in **long straight rows of identical appearance facing the same direction**. It is not merely a bookkeeping problem. Drifting:

- moves **mites and pathogens** between colonies,
- makes end-of-row hives artificially strong while others dwindle,
- confounds your assessment of which colonies are actually performing.

Mitigation is cheap: vary hive colors or add distinctive markings; orient entrances in different directions; use irregular spacing or cluster hives in groups of two to four; and use landmarks such as trees and posts.

This is genuinely part of modern mite management, and it is examined as such (Chapter 16). Reducing hive density, spacing apiaries, addressing collapsing colonies promptly and coordinating with neighboring beekeepers all reduce the reinvasion pressure that undermines individual colony treatments.

7.7 Hive Stands and Fire Ants

Imported fire ants (*Solenopsis invicta*) are a serious problem in Southeastern apiaries. They overwhelm weak colonies, nucs and newly hived swarms, taking brood and stores; they harass colonies continuously; and they make the apiary **hazardous for the beekeeper**. A beekeeper standing in a mound while lifting a heavy super in a full suit is a genuine risk, and this occupational aspect is worth stating.

Protection:

- **Keep hives on stands** rather than on the ground, so the ants must climb a defined path.
- **Treat that path:** legs set in cans or cups of oil, or coated with a grease or sticky barrier. Refresh them; they fill with debris and rain.

- **Clear vegetation** from around and under the stand so ants cannot bridge to the hive.
- **Maintain strong colonies.** Ants principally exploit weak or failing colonies and small nucs.
- Where baiting is used, apply an **approved fire ant bait to mounds at a distance from the hives**, per label, rather than beneath them, so hive products are not contaminated.

Hive stands serve several other purposes in the Southeast and the examination asks for them: they raise equipment above damp ground and flooding; they reduce back strain; they improve air circulation beneath the hive; and they make hives less accessible to skunks, which must then expose their underside to reach the entrance.

7.8 Screened Bottom Boards — What They Do and Don't Do

A screened bottom board is **a monitoring device**. Natural mite fall passes through the mesh onto a removable board or tray below, where it can be counted, and the screen provides some ventilation benefit — real value in a Southeastern summer. Some beetle trap designs use the space beneath.

It is not a *Varroa* control. Controlled trials have found modest reductions in mite population attributable to screened bottoms, far short of control (Ellis, Delaplane & Hood, 2001). No state requires them.

This matters because it belongs to a family of measures that have been evaluated and found to produce **at most modest reductions**, and that must not be relied on as stand-alone controls:

- **Screened bottom boards** — small reduction; useful for monitoring and ventilation.
- **Small cell foundation** — controlled trials have not found a significant reduction in mite population growth (Berry, Owens & Delaplane, 2010).
- **Powdered sugar dusting** — knocks down some phoretic mites, does not reach mites in sealed brood, and has not been shown to control populations.

Presenting any of these as a control is one of the more consequential errors in circulating beekeeping advice, and beekeepers who believe their screened bottom is treating their mites are the ones who lose colonies in autumn.

7.9 Entrance Management

An entrance reducer should be used on newly installed packages, small nucleus colonies and weak colonies, and during nectar dearth, because a smaller entrance is easier for the colony to defend against robbing and against small hive beetles.

The rule is to **match the entrance to the colony's ability to defend it**: open it as the colony grows and during a heavy flow when traffic and ventilation demand it, and reduce it again when the flow ends. In the Southeast the July and August dearth is the critical period.

Entrance management is one of the cheapest and most effective tools available, and it is the first action in a robbing emergency (Chapter 20).

Mouse guards. Fit an entrance reducer or hardware cloth with openings of roughly 3/8 inch in autumn, **before** the weather turns cold enough that mice begin seeking shelter and while the

colony is still actively defending its entrance. Timing matters: a mouse already nesting inside will not be excluded by a guard fitted later — the guard will simply enclose it — and once the colony is clustered it can no longer defend the entrance. Mice destroy comb, chew frames, contaminate with urine and disturb the cluster; the nesting material and odor render comb unusable. Mice are a lesser problem in much of the Southeast than farther north, but are still worth excluding.

7.10 Painting and Finishing

The purpose of finishing the exterior is to **protect the wood from weather and extend equipment life**. It is not to stop bees chewing the wood, and no federal registration marking requirement exists.

- **Exterior only.** Interiors and frames are not painted. Bees coat interior surfaces with propolis, and paint is unnecessary where weather does not reach — as well as undesirable in contact with comb.
- **Light colors are preferred in hot climates.** White or light equipment runs measurably cooler in Southeastern summer sun.
- **Distinctive markings or varied colors reduce drifting** (§7.6.1), so there is a reason beyond decoration to paint your boxes differently.
- Exterior latex over a primer is standard. Some beekeepers use paraffin or wax dipping, which also has a disease-control application (Chapter 15).

7.11 Storing Drawn Comb

Drawn comb is your most valuable equipment, and in the Southeast it is under threat for far more of the year than in the North, because **wax moth remains active through a mild winter**. Stacking comb in an unheated shed over winter works in Minnesota; it does not work in Georgia.

Two pests threaten stored comb:

- **Wax moth** — greater (*Galleria mellonella*) and lesser (*Achroia grisella*). Larvae tunnel through comb for pollen, cocoon residue and debris, leaving silk galleries and frass. They depend on the **protein** in pollen and cocoon residue rather than on pure wax, which is why old dark brood comb is destroyed rapidly while clean new comb is comparatively resistant.
- **Small hive beetle** — larvae will destroy stored comb containing pollen or residual honey.

Acceptable control measures:

1. **Freeze at about 0 °F for 24 to 48 hours**, which kills all life stages of both pests, then store moth-tight. Freezing leaves no residue and is the most reliable non-chemical treatment available to a small beekeeper. Note that it does **not** affect *Paenibacillus larvae* spores and is therefore not a foulbrood control.
2. **Store in light and moving air.** Wax moth strongly avoids light and airflow. Stacks with spacers (a lath between boxes, or boxes cross-stacked) under a roof, open to the light, work well and cost nothing.

3. **Treat with a *Bacillus thuringiensis* subsp. *aizawai* product registered and labeled for stored comb**, which is specific to lepidopteran larvae. (EPA opened the first beehive use of strain ABTS 1857 in 2020; confirm that the product you buy is currently registered for this use in your state and follow its label.) Be aware of temperature limitations for this biological to remain effective.
4. **Cold storage** where freezer or cold-room capacity allows.

Chemical fumigants — know the legal line.

- **Naphthalene mothballs are not acceptable.** Naphthalene is not registered for use on bee comb, and using it there is illegal as well as a residue problem.
- **Paradichlorobenzene (PDB; sold as Para-Moth) is registered by EPA** for protecting **empty stored comb** from wax moth, and EPA's 2020 review described it as the only registered chemical fumigant available for that purpose; a *Bacillus thuringiensis* product (above) is also registered for stored comb. It is lawful **only as the label directs**: on stored supers of empty comb, never on comb containing honey and **never on comb honey**, and the combs must be aired out before they go back on a colony. PDB residues persist in wax and can taint honey, so many extension services and most beekeepers prefer the non-chemical methods above, and it cannot be used in organic production.

Older examination keys sometimes lump PDB with naphthalene as “not acceptable.” The defensible answer is: naphthalene never; PDB only per its label, on empty stored comb, and non-chemical methods preferred.

Preparation matters as much as treatment. Comb should be extracted, returned to bees to be cleaned where possible, and **stored dry**. Residual honey and pollen are what attract beetles. Cull heavily damaged or very old dark comb rather than storing it, and render it promptly — culled dark comb sitting in a shed is prime wax moth and beetle substrate.

7.12 Hurricane and Storm Preparation

Coastal Southeastern apiaries face three hazards: **wind, falling limbs and flooding**. Preparation:

- **Strap each hive** to its stand and the stand to the ground with ratchet straps and earth anchors. Straps prevent boxes separating and combs being lost.
- **Reduce stack height.** A tall stack has a long lever arm; consolidate before the storm.
- **Move colonies off flood-prone ground.** Colonies that survive the wind are frequently lost to standing water afterward.
- **Clear overhanging limbs** well in advance.
- **Plan post-storm access.** Roads will be blocked; know how you will reach the yard.
- **Expect to feed afterward.** Forage is stripped by a major storm and colonies that survive may starve in the weeks following.

Do **not** open hives to reduce wind resistance, remove covers, or rely on the weight of the boxes to hold them down. These appear as distractors on examinations and all three are wrong.

7.13 The Beekeeper's Kit and Records

Essentials for a routine apiary visit:

- A **lit smoker** with adequate fuel and a means of relighting it, plus extra fuel.
- A **hive tool**, and preferably a spare — you will drop one.
- **Protective equipment** appropriate to the colony and the setting, including at minimum a veil.
- A means of **recording observations**: notebook, index cards, or an app.
- **Spare equipment** appropriate to the visit: frames, a box, entrance reducers, a queen cage.
- **Drinking water** for yourself.

Southeastern-specific additions: small hive beetle traps and replacement oil; extra water because of the heat; sun protection; and a plan for what to do if a colony proves unusually defensive.

7.13.1 Records

Recording observations is the item most often omitted and the one that most improves a beekeeper's judgment over a season.

What to record:

- Date, hive identification.
- **Queen status:** eggs seen, queen seen, marking color, laying pattern.
- **Brood:** pattern quality, quantity, stages present.
- **Population and temperament.**
- **Stores:** honey and **beebread** — both.
- **Queen cells:** present, number, position, type.
- **Disease and pests:** any signs, mite counts, beetle numbers.
- **Space and equipment** added or removed.
- **Feeding and treatments:** product, lot, dose, dates on and off, ambient temperature.
- **Action needed next visit.**

How records are used across a season:

- To identify which colonies are worth **breeding from**. Selecting from a single snapshot rewards luck rather than genetics, since performance in a given week depends heavily on position, forage, disturbance history and queen age. Records over a full season turn opinion into selection.
- To detect **declining performance early**.
- To **schedule follow-ups**: checking for queen cells a week after requeening, confirming a mated queen three weeks after a split.
- To document **treatment history** for resistance management and residue traceability, and to distinguish treatment failure from wrong timing or reinvasion when colonies fail.
- To build a **local bloom and management calendar** (Chapter 20).

Records are also the only reliable way to distinguish a genuine stock difference from an accident of position, forage or timing, and they are frequently required or expected for certification programs and for regulatory compliance.

Numbers to Memorize

Item	Figure
Bee space	1/4 – 3/8 in
10-frame deep, full of honey	about 80–90 lb
10-frame medium, full of honey	about 50–60 lb
Deep / medium / shallow depth	9 5/8 / 6 5/8 / 5 11/16 in
Mouse guard opening	about 3/8 in
Freezing comb to kill pests	0 °F for 24–48 hours
Bait hive volume	about 40 liters (one deep box)
Nine-frame spacing	drawn comb only

Key Terms

Bee space — 1/4 to 3/8 inch; smaller gaps propolized, larger filled with comb.

Top- / bottom-bee-space — whether the gap sits above or below the frames; do not mix them.

Burr comb / brace comb — comb built in excess space; between boxes / bridging frames.

Slatted rack — slatted frame beneath the brood nest giving clustering space and buffering drafts.

Follower board — solid board replacing frames to reduce the effective volume a small colony must patrol.

Robbing screen — entrance device displacing the opening so residents learn it and robbers do not.

Screened bottom board — mite-fall monitoring device with some ventilation benefit; **not** a control.

Drifting — bees returning to the wrong hive; increased by uniform rows and one orientation.

Slumgum — the residue left after rendering wax.

Self-Check

1. (MC) Bee space refers to a gap of approximately: A) 1/4 to 3/8 inch, left open as a passageway; smaller gaps propolized, larger filled with burr comb B) 2 inches, matching comb thickness C) 1 inch, used as a corridor between boxes D) 1/16 inch, sealed with propolis

2. **(SA)** State the approximate full weight of a ten-frame deep and a ten-frame medium of capped honey, and explain why many Southeastern beekeepers use all-medium equipment.
3. **(MC)** A screened bottom board is best described as: A) A requirement under most state apiary regulations B) A device preventing small hive beetles from entering C) A monitoring device allowing natural mite fall to be counted, with some ventilation benefit, producing only a small reduction and not a control measure D) An effective stand-alone *Varroa* control
4. **(TF)** Nine frames evenly spaced in a ten-frame honey super produce thicker combs that are easier to uncap, and applying the same spacing to a super of foundation produces comb of equal regularity.
5. **(SA)** Explain how drawn comb should be stored over the winter in the Southeast, naming the two pests that threaten it and the appropriate controls — including one method that is not acceptable.
6. **(MC)** Preparing an apiary for a hurricane should include: A) Opening the hives fully to reduce wind resistance B) Relying on the combined weight of boxes and stores C) Strapping each hive to its stand and the stand to the ground, reducing stack height, moving colonies off flood-prone ground, and planning post-storm access D) Removing all hive covers so wind passes through
7. **(SA)** Describe how you would protect hives in a Georgia or Florida apiary from imported fire ants, and explain why hive stands matter.

Answers

1. A.

2. A full ten-frame deep of capped honey weighs roughly 80–90 pounds; a ten-frame medium roughly 50–60. Many beekeepers standardize on mediums, or on eight-frame equipment, because the boxes are manageable by one person; because interchangeable boxes and frames simplify management and inventory; and because repeated lifting of deeps is the leading cause of back injury in beekeeping. In the Southeast this is compounded by heat — lifting heavy boxes in a full suit in July is genuinely hazardous. The trade-off is more boxes to handle and slightly more brood-nest interruption at box junctions.

3. C.

4. **False** in the second half. Bees build deeper cells at wider spacing, but they need an accurate reference surface to build straight, which drawn comb supplies and foundation does not. Foundation spaced wide produces wavy, cross-built comb. Draw comb at the full frame complement and reduce the spacing only afterward.

5. The threats are **wax moth** (*Galleria mellonella* and *Achroia grisella*) and **small hive beetle**. Because Southeastern winters are mild, wax moth remains active far longer than in the North, so simply stacking comb in an unheated shed is inadequate. Acceptable: freeze at about 0 °F for 24–48 hours to kill all life stages, then store moth-tight or in sealed containers; store comb in light and moving air, which strongly deters wax moth; treat with a *Bacillus thuringiensis* subsp. *aizawai* product registered and labeled for stored comb; or use cold storage. **Naphthalene is never acceptable** (not registered for comb). **Paradichlorobenzene** is registered for empty stored comb only and may be used only as its

label directs — never on comb containing honey or on comb honey, with the combs aired out before reuse — and because it leaves residues in wax, non-chemical methods are preferred. Comb should be extracted, returned to the bees to be cleaned where possible, and stored dry, since residual honey and pollen attract beetles.

6. C.

7. Keep hives on stands so ants must climb a defined path, and treat that path — legs set in cans or cups of oil, or coated with grease or a sticky barrier — refreshing it as it fills with debris. Clear vegetation from around and under the stand so ants cannot bridge to the hive. Maintain strong colonies, since ants principally exploit weak colonies and small nucs. Where baiting is used, apply an approved fire ant bait to mounds at a distance from the hives, per label, so hive products are not contaminated. Stands also raise equipment above damp ground and flooding, reduce back strain, improve air circulation, and make hives less accessible to skunks.

References for Further Study

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Chapter 8: Honey Production and Extraction

Learning Objectives

When you have finished this chapter you should be able to:

- Decide when a frame of honey is ready to harvest and verify the decision.
 - State the moisture limits that matter — the US grade limits, the Codex limit and the fermentation threshold — and explain the differences among them.
 - Compare the methods of clearing bees from supers and choose appropriately for scale, weather and crop.
 - Explain why supers must be extracted promptly in the Southeast and what happens if they are not.
 - Describe the extraction process, compare radial and tangential extractors, and strain and settle honey correctly.
 - Explain what overheating does to honey and state a safe warming temperature.
 - Explain granulation to a customer and make creamed honey by the Dyce process.
 - Produce a varietal honey such as sourwood or tupelo, and state the single most important step.
 - Produce comb honey and state how it differs from extracted honey production.
 - Handle a batch that tests too wet.
 - Operate a honey house so that the relevant hazards are controlled.
 - Explain what makes honey resistant to microbial spoilage and why it is nonetheless not sterile.
-

8.1 Deciding When to Harvest

The field rule: a frame should be largely capped, commonly 80 percent or more.

Capping is the bees' own signal that ripening is complete — that the moisture has typically fallen to about 17–18.6 percent. That is ripe, but it is not a guarantee against fermentation, which also depends on the yeast load. It is a better indicator than any judgment you can make by eye, and it costs nothing to read.

Two supplements to the rule:

The shake test. Hold the frame horizontally over the open hive and shake it sharply, once, downward. If nectar flies out of the uncapped cells, the honey in them is not ripe. If nothing comes out, the uncapped cells are probably dry enough. This is a quick check for a frame with scattered uncapped cells.

The refractometer. For frames with wide uncapped areas, or when you want a number rather than an impression, use a honey refractometer. In the humid Southeast, where honey ripens more slowly and unripe honey is a recurring cause of fermented product, a refractometer is a worthwhile investment even for a small producer. Test **individual supers** rather than only the finished tank: one wet super can raise an entire tank above specification.

Common wrong answers worth recognizing: a frame need not be capped from bar to bar (a single uncapped cell tells you nothing about the whole frame); heaviness in the hand is not a reliable proxy for moisture; and uncapped honey does **not** reliably finish drying in a warm honey house once the supers are stacked — stacked supers have very little air movement between the combs.

8.2 Moisture

Three numbers, and you need all three:

Number	Meaning
18.6%	Maximum moisture for US Grade A and Grade B extracted honey — the grade standard’s requirement of at least 81.4 percent soluble solids . It is also the cutoff most honey shows use, above which an entry is disqualified.
20%	Maximum moisture for US Grade C and the general limit in the Codex standard (Codex allows up to 23 percent for heather, <i>Calluna</i> , honey). Many buyers require lower.
about 17–17.5%	The level below which fermentation is generally prevented .

Under the US grade standards, soluble solids (moisture) is a **pass/fail requirement** for each grade, not one of the scored factors; honey that fails the Grade C requirement is “substandard.”

Between about 17.5 and 20 percent, fermentation risk rises with moisture, and steeply above about 18 to 19 percent — but it depends on the **yeast load** as well. Honey is not sterile (§8.11), and osmophilic yeasts tolerant of high sugar concentrations are always present in some number. A batch at 18.5 percent with a low yeast count may keep for years; the same moisture with a high count may ferment in months.

Two further complications worth knowing:

- **Partial granulation raises the moisture of the remaining liquid phase.** Glucose crystallizing out of solution takes no water with it, so the liquid fraction becomes more dilute. A partly granulated jar can therefore ferment even though the original batch tested acceptable. This is a real mechanism and it explains a good many customer complaints.
- **Honey is hygroscopic.** It takes up moisture from humid air. Storage in **sealed containers** is not optional, particularly here.

Measuring. Use a honey refractometer. Calibrate it (usually with the supplied oil or a standard) and read it at the temperature for which it is calibrated, or apply the appropriate temperature correction. An uncalibrated refractometer confidently read is worse than no refractometer.

8.3 Clearing Bees from Supers

Method	How it works	Assessment
Bee escape board	Fitted under the supers a day or two before removal; bees work down through a one-way device and cannot return	Gentlest on colony and crop, no chemicals. Slow, requires two visits. Works best when nights are cool, which limits it in a Southeastern summer.
Fume board with repellent	A chemical repellent on an absorbent board drives bees down	Fast; suits larger operations. Must be used strictly per label; can taint honey if overused in high heat , a real risk in a Southeastern summer. Works only when it is warm (follow the label's minimum temperature); a cool early morning slows the vapor.
Bee blower	Air blast through the super from beneath, blowing bees out at the entrance	Effective, chemical-free, fast. Noisy and disruptive; the colony is upset for the rest of the day.
Brushing / Bump and Brush	Each comb shook and then brushed off over the open hive	Fine for a few frames. Slow, and irritates the bees.

For a hobbyist or small sideline operation taking a handful of supers, escape boards or brushing serve. For a larger pull, fume boards or a blower. The choice depends on scale, weather and the number of supers.

Whichever you use, **do not leave pulled supers standing open in the yard**. During the Southeastern dearth that is one of the most reliable ways to start an apiary-wide robbing frenzy. Cover them, get them into a truck or a bee-tight room, and move them.

8.4 The Southeastern Rule: Extract Promptly

Supers removed from colonies in the Southeastern summer should be extracted within a day or two and held in a beetle-tight space.

This is one of the most important practical differences between Southeastern and northern honey handling and it is examined directly. A northern beekeeper can stack supers in a shed for a week. A Southeastern beekeeper who does so may find a **slimed, fermenting mess**.

The mechanism is simple: **bee defense is what limits small hive beetle development**. Any hive product removed from bee protection is vulnerable. Adult beetles are already in the

supers when you pull them, they lay in the comb, and the larvae develop unchecked in undefended comb, tunneling through and defecating in the honey, introducing a yeast that ferments it into a frothy, foul-smelling orange mass. A slimed super is a **total loss**, and the odor attracts further beetles.

The standard practices that follow:

- **Extract within one to two days** of removal.
- Hold supers in a **beetle-tight** room, preferably **cooled or dehumidified**.
- **Freeze** comb where practical.
- Handle **cappings and wet comb** immediately rather than leaving them standing.
- Do not leave pulled supers on colonies through the summer “so the bees will finish them.” Once the flow ends the colony contracts, and comb it can no longer patrol is exactly what beetles exploit. Standing honey also picks up moisture in humid weather and can ferment.

8.5 Extraction

8.5.1 Uncapping

Options: a heated uncapping knife, a serrated cold knife, an uncapping fork or scratcher for low spots, a roller, or a powered uncapping machine for larger operations. Cappings drop into an uncapping tank or tub for draining and later rendering (Chapter 11).

Keep cappings separate from the start. Cappings wax is newly secreted, pale, clean, never used for brood rearing, and carries substantially lower pesticide residues than brood comb wax. It is worth several times as much. Mixing all your wax together at the rendering stage throws that away, and it is a small discipline with a substantial return.

8.5.2 Radial versus tangential

	Radial	Tangential
Frame orientation	Held like spokes of a wheel , top bars outward	Held with one face to the wall
Sides emptied	Both at once	One at a time; frames must be reversed
Speed	Faster, less handling	Slower, more handling
Comb stress	Higher; needs well-built comb	Gentler if run slowly; kinder to fragile new comb

Radial extraction is faster and requires less handling. Tangential extraction, run slowly, can be gentler on fragile new comb. In either case: the honey should be **warm**, the speed should be increased **gradually**, and heavy or newly drawn combs need care to avoid blowing out the midrib. A hobbyist with a few colonies is usually best served by a small radial or a convertible unit.

8.5.3 Straining and settling

After extraction, honey is **strained** through nylon or stainless mesh to remove wax bits, bee parts and other debris, and then allowed to **settle** in a tank for a few days so that entrained air rises to the surface as foam, which is skimmed. The result is clear, clean honey.

Ordinary straining leaves the natural pollen in place. This is the important distinction, and it is examined. Straining and settling are normal, expected practice and are in no way controversial.

Ultrafiltration — forcing honey under pressure through a fine filter, often after dilution and heating — removes pollen. That is treated differently under labeling guidance, because removing pollen defeats the determination of geographic origin, and ultrafiltered honey has been associated with honey fraud investigations. A small producer straining through mesh and letting the tank settle is doing nothing that anyone will object to. Do not confuse the two, and do not let a customer confuse them either.

8.6 Heat and Honey

What heat does:

- **Hydroxymethylfurfural (HMF)** forms and accumulates.
- **Invertase and diastase** — the enzymes bees added — are destroyed. Diastase activity and HMF are the two standard quality indices in international honey trade.
- **Aroma volatiles** are lost.
- **Color darkens.**

All of these are measured in commercial quality specifications, so overheated honey can fail a specification even when it was excellent at harvest.

A reasonable practice is to warm honey no higher than about 100 to 110 °F, and for the shortest time necessary, using a warming cabinet or a warm room rather than direct heat. Honey show entries are sometimes gently warmed to just under 140 °F to clear bubbles and incipient crystals, but that is a short exposure for a specific purpose and is not how you should handle a crop.

Two further points:

- Honey held for long periods at **warm warehouse temperatures accumulates HMF without any deliberate heating**. Cool storage and stock rotation matter.
- **Heating honey to reduce moisture is a poor substitute for harvesting properly ripened honey.** It works, after a fashion, and it costs you quality.

8.6.1 Storage

Store honey in **sealed containers**, because it is hygroscopic and will take up atmospheric moisture. Store **cool** rather than warm: warmth drives HMF up, degrades enzymes, darkens color and dulls flavor, and the effect accumulates with time at temperature.

A frequently examined false statement holds that warm storage is preferable because it prevents granulation. It is not. Granulation is natural, reversible with gentle warming, and no defect at all; thermal degradation is neither natural nor reversible.

8.7 Granulation and Creamed Honey

8.7.1 Why honey granulates

Granulation is driven chiefly by the **ratio of glucose to fructose** and by the **glucose-to-water ratio**. Glucose is the sugar that crystallizes; fructose stays in solution. Honeys high in glucose granulate quickly; honeys high in fructose stay liquid.

Two other factors: **nucleation particles** — pollen grains, fine wax, air bubbles, dust — give crystals somewhere to start, and **temperature**, with crystallization fastest at around **57 °F**. That last figure has two practical uses: it explains why honey in a cool pantry or a garage granulates faster than honey in a warm kitchen, and it is the temperature at which creamed honey is made.

Southeastern examples. Tupelo (*Nyssa ogeche*) is the classic honey that resists granulation, because of its unusually high fructose relative to glucose — and that property is the basis of its commercial premium. **Clover** and **cotton** honeys granulate relatively quickly; so, in many regions, do brassica and dandelion honeys. **Goldenrod** granulates readily.

The practical consequences: fast-granulating honeys must be extracted promptly and are good candidates for creamed honey, while slow-granulating honeys command a premium as liquid product.

8.7.2 Advising a customer

Many buyers believe granulation indicates a defect, adulteration, or that the honey has “gone bad.” The correct advice:

Granulation is natural and indicates neither spoilage nor adulteration. It is what pure honey does. The jar can be reliquefied gently in a warm water bath, away from high heat and away from the microwave, or simply used as it is — many people prefer it spread.

Customer education is part of selling honey. A producer who explains granulation, or who offers **creamed honey** as a deliberately granulated product, turns a perceived problem into a selling point.

8.7.3 Creamed honey: the Dyce process

Developed by Elton J. Dyce at Cornell University and patented in 1935 (US Patent 1,987,893; filed 1931).

1. Take liquid honey, ideally one that granulates readily.
2. **Heat it to destroy yeasts** — Dyce specified about **160 °F** — then strain it and **cool** it (to about 75 °F) before seeding. Pasteurization matters because granulated honey has a

wetter liquid phase and would otherwise be prone to ferment; many small producers skip it and accept a shorter shelf life, or simply start with dry honey and gentle warming.

3. **Seed** it with finely ground granulated honey — Dyce used about **5 percent**, and 5 to 10 percent is common practice — honey that has been crystallized and then milled or blended to a very fine crystal.
4. **Mix thoroughly without incorporating air.** Air bubbles produce a foamy surface and a poor appearance.
5. Hold at a temperature near **57 °F for about one to two weeks**, until set.

The abundant fine seed crystals, plus the temperature at which crystal growth is fastest, cause the honey to granulate quickly with a very fine crystal size, producing a smooth, spreadable texture.

Nothing is added but honey. The seed is itself honey, so the finished product remains pure honey and may be labeled as honey. This is an examined point: candidates sometimes assume something must be mixed in.

Creamed honey is often called set honey, spun honey, whipped honey or honey fondant. “Whipped” is a slight misnomer, since air is exactly what you are trying to avoid.

8.8 Varietal Honey

A varietal (or monofloral, or unifloral) honey is one produced predominantly from a single plant source. In the Southeast the two premium varietals are **sourwood**, from the mountains of north Georgia, western North Carolina, upstate South Carolina and east Tennessee, blooming late June and July; and **tupelo**, from the Ogeechee tupelo in the river swamps of the Apalachicola basin and adjacent drainages, blooming late April and early May. Both command substantial premiums. Gallberry, from the coastal plain, is a third significant regional varietal.

8.8.1 How to produce one

1. **Remove and extract all previously stored surplus honey before the target bloom begins**, leaving the colony with empty drawn supers.
2. **Place clean supers on immediately before or at the start of the target bloom.**
3. **Remove and extract those supers promptly when the target bloom ends**, before the bees add honey from subsequent sources.
4. **Keep the crop segregated** through extraction, settling and bottling so that it is not blended with other honey.

The single most important step is the first one: clearing the supers of other honey before the target flow begins. Anything already in the comb will be extracted along with the varietal. A candidate who says only “put clean supers on” has missed half of it — the supers must be clean *and* the colony must have no earlier crop still in the boxes below that will be pulled with it.

Any mite treatment must also be completed **before** those supers go on, since many products require supers off (Chapter 16). This is a real constraint on the sourwood producer, whose target bloom arrives in late June, and it must be planned for in the spring.

Producing tupelo follows exactly the same discipline against a much narrower bloom window, with the added risks of river flooding and of weather during a short bloom. It is a high-risk, high-value proposition, which is why the discipline is worth the extra handling.

8.9 Comb Honey

Comb honey production differs from extracted honey production in several ways the examination expects you to name:

- **New white comb drawn on clean foundation**, during a **strong flow**, by a **populous colony**. Old comb cannot be used.
- **Pulled as soon as it is capped**, so that it is not travel-stained — the darkening of comb surfaces from bees walking on it.
- **Attention to wax residues**, because the wax is eaten. Foundation made from recycled wax carrying miticide residues is unacceptable for comb honey. This is a real consideration and an argument for cappings-derived or residue-tested foundation.
- **Appearance is a large part of the value**: uneven capping, incomplete filling, travel staining, and punctured cells all downgrade the product.

The technique is to force a strong colony into restricted space during a reliable heavy flow. In the Southeast that usually means the April and May flow. Formats include **cut comb** (cut from a frame of thin surplus foundation and drained), **chunk honey** (a piece of comb in a jar topped with liquid honey — a traditional Southeastern product), **round sections** (Ross Rounds and similar) and **basswood section boxes** (traditional, difficult).

Comb honey also needs to be **frozen before sale** — typically 24 to 48 hours at 0 °F — to kill any wax moth or small hive beetle eggs, which is essential in the Southeast.

8.10 A Wet Batch: What to Do

Suppose a batch of extracted honey tests at **19.5 percent moisture**.

The risk. It is above the 18.6 percent limit for US Grades A and B (it could grade no better than C) and, more practically, **above the level at which fermentation is reliably prevented**. If it is bottled and stored it may ferment, producing foam, a sour or alcoholic odor, and an unsalable product — potentially after it is in a customer's pantry, which is worse than finding out in the tank.

Two acceptable remedies:

1. **Reduce the moisture** by exposing the honey to warm, dry, **moving** air — in a warm room with a dehumidifier and fans, or in supers spaced for airflow before extraction — at a temperature low enough to avoid heat damage. Air movement is the operative variable; a warm room with still air does very little.
2. **Blend it with a drier batch** to bring the combined moisture below target, and **retest before bottling**.

Not acceptable: adding water (obviously), or bottling and selling it as is and hoping.

The better answer starts earlier. Harvest only well-capped frames; test individual supers rather than only the finished tank; and place wet frames back on the hive, where the bees will clean them or finish ripening them. One wet super can put an entire tank above specification.

8.11 Honey Microbiology and Food Safety

8.11.1 Why honey resists spoilage

Three mechanisms:

1. **Very low water activity.** The sugar concentration ties up available water so that most microorganisms cannot grow.
2. **Acidity.** Honey's pH averages about **3.9** (typically about 3.5 to 4.5; the USDA survey of US honeys found a range of 3.4 to 6.1), chiefly from gluconic acid produced by glucose oxidase.
3. **Hydrogen peroxide**, generated by the bee-derived enzyme **glucose oxidase** acting on glucose when honey is diluted, together with other antimicrobial compounds including phenolics and, in some honeys, plant-derived compounds.

8.11.2 Why it is not sterile

Two exceptions, and they are exactly the two practical food safety issues in honey:

- **Osmophilic yeasts** tolerant of high sugar concentrations survive, and will **ferment** honey if the moisture is high enough. This is the moisture story above.
- **Bacterial spores survive** in a dormant state even though they cannot grow — including spores of ***Clostridium botulinum***. This is the infant botulism story below.

8.11.3 The infant advisory

Honey labels commonly carry an advisory that honey should not be fed to infants under twelve months. The reason:

Honey may carry *Clostridium botulinum* spores, which can germinate in an infant's immature gut and produce toxin, causing infant botulism. The spores are harmless to older children and adults, whose established gut flora prevents colonization. The hazard is the **spore**, not preformed toxin.

The spores are environmental and cannot be reliably excluded by any practical processing, and heating enough to destroy them would ruin the honey. A producer selling honey should be able to explain the advisory accurately rather than dismissing it as fussiness, and should check whether their state requires the statement on the label.

8.11.4 Honey house hazards

A honey house should be operated so that the following are controlled:

- **Physical hazards** — glass (a bottling operation deserves a specific glass policy and a breakage procedure), metal fragments, wood splinters, hardware.

- **Chemical hazards** — cleaners, sanitizers, lubricants. Keep them segregated from product areas; use food-grade lubricants on equipment.
- **Moisture control** — against fermentation.
- **Heat and holding time** — against thermal degradation.
- **Pest entry** — beetle-tight and insect-tight construction, in the Southeast especially.
- **Lot traceability for recall.**

Lot coding is the element small producers most often skip and the one that makes a proportionate response possible if a problem is found. Without it, a single bad tank puts the whole season's output in question. A lot code can be as simple as a date and a tank number inkjetted or handwritten on the jar or the case.

8.11.5 Wet supers after extraction

Return wet supers to the colonies they came from, or set them above an inner cover on strong hives, **late in the day** and with an eye to robbing. Then remove and store them dry.

Do not set the boxes out in the open in the yard for the apiary to share. During the Southeastern dearth this is one of the most reliable ways to start an apiary-wide robbing frenzy, and it spreads disease between colonies as effectively as any practice in beekeeping. Returning supers to their own colonies for cleaning protects against both, and against the small hive beetle and wax moth damage that residual honey and pollen encourage.

Numbers to Memorize

Item	Figure
Harvest rule	at least 80% capped
US Grade A and B maximum moisture	18.6% (at least 81.4% soluble solids)
US Grade C and Codex general maximum moisture	20%
Fermentation generally prevented below	about 17–17.5%
Honey show disqualification threshold	>18.6% (= Grade A/B limit)
Honey pH	average about 3.9; typically about 3.5–4.5
Maximum warming temperature for bottling	about 100–110 °F
Fastest crystallization temperature	about 57 °F
Creamed honey (Dyce)	heat about 160 °F to kill yeasts, cool; seed about 5% (5–10% common); hold about 57 °F for 1–2 weeks
Extract supers within	1–2 days (Southeast)
Freeze comb honey	0 °F, 24–48 hours
Infant honey advisory	under 12 months

Key Terms

Shake test — sharply shaking a frame horizontally to see whether unripe nectar flies from uncapped cells.

Refractometer — instrument measuring honey moisture by refractive index; must be calibrated and temperature-corrected.

Radial / tangential extractor — frames held like spokes, both sides at once / one face out, requiring reversal.

Straining and settling — removing debris and letting entrained air rise; leaves natural pollen in place.

Ultrafiltration — pressure filtration removing pollen; treated differently under labeling guidance.

HMF (hydroxymethylfurfural) — heat and storage degradation product; a quality index.

Diastase number — a measure of enzyme activity used as a freshness/heat index.

Dyce process — heating honey to kill yeasts, then seeding it with finely granulated honey and holding near 57 °F to make creamed honey.

Varietal / monofloral honey — honey predominantly from one plant source.

Travel stain — darkening of comb honey surfaces from bees walking on them.

Osmophilic yeast — sugar-tolerant yeast responsible for honey fermentation.

Water activity — the availability of water to microorganisms; honey's is too low for most growth.

Self-Check

1. (MC) The standard field rule for deciding that a frame of honey is ready to harvest is: A) It should feel heavy and be capped along the top bar B) It should be capped from bar to bar C) It should be at least half capped, with the remainder finishing in a warm honey house D) It should be largely capped, commonly 80% or more, with wide uncapped areas shake-tested or read on a refractometer

2. (SA) State the maximum moisture permitted under the US grade standards, the level below which fermentation is generally prevented, and how moisture is measured.

3. (MC) Straining and settling honey after extraction serves to: A) Remove wax and debris and dissolve glucose crystals B) Remove wax and debris and remove pollen grains that cloud the jar C) Remove wax and debris and drive moisture off in the settling tank D) Remove wax, bee parts and debris and let entrained air rise so bottled honey is clear; ordinary straining leaves natural pollen in place

4. (SA) Describe how creamed honey is made and state why nothing is added to it.

- 5. (TF)** Honey should be stored in sealed containers because it is hygroscopic, and warm storage is preferable to cool because warmth prevents granulation without affecting quality.
- 6. (SA)** Describe how a beekeeper produces a varietal honey such as sourwood or tupelo, and state the single most important step.
- 7. (MC)** A honey house in Georgia holds supers for a week before extraction in hot weather. The likely result is: A) Honey drying down and improving in density B) Wax moth larvae tunneling through the cappings C) Small hive beetle larvae developing unchecked in undefended comb, sliming the supers and ruining the crop D) Honey granulating in the comb
- 8. (SA)** A batch tests at 19.5% moisture. Explain the risk and give two acceptable remedies.

Answers

1. D.

2. The US grade standards allow a maximum of **18.6 percent** moisture (at least 81.4 percent soluble solids) for **Grades A and B** and **20 percent** for **Grade C**; the Codex standard's general limit is also 20 percent. Many buyers require lower, and honey shows commonly disqualify entries above 18.6 percent. Fermentation by osmophilic yeasts is generally prevented below about **17 to 17.5 percent**, with risk rising from there and steeply above about 18 to 19 percent and depending also on the yeast load present. Moisture is measured with a **honey refractometer**, calibrated and read at its calibration temperature or corrected accordingly. Note also that partial granulation raises the moisture of the remaining liquid phase, so a partly granulated jar can ferment even when the original batch tested acceptable.

3. D.

4. Liquid honey is heated to destroy yeasts (Dyce specified about 160 °F), strained and cooled, then seeded with about 5 percent (commonly 5 to 10 percent) finely ground granulated honey, mixed thoroughly without incorporating air, and held at a temperature near 57 °F for one to two weeks. The abundant fine seed crystals plus the temperature at which crystal growth is fastest cause rapid granulation with a very fine crystal size, giving a smooth spreadable texture. **Nothing is added but honey** — the seed is itself honey — so the finished product remains pure honey and may be labeled as such. This is the Dyce process (1935).

5. False in the second half. Warm storage is the more damaging: heat drives HMF up, degrades the enzymes used as quality markers, darkens the color and dulls the flavor, cumulatively with time at temperature. Granulation is natural, reversible with gentle warming in a water bath, and no defect at all. Sealed containers in cool, dry storage address the real hazards, which are moisture uptake and slow thermal degradation.

6. Remove and extract all previously stored surplus honey before the target bloom begins, leaving empty drawn supers; place clean supers on immediately before or at the start of the target bloom; remove and extract those supers promptly when the bloom ends, before the bees add honey from later sources; and keep the crop segregated through extraction, settling and bottling. **The single most important step is clearing the supers of other honey before the target flow begins**, since anything already in the comb will be extracted along with the varietal. Any mite treatment requiring supers off must also be completed beforehand.

7. **C.** Bee defense is what limits beetle development; any hive product removed from bee protection is vulnerable. Extract within one to two days, hold supers in a beetle-tight and preferably cooled or dehumidified room, freeze comb where practical, and deal with cappings and wet comb immediately.

8. At 19.5 percent the honey is above the 18.6 percent limit for US Grades A and B (it could grade no better than C) and above the level at which fermentation is reliably prevented, so if bottled and stored it may ferment, producing foam, a sour or alcoholic odor and an unsalable product. Two acceptable remedies: reduce the moisture by exposing the honey to warm, dry, **moving** air — a warm room with a dehumidifier and fans, or supers spaced for airflow before extraction — at a temperature low enough to avoid heat damage; or blend it with a drier batch and retest before bottling. Adding water or bottling as is are not acceptable. Better still, harvest only well-capped frames and test individual supers, since one wet super can raise a whole tank above specification.

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Chapter 9: Honey Labels and Regulation

Learning Objectives

When you have finished this chapter you should be able to:

- State the mandatory elements of a United States retail honey label and explain where state requirements add to them.
 - Explain why a product with added sweetener may not be labeled as honey.
 - Explain what a health claim is, why it is regulated, and what makes a product an unapproved drug.
 - Describe what a cottage food law is and how it typically applies to a small Southeastern honey producer.
 - Distinguish an exemption from licensing from an exemption from labeling.
 - Explain why selling across state lines or wholesale changes a producer's obligations.
 - Describe the structure of apiary regulation in the United States and identify the correct agency for a given problem.
 - State what a beekeeper must do before moving colonies to another state.
 - Explain notifiable disease reporting and the authority to order destruction.
 - Describe the content of typical municipal beekeeping ordinances.
 - State the general legal principles governing liability for stings and the practical steps that reduce exposure.
 - Name the relevant national and regional organizations and say what each contributes.
-

9.1 A Note Before You Start

Everything in this chapter is subject to change, and much of it differs between Georgia, Florida, South Carolina, North Carolina, Alabama, Mississippi and Tennessee. The examinable competency is not a recitation of current rules; it is knowing **what kind of rule governs what, which agency to ask, and what questions to ask them.**

An examiner will accept, and often expects, “I would check the current requirements with my state department of agriculture” as part of an answer. An examiner will not accept a confidently recited provision that was superseded two years ago. Learn the framework; look up the details.

9.2 Honey Labeling

9.2.1 The mandatory elements

A United States retail honey label must generally include:

1. **A statement of identity** — what the product is. “Honey.” If a floral source is claimed, it must be truthful and the honey must be predominantly from that source (“Sourwood Honey,” “Wildflower Honey”).

2. **The net quantity of contents** — by weight for honey, in both US customary and metric units, placed in the lower 30 percent of the principal display panel, in a type size proportionate to the panel area.
3. **The name and place of business of the packer or distributor** — a real business name and address. A post office box alone is generally insufficient unless the firm is listed in a current directory.
4. **Country of origin** for imported honey.
5. **Nutrition labeling**, unless an exemption applies. Small businesses may qualify for an exemption, but the exemptions have conditions — typically relating to annual sales volume and units sold — and a producer making a nutrient content claim loses the exemption.
6. **Any state-required statements**, which commonly include an infant advisory and, in cottage food states, a disclosure that the product was made in a home kitchen not subject to inspection.

The elements small producers most often get wrong: omitting the net weight statement or putting it in the wrong place or type size; using a name without an address; assuming nutrition labeling never applies; and printing several hundred labels before checking the state rules.

Add a lot code. It is not federally required for a small producer, but without it you cannot mount a proportionate response if a problem is found, and a single questionable tank puts the whole season's output in doubt (Chapter 8).

9.2.2 Honey is a single-ingredient food

A product consisting of honey to which a sweetener has been added may not be labeled as honey, however the ingredients are declared. This is examined as a true/false item and it catches people, because the instinct is that full disclosure cures everything. It does not.

The reasoning is that honey is defined by what the bees produced from nectar or honeydew. A blend of honey and corn syrup is not honey; calling it honey is **misbranding** regardless of the ingredient statement. Such a product must be named for what it is — “honey and cane syrup blend,” say — with the ingredient statement in descending order of predominance.

The same principle explains why **ultrafiltration** and **unsupported floral source claims** attract scrutiny. It also explains why feeding sugar syrup while harvest supers are on the colony creates an **adulteration** problem (Chapter 5): the bees store the syrup, you extract it, and the result is not honey.

Flavored or infused honeys — honey with cinnamon, with chili, with herbs — are a different case: they are honey with an added ingredient and must be labeled as such, not as plain honey.

9.2.3 Health claims

Making a claim that a food treats, prevents, mitigates or cures a disease can make the product an unapproved drug and the label misbranded.

This is regulated, and enforcement actions against honey and bee product sellers for disease claims are well documented. Three things are worth knowing:

- **Implied claims count.** Imagery, testimonials, a link to a page about “honey for allergies,” and website copy are all part of the labeling when they accompany the product.
- **A disclaimer does not cure a disease claim.** The “this statement has not been evaluated” formula belongs to a narrow category of dietary supplement structure/function claims and does not license a treatment claim on a food.
- **Selling face to face at a farmers market does not exempt you.** Direct sales are not outside the food authority’s rules.

The practical advice: describe the honey accurately — its floral source, its origin, its color and flavor, how it was produced — and let quality and provenance do the selling. “Local raw sourwood honey from our hives in Rabun County” is a strong claim that is entirely truthful. “Cures your allergies” is a regulatory problem.

9.3 Grade Standards

The **United States Standards for Grades of Extracted Honey** (USDA AMS, 1985) are **voluntary** standards used for trading and quality description. They exist **alongside** mandatory food safety and labeling law, which is not voluntary.

The distinction is frequently misunderstood, and it is examined. A producer is **not** required to grade honey. A producer **is** required to label it truthfully and to produce it under sanitary conditions.

Grade standards give a common commercial vocabulary, useful when selling wholesale and when entering a honey show. The grades are US Grade A, B, C and Substandard. Grading works in two steps:

- **Soluble solids (moisture) is a pass/fail requirement**, not a scored factor: Grades A and B require at least **81.4 percent soluble solids** (no more than 18.6 percent moisture), Grade C at least **80.0 percent** (no more than 20 percent).
- **Scored factors** are **flavor and aroma** (up to 50 points), **absence of defects** (up to 40) and, for filtered honey only, **clarity** (up to 10). A total of at least 90 points is needed for Grade A, 80 for Grade B and 70 for Grade C.

A producer need not grade honey at all — but a grade printed on a label must be true.

Color is a separate classification, not a grade, read on a **Pfund grader** (in millimetres) or an equivalent comparator:

USDA color class	Pfund scale
Water White	8 mm or less
Extra White	over 8 to 17 mm
White	over 17 to 34 mm
Extra Light Amber	over 34 to 50 mm
Light Amber	over 50 to 85 mm
Amber	over 85 to 114 mm
Dark Amber	over 114 mm

Color correlates loosely with flavor intensity and with floral source, and has a strong effect on price, with light honeys generally preferred for table use. It is **not** a measure of quality in the sense of purity or freshness — and honey darkens with heating and storage, so a dark honey may be a dark varietal or an abused light one. In the Southeast, **sourwood and tupelo** are prized light honeys while **tulip poplar** is characteristically dark.

9.4 Cottage Food Laws

A **cottage food law** is a **state** statute or rule permitting certain low-risk foods to be produced in a home kitchen and sold directly to consumers, subject to limits on sales channels, annual sales volume, labeling and sometimes registration or training.

Honey is commonly treated as a permitted product. In several states, honey sold by a small producer in limited quantities is additionally exempt from some food processing licensing requirements under a honey-specific provision separate from the general cottage food rule.

Requirements differ substantially among the Southeastern states, and they change. A producer must check the current rules of their own state **and county**, including any limits on wholesale, internet or out-of-state sales.

9.4.1 The distinction that matters

An exemption from licensing is not an exemption from labeling, and it is not an exemption from food safety obligations.

This is the examinable habit. A producer who reads “honey is exempt” and concludes that no rules apply has misread it. Typically:

- You may still be required to label fully.
- You may be required to add a **specific cottage food disclosure statement**.
- You remain subject to adulteration and misbranding law.
- You remain liable for a defective product.

9.4.2 When the exemption stops applying

Selling honey across state lines, or selling wholesale to retailers, generally brings a producer under requirements that do not apply to direct-to-consumer sales under a cottage food exemption. This is examined as a true/false item.

Cottage food exemptions typically apply only to **direct sales within the state**, and often only up to a sales limit. Wholesale, internet and interstate sales generally require operating from an inspected or licensed facility and complying fully with federal labeling and, depending on scale, food safety requirements under the FDA Preventive Controls for Human Food rule.

A producer planning to grow should determine these requirements before committing to a market channel — before signing with a retailer, before building a website with a shopping cart, and before printing labels.

9.4.3 Selling at a Southeastern farmers market: a checklist

1. **Determine the state and local requirements.** Does the state's cottage food or honey-specific exemption cover your operation? Is registration, a food handler certification, a permit, or an inspection of the extraction facility required? What does the market itself require — insurance, a vendor agreement, a sales tax certificate?
2. **Prepare compliant labels:** statement of identity, net weight, producer name and address, any state-required statements such as an infant advisory or a cottage food disclosure, and a lot code.
3. **Ensure the honey is properly ripened,** tested for moisture, clean and attractively packaged.
4. **Obtain liability insurance.** This is the item most often skipped and the one whose absence will hurt most.
5. **Keep records** of production lots.
6. **Confirm that scales used for sale are legal for trade** if you weigh honey at the market. State weights and measures officials do check.

9.5 Apiary Regulation

9.5.1 It is a state function

Apiary inspection and the regulation of bee diseases in the United States is primarily a state function. Each state's department of agriculture or equivalent agency administers apiary law, which may cover:

- **Registration** of beekeepers, apiaries or colonies
- **Inspection**
- **Notifiable disease reporting**
- **Movement certificates** and entry requirements
- **Orders to treat or destroy**

It is **not** a county function administered by extension, and it is **not** a federal function administered by APHIS, although APHIS administers **importation** under the Honey Bee Act of 1922 (Chapter 1) and cooperates on exotic pest response.

Because it is a state matter, requirements differ substantially among the Southeastern states. **Florida requires registration of all colonies.** Others differ. Know your own state's law, and if you move colonies, satisfy the **destination** state's entry requirements rather than assuming reciprocity.

9.5.2 Moving colonies interstate

Before moving colonies from Georgia to another state for pollination or a honey flow:

1. **Contact the destination state's apiary regulatory authority** and determine its current entry requirements. These commonly include a **certificate of inspection** issued within a specified period by the origin state's apiary inspector, and may include additional requirements relating to Africanized bees, small hive beetle or other pests.

2. **Arrange the inspection with the state apiarist well in advance.** Inspections must be scheduled, and the certificate has a validity period.
3. **Confirm any permit, notification or registration** required by the destination state.
4. **Carry the documentation with the load.**
5. **Confirm the requirements again for the return trip** if applicable.

Failure to comply can result in **quarantine, refusal of entry, or destruction of colonies at the state line**, and it is one of the more consequential regulatory risks in migratory beekeeping. Requirements change; last year's information should not be relied on.

9.5.3 Notifiable disease

American foulbrood is a notifiable or reportable condition in many states, meaning a beekeeper or inspector who identifies it may be legally required to report it, and the state may have authority to order destruction of infected colonies and equipment.

The rationale is that AFB spores persist for decades and a single infected colony threatens every apiary within flight range. **The disease is treated as a community problem rather than a private one.**

The practical implication for a beekeeper is that suspected AFB should be **reported to the state apiary inspector rather than handled quietly**, and that the inspector's direction, where legally binding, must be followed. See Chapter 15 for the immediate containment steps.

9.5.4 Which agency for which problem

Problem	Contact
Suspected AFB or other notifiable disease	State apiary inspector (state dept. of agriculture)
Moving colonies interstate	Destination state's apiary authority; origin state apiarist for the certificate
Suspected pesticide misuse killing colonies	State lead pesticide agency , usually the department of agriculture, plus the state apiary inspector
Suspected exotic pest (yellow-legged hornet, <i>Tropilaelaps</i>)	State department of agriculture; USDA APHIS
Honey labeling questions	FDA guidance; state dept. of agriculture for state requirements
Local ordinance / zoning	Municipal or county government
Importation of bees or germplasm	USDA APHIS

On the pesticide item: **pesticide enforcement is carried out by the states under cooperative agreements with EPA**. The state lead agency, not EPA directly and not FDA and not the county extension agent, is the body that draws legal samples and opens a misuse investigation. Report promptly, because residues degrade, and follow the agency's chain-of-custody instructions rather than sending samples independently to a private laboratory in the first instance (Chapter 13).

9.6 Local Ordinances

Municipal and county ordinances affecting beekeeping in the Southeast commonly address:

- **Number of colonies allowed per lot size**
- **Setbacks** from property lines, dwellings and public ways
- **Flyway barrier requirements** — a fence or hedge of specified height near the hives, forcing bees to gain altitude immediately and thereby lifting flight paths above head height
- **Provision of a water source** on the beekeeper's own property
- **Registration or notice to adjoining neighbors**
- Sometimes requirements about requeening defensive colonies, or prohibitions in certain zones

Ordinances vary widely and change. **Check the current municipal or county code before establishing an apiary and again before expanding.**

Two further complications:

- Many states have **right-to-farm** provisions that may limit local restriction of agricultural activity, but their application to beekeeping in residential zones varies considerably, and you should not assume protection.
- **Homeowner association covenants operate separately from public law.** An HOA can restrict beekeeping where the municipality permits it, and a right-to-farm statute will not usually help you against a private covenant.

9.7 Liability and Neighbors

9.7.1 The legal framework

Liability for a neighbor stung by bees from your apiary generally arises under two heads:

- **Negligence** — whether the beekeeper exercised **reasonable care** in siting and managing the colonies. The standard is what a reasonable beekeeper would do.
- **Nuisance** — where the operation **substantially and unreasonably interferes** with a neighbor's use and enjoyment of their property. Note that nuisance does not require anyone to be injured.

Compliance with applicable ordinances is relevant but not necessarily sufficient.

Meeting the setback in the code does not automatically defeat a nuisance claim if your bees are, in fact, making the neighbor's yard unusable.

Note the general framework; do not offer legal advice. If a specific dispute arises, the correct response is that the person should consult a qualified attorney in that state.

9.7.2 Practical steps that reduce exposure

- **Keep gentle stock and requeen defensive colonies promptly.**
- **Provide a dependable on-site water source**, well inside your own boundary (Chapter 5).

- **Use flyway barriers** — fencing, hedges, screening — to raise flight paths above head height.
- **Site hives away from property lines, walkways and neighbors' outdoor living areas.**
- **Screen the apiary from view**, which reduces the psychological component of complaints.
- **Practise swarm control.** Most complaints that escalate begin with a swarm in a neighbor's tree.
- **Maintain good relations and communication.**
- **Carry liability insurance.**
- **Comply with local ordinances and state registration requirements.**

9.7.3 Neighbor relations as management

The most effective way to maintain good relations is to talk with neighbors before siting the apiary, keep gentle stock and requeen promptly if a colony turns defensive, provide water, use flyway barriers and sound siting, practise swarm control, and share honey and information.

Most neighbor complaints concern **bees at water sources** and **swarms**, both of which are manageable. Most escalate not because of an unavoidable conflict but because the beekeeper was unknown, unreachable, or unresponsive. A jar of honey and an offer to answer questions is cheaper than a zoning dispute.

Concealing an apiary is counterproductive if a problem arises. The neighbor who discovers, in the middle of a complaint, that you hid the hives from them has learned something about you that will color everything that follows.

9.7.4 Worked example: the swimming pool

A neighbor complains that your bees are drowning in their pool and demands you remove the hives.

Respond promptly, courteously and in person. Acknowledge the problem rather than disputing that the bees are yours; the argument about whose bees they are is one you cannot win and should not have.

Explain the biology briefly: bees need water, especially in summer for cooling and year-round for brood food, and they fix on a source and recruit others to it.

Offer the technical fix: establish a dependable water source in your own yard with landing surfaces — gravel, corks, a wet board — sited closer to the hives than the pool, and make it attractive. Be honest that bees already fixed on the pool will take time to shift, so persistence is needed, and that a pool cover or running the filter helps in the interim.

Review your own practice: siting, flyway barriers, colony numbers.

Offer honey and ongoing communication. Give them your phone number.

If the relationship remains difficult, check the local ordinance and consider relocating some colonies to an out-apiary. Responding defensively or ignoring the complaint is what turns a nuisance into an ordinance.

9.8 Structural Removals as a Business

A homeowner asks you to remove a colony from a wall. Before agreeing, the important business considerations are:

- **A written agreement covering the scope of work.** Who opens the structure? Who repairs it? Who pays for what?
- **Liability and insurance.** You are doing construction work on someone's house.
- **What happens if the queen or all the bees cannot be recovered.** Manage the expectation in advance; complete removal is often not achieved.
- **Whether you are equipped for the job** — physically, in skill, and in insurance.

Structural removals are construction work as much as beekeeping, and the most common disputes concern **repair responsibility** and **unrealistic expectations about complete removal**. In areas with African-derived bees, an additional consideration is temperament assessment and the safety of occupants and neighbors during the work (Chapter 6).

A beekeeper without insurance and construction competence should refer the job rather than accept it. That is a professional judgment, not a failure.

The two removal methods are covered in Chapter 18.

9.9 Organizations

Knowing where authoritative, current information comes from is itself a competency, particularly in a field where a great deal of confident misinformation circulates online.

National - American Beekeeping Federation (ABF) and **American Honey Producers Association (AHPA)** — represent commercial and sideline beekeepers on policy, trade and research funding. - **Apiary Inspectors of America (AIA)** — coordinates state regulatory officials; contributes to national colony loss surveys. - **Bee Informed Partnership (BIP)** — ran the national colony loss and management surveys for many years (the loss survey is now run by Auburn University with Oregon State University and the Apiary Inspectors of America); tech-transfer teams for commercial beekeepers; archive of past reports. - **Honey Bee Health Coalition** — produces widely used practical guidance, notably *Tools for Varroa Management*. - **Project Apis m.** — funds and coordinates honey bee research; issued the guidance following the 2024–25 loss event. - **Pollinator Partnership, Xerces Society** — pollinator habitat and conservation.

Regional - Eastern Apicultural Society (EAS) — regional conference, short courses, and a long-established Master Beekeeper certification program. - **Heartland Apicultural Society, Western Apicultural Society** — equivalents in other regions.

State and local - Georgia Beekeepers Association, Florida State Beekeepers Association, South Carolina Beekeepers Association, North Carolina State Beekeepers Association, Alabama

Beekeepers Association, Mississippi Beekeepers Association, Tennessee Beekeepers Association — and the local associations under them.

University extension - UGA, UF/IFAS, Clemson, NC State, Auburn, Mississippi State and University of Tennessee all publish apiculture material tailored to their states.

9.9.1 Why associations and extension matter

The examination asks this directly, and the answer is **regional specificity**. State and local associations and university extension services supply bloom calendars, pest and disease pressure information, regulatory guidance and management timing **that general books lack**, and they offer mentoring, education and a link to the state apiary inspection service.

They do not set pesticide label restrictions, do not certify honey for export, and do not supply subsidized bees. A Southeastern beekeeper needs a Southeastern calendar, and this is where it comes from.

9.9.2 What master beekeeper programs examine

A common false statement holds that master beekeeper programs assess practical skills and teaching but **not** regulatory or public service topics, on the grounds that these vary too much between states.

They do examine them, and for a plain reason: **a master beekeeper is expected to advise other people**. That means knowing what a pesticide label obliges, what the state apiary law requires, what may lawfully go on a honey jar, and when a suspected notifiable disease must be reported. Programs typically combine written, practical, oral and public service components, and the variation between states is handled by examining candidates on their own state's requirements.

Numbers to Memorize

Item	Figure
Net quantity statement placement	lower 30% of principal display panel
US grade maximum moisture	18.6% for Grades A and B; 20% for Grade C
Pfund color grades	Water White › Extra White › White › Extra Light Amber › Light Amber › Amber › Dark Amber
Extracted honey grades	US A, B, C, Substandard
Grading categories	moisture, flavor & aroma, absence of defects, clarity
Infant honey advisory	under 12 months
Grade standards	USDA AMS, 1985; voluntary
Apiary regulation	state function
Pesticide enforcement	state lead agency under cooperative agreement with EPA

Key Terms

Statement of identity — the required declaration of what the product is.

Misbranding — labeling that is false or misleading, or that omits required information.

Adulteration — the addition of something that should not be there, or the substitution of an inferior substance.

Cottage food law — state rule permitting certain low-risk foods produced in a home kitchen to be sold directly to consumers.

Unapproved drug — what a food becomes if its labeling claims it treats, prevents or cures disease.

Pfund grader — the instrument used to classify honey color.

Notifiable disease — a condition that must by law be reported to the regulatory authority.

Certificate of inspection — the document a state apiarist issues attesting to colony health, commonly required for interstate movement.

Flyway barrier — a fence or hedge forcing bees to gain altitude on leaving, lifting flight paths above head height.

Right-to-farm statute — state law limiting nuisance actions against agricultural operations; application to residential beekeeping varies.

Self-Check

- 1. (MC)** United States honey labels for retail sale must generally include: A) Statement of identity, net quantity, beekeeper's name and address, and floral source B) Statement of identity, net quantity, packer's address, and a state grade mark C) Statement of identity, net quantity, packer's name and address, and a lot code; nutrition labeling always waived D) Statement of identity, net quantity, name and place of business of the packer or distributor, and country of origin for imported honey; nutrition labeling applies unless an exemption applies, and states may add more
- 2. (TF)** A product consisting of honey to which a sweetener has been added may still be labeled as honey, provided the added sweetener is a natural sugar and is declared in the ingredient statement.
- 3. (SA)** Explain what a cottage food law is and how it typically applies to a small Southeastern honey producer.
- 4. (MC)** Apiary inspection and regulation of bee diseases in the United States is primarily: A) A county function administered by extension offices B) A state function, with each state's department of agriculture administering apiary law C) A voluntary function administered by state beekeeping associations D) A federal function administered by USDA APHIS

- 5. (SA)** Explain what a beekeeper should do before moving colonies from Georgia to another state.
- 6. (MC)** If a beekeeper suspects pesticide misuse has killed their colonies, the appropriate agency to contact is: A) The regional EPA office directly B) The state lead pesticide agency, usually the department of agriculture, together with the state apiary inspector C) The Food and Drug Administration D) The county extension agent
- 7. (SA)** Describe the general legal principles governing liability if a neighbor is stung by bees from your apiary, and list practical steps that reduce your exposure.
- 8. (TF)** The United States Standards for Grades of Extracted Honey are voluntary standards used for trading and quality description, existing alongside mandatory food safety and labeling law.

Answers

1. D.

2. False. Adding a sweetener means the product is no longer honey for labeling purposes, and calling it honey is misbranding however the ingredients are declared. It must be named for what it is — a blend — with an ingredient statement in descending order. Honey is a single-ingredient food defined by what the bees produced, which is also why ultrafiltration and unsupported floral source claims attract scrutiny.

3. A cottage food law is a state statute or rule permitting certain low-risk foods to be produced in a home kitchen and sold directly to consumers, subject to limits on sales channels, annual sales volume, labeling and sometimes registration or training. Honey is commonly a permitted product, and several states additionally exempt small honey producers from some food processing licensing requirements, though labeling requirements still apply. Requirements differ substantially among the Southeastern states, so a producer must check the current rules of their own state and county, including limits on wholesale, internet and out-of-state sales. The critical distinction is that **an exemption from licensing is not an exemption from labeling or from food safety obligations.**

4. B.

5. Contact the destination state's apiary regulatory authority and determine its current entry requirements, which commonly include a certificate of inspection issued within a specified period by the origin state's apiary inspector and may include requirements relating to Africanized bees, small hive beetle or other pests. Arrange the inspection with the Georgia state apiarist well in advance, since inspections must be scheduled and the certificate has a validity period. Confirm any permit, notification or registration required by the destination state, and carry the documentation with the load. Confirm requirements again for the return trip. Failure to comply can result in quarantine, refusal of entry or destruction at the state line, and requirements change, so last year's information should not be relied on.

6. B. Pesticide enforcement is carried out by the states under cooperative agreements with EPA. Report promptly because residues degrade, preserve samples, document the scene, and follow the agency's chain-of-custody instructions rather than sending samples independently to a private laboratory first.

7. Liability generally arises under ordinary **negligence** principles — whether the beekeeper exercised reasonable care in siting and managing the colonies — and under **nuisance** law, where the operation substantially and unreasonably interferes with a neighbor's use and enjoyment of their property. Compliance with applicable ordinances is relevant but not necessarily sufficient. Practical steps: keep gentle stock and requeen defensive colonies promptly; provide a dependable on-site water source; use flyway barriers to raise flight paths above head height; site hives away from property lines, walkways and neighbors' outdoor living areas; screen the apiary from view; practise swarm control; maintain good relations and communication; carry liability insurance; and comply with local ordinances and state registration requirements. A specific dispute should go to a qualified attorney.

8. True.

References for Further Study

Federal guidance and law - US FDA, *Guidance for Industry: Proper Labeling of Honey and Honey Products* (2018). - 21 CFR part 101 (food labeling); 21 U.S.C. 343 (misbranding); 21 U.S.C. 321(g) (drug definition). - US FDA, Preventive Controls for Human Food rule, 21 CFR 117. - USDA AMS, *United States Standards for Grades of Extracted Honey* (1985). - Honey Bee Act of 1922, 7 U.S.C. 281–286; USDA APHIS importation regulations.

State - State apiary acts and department of agriculture apiary programs for Georgia, Florida, South Carolina, North Carolina, Alabama, Mississippi and Tennessee. - State cottage food statutes and department of agriculture guidance. - Municipal and county codes; state right-to-farm statutes.

Organizations - Apiary Inspectors of America: apiaryinspectors.org - Bee Informed Partnership (former operator of the national loss survey, now run by Auburn University with Oregon State University and the Apiary Inspectors of America): beeinformed.org - Honey Bee Health Coalition: honeybeehealthcoalition.org - Eastern Apicultural Society: easternapiculture.org

Regional and extension - UGA, UF/IFAS, Clemson, NC State, Auburn, Mississippi State and University of Tennessee Extension apiculture programs.

Chapter 10: Honey Promotion and Judging

Learning Objectives

When you have finished this chapter you should be able to:

- Describe how honey is judged in a show, name the scoring categories and explain what a judge is actually looking at.
 - Prepare an entry for a honey show in the principal classes.
 - Explain the black jar class and what it is for.
 - Describe the sensory vocabulary used to evaluate honey and taste a honey systematically.
 - Position and market a local honey crop honestly and effectively.
 - Explain granulation, rawness, “local honey for allergies” and other customer questions accurately.
 - Plan a farmers market or retail presentation.
 - Speak about honey bees to a school group, garden club or reporter accurately and memorably.
 - Identify the public service opportunities that count toward certification and describe what makes them valuable.
-

10.1 Why Judging Is Worth Learning

Two reasons, and neither is the ribbon.

The first is that **the honey show scorecard is a checklist of everything that can go wrong with a jar of honey**, weighted by how much it matters. Learning it will improve your product whether or not you ever enter a show. A producer who can look at a jar and see what a judge would see is a producer who catches a problem before a customer does.

The second is that honey shows are a **public-facing activity of local associations**, and stewarding, organizing or judging one is a recognized public service contribution. The Journeyman rank expects you to be useful to other beekeepers; running a clean, fair honey show at a county fair is one of the more visible ways of doing it.

10.2 How Extracted Honey Is Judged

Scorecards vary between shows, so **always read the rules for the specific show you are entering**. But the structure is consistent, and the North Carolina State Fair scorecard, widely used and taught in the Southeast, is representative:

Category	Points
Cleanliness (freedom from lint, dirt, wax, foam, air bubbles)	30
Flavor	15
Color and brightness	15
Container appearance	15

Category	Points
Density (moisture content)	10
Absence of granulation / crystallization	10
Uniformity of entries in the class	5
Total	100

Note what this tells you. **Cleanliness is worth nearly a third of the score** — more than flavor and color combined. Honey shows are, to a considerable extent, won and lost on the bench in the honey house rather than in the apiary. The granulation points are a presentation judgment: granulation is natural and not a defect in the honey itself (Chapter 8), but a liquid-honey class is judged as liquid, so a granulated jar loses those points.

Note also that **flavor is worth only 15 points**. This is not because flavor does not matter; it is because the judge is assessing whether the honey is free of off-flavor and fault, not ranking floral types against one another. A superb sourwood and a superb clover are both scored on whether they are clean, characteristic and free of defect.

10.2.1 Automatic disqualification

Moisture above 18.6 percent is typically an automatic disqualification in a honey show. The figure is the same as the US Grade A and B limit (at least 81.4 percent soluble solids) and stricter than the 20 percent allowed for Grade C (Chapter 8): the show is asking for a product that, at 18.6 percent, will typically not ferment in a display case or on a shelf; the fermentation-safe level is lower, about 17–17.5 percent.

Other common automatic disqualifications: an entry in the wrong class, an entry with the producer’s identity visible, an incorrect number of jars, or a jar of a type the class does not permit.

10.2.2 What the judge is actually doing

The judge works methodically and in good light, often with a light box, and typically:

- **Holds the jar to a bright light** and looks through it for suspended particles, foam, air bubbles, lint, wax flecks, crystals and cloudiness.
- **Inverts the jar** slowly to watch what rises and what falls, and to check for a “foam line” at the shoulder.
- **Checks the fill level** — consistent across the entries, and at the level the class specifies.
- **Inspects the lid and jar**: clean, undamaged, correctly seated, no drips or fingerprints, no adhesive residue.
- **Measures moisture** with a refractometer.
- **Reads color** against a Pfund grader or comparator to check the entry is in the correct color class.
- **Tastes**, usually from a fresh spoon per entry, evaluating for characteristic flavor and for defects — fermentation (sour, alcoholic), overheating (caramelized, “cooked”), smoke taint, off-flavors from the floral source or from contamination.
- **Compares the jars against each other** for uniformity, if the class requires multiple jars.

10.2.3 The common defects

Defect	Cause	Prevention
Foam / air bubbles	Insufficient settling time; agitation during bottling	Settle the tank for several days; skim; bottle slowly down the inside of the jar
Lint	Straining through cloth; dusty environment; a wiped jar	Strain through nylon or stainless mesh, never cloth; work in a clean space; do not wipe jars with a linty cloth
Wax flecks	Inadequate straining	Strain and settle
Crystals / incipient granulation (natural and not a quality defect, but a presentation fault in liquid show classes)	Time and temperature; nucleation sites	Gentle warming (under about 140 °F) shortly before the show; fresh honey entered promptly
Cloudiness	Fine particles, air, incipient crystals	Settling and straining
High moisture	Harvesting uncapped honey	Harvest well-capped frames; test individual supers
Sour / alcoholic flavor	Fermentation	Moisture control
Caramelized flavor, darkened color	Overheating	Warm gently and briefly
Smoke taint	Excessive smoke at harvest	Use cool white smoke sparingly
Fingerprints, drips, damaged lids	Careless final handling	Handle with clean hands or gloves; final wipe with a lint-free cloth; fresh lids

Preparing an entry, in practice: select honey from a single well-ripened batch; warm it gently — many judges and exhibitors use a water bath below about 140 °F — to dissolve incipient crystals and let bubbles rise; strain it through fine mesh; settle it and skim; bottle it slowly into brand-new jars with brand-new lids, filling to the specified level; let the jars stand for a day or two so any remaining air rises, and skim or re-fill if needed; wipe the outside with a lint-free cloth; and transport them upright and protected.

10.3 The Classes

Typical honey show classes:

Extracted honey by color class — commonly Light (Water White through Extra White or White), Amber (Extra Light Amber through Light Amber), and Dark (Amber and darker). Read the show's definitions; they vary. Entering in the wrong color class is a routine disqualification.

Chunk honey — a piece of comb in a jar, topped with liquid honey. Judged on the comb's appearance and fit, the clarity of the liquid, and the absence of leakage or crystal.

Cut comb — a square of comb, drained, in a clear container. Judged on uniformity of capping, absence of travel stain, cleanliness of the cut edges, freedom from pollen and brood, and weight.

Section comb / round sections — judged on completeness of filling and capping, evenness, and cleanliness.

Creamed honey — judged on fineness and uniformity of crystal, spreadability, absence of frosting (white patches where the honey has pulled from the glass) and absence of air.

Beeswax — a block or cake, judged on color, cleanliness, uniformity, freedom from cracks and debris, aroma, and the absence of a dirty layer on the underside. See Chapter 11 for rendering technique.

Candles, cosmetics, mead, baked goods, photography, gadgets, frames of honey — most shows have several such classes, and they are a good route into exhibiting for a beekeeper whose honey is not yet show-ready.

10.3.1 The black jar class

The **black jar** (or “blind tasting”) class is judged **on flavor alone**. The honey is presented in an opaque container so that color, clarity, moisture and container appearance are invisible to the judge, who tastes and ranks.

It exists for a reason worth understanding. Every other class rewards processing skill, and processing skill can be bought with equipment and learned in a season. The black jar rewards **the honey itself** — the floral source, the ripening, the freshness, the absence of taint. A beekeeper with a mountain sourwood and a settling tank can beat a beekeeper with a professional bottling line and a mediocre crop.

It is also the class most worth entering if you are trying to learn. A black jar placement tells you that your honey is genuinely good; a first place in the light extracted class tells you that your bottling is good, which is a different and more easily fixed thing.

10.4 Tasting Honey

Sensory evaluation of honey follows a structure familiar from wine and olive oil. It is worth practising because it makes you a better producer and a far better seller.

Look. Color, clarity, brightness, viscosity as it falls from the spoon.

Smell. Warm a small amount in a covered glass or in the hand and then smell it. Aroma families used in honey sensory work include floral, fruity, vegetal, herbaceous, spicy, woody, resinous, animal, caramel/confectionery, and chemical or fermented (the fault group).

Taste. Take a small amount, warm it in the mouth, and attend in sequence to: - **Sweetness** and its intensity - **Acidity** — most honeys have a perceptible acidity - **Bitterness** — present in some varieties legitimately (chestnut, buckwheat) and a fault in others - **Aroma by retronasal route** — the flavors that appear as you exhale - **Persistence** — how long the flavor lasts - **Texture** — smooth, waxy, crystalline

Faults to name: fermentation (sour, yeasty, effervescent), overheating (caramel, cooked, burnt-sugar), smoke, “beekeeper’s taint” from paint, fuel or repellent, and off-flavors carried from particular plants.

Southeastern reference points worth having in your palate: sourwood (light, delicate, with a distinctive spicy-anise character and a notable aftertaste), tupelo (light, mild, buttery, famously non-granulating), gallberry (light amber with body and a mild flavor), tulip poplar (dark reddish amber, strong, with a molasses-like note), gallberry-poplar blends (the common coastal-plain product), and goldenrod (strong, distinctive, sometimes noted as “sock-like” while curing, granulating readily).

Off-flavors you may encounter: **bitterweed** or sneezeweed (*Helenium* spp.), which grows in pastures and disturbed ground and imparts a genuinely bitter flavor; **privet**, which is strongly flavored and not to everyone’s taste; **onion** and certain other alliums; and heavy late-season **goldenrod and aster**, whose odor and flavor limit the table market.

The way to avoid a tainted crop is the same discipline that makes varietal production possible: **know the local bloom sequence, harvest and segregate crops by flow rather than letting honey accumulate through the season in the same supers, and taste each batch before blending or bottling.** Keep strongly flavored honey separate for the baking market or leave it on the colonies as winter stores. The practice pays twice.

10.5 Promotion and Marketing

10.5.1 What you are actually selling

Local honey competes with a commodity product on a supermarket shelf at a fraction of the price. You will not win on price and you should not try. What a small producer sells is:

- **Provenance** — a named place, a named producer, a known floral source.
- **Freshness and minimal processing** — strained and settled, not ultrafiltered, not heated.
- **Varietal character** — sourwood, tupelo, gallberry, tulip poplar, wildflower with a named season.
- **The story of the operation** — accurately told.
- **Access to the producer** — a person who can answer questions.

All of these are true claims that carry no regulatory risk, and all of them are more persuasive than a health claim would be.

10.5.2 Presentation

Label design matters, and it should do three things at once: comply (Chapter 9), identify, and look like something someone would give as a gift. Keep it clean and legible; put the floral source and the place on the front; resist clutter.

Jar choice communicates. Glass reads as premium; plastic reads as economy and travels better. Hex jars, muth jars and skep jars are traditional forms with real recognition value. Consistency across your line matters more than any individual choice.

A range of sizes sells more honey than a single size. Small jars sell as gifts and as trial purchases; large jars sell to people who have already decided.

At a market stall: a clean cloth, honey at two heights, a color range visible side by side, a tasting arrangement if your market permits it (check the rules — many require single-use utensils and a covered sample container), a sign with prices, and a person who makes eye contact. A comb honey display or an observation hive draws a crowd; a jar of honey does not.

10.5.3 Customer questions, answered accurately

“Is this raw?” “Raw” has no federal definition. In common usage it means unheated (or gently warmed only) and not filtered beyond ordinary straining. Say what you actually do — “I strain it and let it settle; I don’t heat it above about a hundred degrees and I don’t filter the pollen out” — rather than leaning on a word that means whatever the customer thinks it means.

“It’s gone solid — has it gone bad?” Granulation is natural, is what pure honey does, and indicates neither spoilage nor adulteration. It can be reliquefied gently in a warm water bath — not a microwave — or used as it is. Offer creamed honey if you make it.

“Does local honey help with allergies?” Handle this one carefully. The honest answer is that the idea is plausible-sounding but poorly supported: the pollens that cause seasonal allergic rhinitis are chiefly **wind-borne** — ragweed, grasses, tree pollens — and those are not the pollens bees collect, which come from insect-pollinated flowers. The small trial evidence is mixed and mostly weak. You may say that many customers report it helps them and that you cannot promise it, and you must not put it on the label, in your signage or on your website, because a claim that a food treats a condition can make it an unapproved drug (Chapter 9). Saying “I can’t make that claim, and here’s why” is more credible than either promising or dismissing.

“Is honey better than sugar?” It is sugar, chemically, with trace enzymes, antioxidants, acids and minerals. It has a lower glycemic index than sucrose in most honeys and a distinctive flavor. Do not oversell it, and do not recommend it to anyone managing diabetes.

“Why is yours darker/lighter than the one I bought last year?” Because it came from different flowers. Explain the bloom sequence. This question is a gift; it is the opening to everything interesting about your operation.

“Do you kill the bees to get the honey?” People do ask. No — the extractor spins the honey out and the comb goes back.

10.6 Public Speaking and Education

A Journeyman beekeeper is expected to be able to speak accurately to non-beekeepers. Several examination items test this directly, and it is where public service credits usually come from.

10.6.1 The core message, accurately

When speaking to a school group, a garden club or a reporter:

- **Separate managed honey bee colony losses from native pollinator conservation.** These are two different problems.

- **Explain that honey bees are managed livestock**, introduced from Europe in the 1620s, and that **colony numbers are held up by beekeepers replacing their losses each year** — at real cost.
- **Describe the real problems:** *Varroa* and the viruses it transmits, poor nutrition in simplified landscapes, pesticide exposure, and disease.
- **Acknowledge the genuine conservation concern for native pollinators** — roughly 4,000 species in North America, mostly solitary, several in documented decline.
- **Give them something to do:** plant a succession of bloom, mow less, use pesticides carefully and at the right time of day, leave bare ground and stems for nesting, buy from local producers.

What not to do: do not say honey bees are going extinct; do not treat managed losses and native declines as a single crisis; do not call for things you cannot support; and do not describe Africanized bees as “killer bees.”

Accuracy is the persuasive choice. Overstating the case invites correction from somebody in the room and undermines your authority on the points that actually matter. The true story — that beekeepers absorb annual losses averaging about forty percent, and more than half in the worst recent years, and rebuild every spring, driven largely by a parasitic mite that arrived in 1987 and the viruses it injects — is more interesting than the exaggeration, and nobody can correct you.

10.6.2 Talking to other beekeepers

A recurring examination scenario: a club member says they do not monitor for mites because their bees look healthy. You have to change that habit without condescension. A version that works:

Bees look healthy right up until they do not. Mites reproduce inside sealed brood where you cannot see them, and their populations grow multiplicatively through the season, so a colony can carry a damaging load with no outward sign. By the time you see deformed wings, crawling bees or a dwindling population, the mite population is near its seasonal peak and the bees that should have carried the colony through winter were already damaged while they were developing. Monitoring costs a few minutes and a cup of bees, and it turns a guess into a number you can compare against a threshold and track over time. Looking at a colony tells you how it is today. A mite count tells you whether it will be alive in February.

Delivering that clearly and kindly is itself an examinable skill, because much of a knowledgeable beekeeper’s value to a local association lies in changing this specific habit.

Similarly, the over-enthusiastic first-year beekeeper who inspects every two days: **redirect the enthusiasm rather than suppressing it**. Explain that frequent opening chills brood in cool weather, disrupts temperature and humidity regulation, breaks seals the bees must repair, sets back comb building and brood rearing, risks injuring the queen, and makes the colony more defensive. Then give them something to do instead: observe entrance activity, watch incoming pollen colors and match them to plants, heft the hive, keep written records, and have a specific question in mind before every inspection so it has a purpose. Roughly every seven to ten days in the active season, in warm calm conditions in the middle of the day.

10.6.3 Public service opportunities

The certification programs recognize, and the community actually needs:

- Educational presentations to non-beekeeping groups — schools, garden clubs, civic organizations, libraries
- Local association leadership and committee work
- Volunteer swarm removal, and maintaining the local swarm call list
- **Mentoring a new beekeeper through a full season** — the single most valuable thing on this list
- Public demonstrations at fairs and festivals, including observation hives
- Supporting youth bee projects — 4-H, FFA, scouts
- Prison and veterans' beekeeping programs
- Establishing pollinator gardens for schools, churches and community organizations
- Stewarding or organizing a honey show
- Serving as a contact point for your state's exotic pest reporting program

Document them as you go. A portfolio assembled the week before an application is a portfolio missing most of what you actually did.

Numbers to Memorize

Item	Figure
Honey show moisture disqualification	above 18.6%
Cleanliness, share of typical scorecard	30 of 100 points
Flavor / color / container	15 each (typical)
Density / granulation	10 each (typical)
Uniformity	5 (typical)
Maximum warming for show prep	below about 140 °F
Black jar class	judged on flavor alone

Key Terms

Black jar class — a blind class judged on flavor alone, in an opaque container.

Frosting — white patches in creamed honey where it has pulled away from the glass; a cosmetic fault.

Travel stain — darkening of comb surfaces from bees walking on them; downgrades comb honey.

Chunk honey — a piece of comb in a jar topped with liquid honey.

Cut comb — a drained square of comb sold in a clear container.

Retronasal — the route by which aroma reaches the olfactory receptors from the mouth; where most “flavor” actually happens.

Pfund grader — the instrument used to classify honey color.

Uniformity — consistency between the multiple jars of a single entry.

Self-Check

- 1. (SA)** Name the categories on a typical extracted honey show scorecard and the approximate points for each. Which is weighted most heavily, and what does that tell a producer?
- 2. (MC)** The black jar class at a honey show is judged on: A) Color and brightness alone B) Flavor alone, the container being opaque C) Moisture content alone D) Container appearance and uniformity
- 3. (SA)** A jar of your honey shows a line of fine foam at the shoulder and a few wax flecks suspended in it. Diagnose and prescribe.
- 4. (SA)** A customer at a farmers market asks whether your local honey will help her seasonal allergies. Draft your reply.
- 5. (MC)** When speaking to a school group about honey bees, a knowledgeable beekeeper should: A) Describe losses without raising Varroa or pesticides, so as not to discourage the audience B) Treat managed honey bee losses and native pollinator declines as a single conservation crisis C) Present the honey bee as the pollinator of most wild plants and call for a pesticide ban D) Give accurate information, separating managed colony losses from native pollinator conservation concerns, explaining that colony numbers are held up by beekeepers replacing their losses, and describing the real problems of Varroa, pesticides, forage and disease
- 6. (SA)** A beekeeper reports that their honey has an unpleasant bitter or weedy off-flavor in some years. Give two plausible botanical explanations relevant to the Southeast and describe how to avoid the problem.

Answers

- 1.** Cleanliness (freedom from lint, dirt, wax, foam and bubbles) 30; flavor 15; color and brightness 15; container appearance 15; density/moisture 10; absence of granulation 10; uniformity of entries 5. **Cleanliness is weighted most heavily** — nearly a third of the score, more than flavor and color combined. It tells a producer that honey shows are largely won on the bench in the honey house: settling, straining, careful bottling and clean new containers matter more than most exhibitors expect. Moisture above 18.6 percent is typically an automatic disqualification regardless of score.
- 2. B.** It rewards the honey itself rather than processing skill, which is why it is the most informative class to enter if you want to know how good your crop actually is.
- 3.** Foam at the shoulder indicates **entrained air that has not been given time to rise**, and wax flecks indicate **inadequate straining**. Remedy: strain through fine nylon or stainless mesh (never cloth, which sheds lint), then settle the honey in a tank for several days and skim the surface before bottling; bottle slowly down the inside of the jar to avoid re-introducing air; and let filled jars stand a day or two so any remaining bubbles rise, skimming or topping up

before the show. Gentle warming below about 140 °F shortly before bottling helps bubbles rise and dissolves incipient crystals.

4. Something like: “A lot of my customers tell me it helps them, and I’m glad when it does — but I can’t promise it, and I’m not allowed to claim it. The honest science is that the pollens that set off hay fever are mostly wind-blown ones — ragweed, grasses, tree pollen — and those aren’t the ones bees collect; bees work insect-pollinated flowers. The few studies are small and mixed. What I can tell you for certain is where it came from and what’s in it: it’s from my hives in [place], mostly [floral source], strained and settled, nothing added and nothing taken out.” The key points are that you neither promise nor dismiss, and that you do not put the claim on the label, on signage or on a website, because an unauthorized disease claim can make the product an unapproved drug and the label misbranded.

5. D.

6. Two plausible causes: **bitterweed or sneezeweed** (*Helenium* spp.), which grows in pastures and disturbed ground and imparts a genuinely bitter flavor; and honey from strongly flavored sources such as **privet**, or a late-season **goldenrod and aster** crop, both of which have distinctive odors and flavors that many buyers dislike. Onion and certain other sources can also taint a crop. To avoid it: know the local bloom sequence; harvest and segregate crops by flow rather than accumulating honey through the season in the same supers; and taste each batch before blending or bottling, keeping strongly flavored honey separate for the baking market or leaving it on the colonies as winter stores. The same discipline is what makes varietal production possible, so it pays twice.

References for Further Study

Judging and showing - Eastern Apicultural Society, honey show resources and judging criteria: easternapiculture.org - NC State Extension / WNC Bees, *Judging Liquid (Extracted) Honey* - Texas Beekeepers Association and Metro Atlanta Beekeepers Association honey show rules — useful examples of current regional practice - Grafton, J. & Thompson, J., *Honey Judging Course* materials (Maryland State Beekeepers Association) - Bee Culture magazine, *Honey Shows* and *Planning a Honey Show*

Sensory evaluation - Piana, M. L. et al. “Sensory analysis applied to honey: state of the art.” *Apidologie* 35:S26–S37 (2004). - Italian National Register of Experts in the Sensory Analysis of Honey — the reference methodology.

Marketing and public education - Graham, J. (ed.) *The Hive and the Honey Bee*. Dadant, 2015. Marketing chapters. - US Beekeeping Survey annual colony loss results (Auburn University, Oregon State University and Apiary Inspectors of America; formerly the Bee Informed Partnership): apiaryinspectors.org — the source for accurate loss figures. - Xerces Society and Pollinator Partnership materials on native pollinator conservation.

Regulatory - US FDA, *Guidance for Industry: Proper Labeling of Honey and Honey Products* (2018), and 21 U.S.C. 343(r) on health claims.

Chapter 11: Hive Products Beyond Honey

Learning Objectives

When you have finished this chapter you should be able to:

- State the melting point of beeswax and explain why it matters in two different ways.
 - Describe two methods of rendering beeswax and list the errors that spoil the product.
 - Explain why cappings wax is more valuable than wax from old brood comb.
 - Explain the residue problem in beeswax and its consequences for the foundation supply chain.
 - Describe what propolis is, how a propolis trap works, and why trapped propolis is cleaner than scraped.
 - Operate a pollen trap and handle the product correctly.
 - Describe royal jelly production and storage requirements.
 - Describe how bee venom is collected and the hazards involved.
 - State the considerations a beekeeper must address before selling wax products or cosmetics.
-

11.1 Beeswax

11.1.1 What it is

Beeswax is secreted by four pairs of glands on the **ventral surface of abdominal sterna 4 through 7** of worker bees, chiefly during roughly the second and third weeks of adult life (Chapter 3). It emerges as small transparent scales on the wax mirrors, is collected by the bee with her legs, chewed and worked with mandibular gland secretions, and built into comb.

Chemically it is a complex mixture of long-chain esters, free fatty acids, hydrocarbons and alcohols. It is **lipophilic** — fat-soluble — and that single property drives most of the residue story below.

11.1.2 Melting point

Beeswax melts at approximately 144 to 149 °F (about 62 to 65 °C).

This number matters twice.

In the honey house: wax is flammable. Its flash point is far above its 144–149 °F melting point, but direct heat overshoots easily and a pot of overheated wax can ignite, so wax must **never** be melted over direct heat. Use a double boiler, a solar melter, or a steam or hot-water system.

In the apiary and on the road: comb softens well below its melting point, and hives can suffer catastrophic **comb collapse** in extreme heat. The classic disaster is a load of bees in a closed vehicle during a summer move in the Southeast, where interior temperatures readily

exceed the softening point and the combs let go. Move bees at night or in cool weather, with ventilation, and never leave a closed vehicle full of bees standing in the sun.

11.1.3 The cost of wax

A colony expends something on the order of **6 to 8 pounds of honey per pound of beeswax**, and considerably higher figures are defensible depending on how the metabolic cost of maintaining comb-building temperature is accounted for. The uncertainty in published estimates does not affect the management conclusion:

Drawn comb represents a real cost charged against the honey crop. Protecting it from wax moth, beetles, mice and careless handling is worth genuine effort, and a beekeeper who has drawn comb begins each spring with a substantial head start.

11.1.4 Rendering

Method 1: the solar wax melter. A glazed, insulated box, tilted toward the sun, with a metal tray inside that channels melted wax through a strainer into a collecting pan. Excellent in the Southeast, where sun is abundant.

- *Advantages:* no fuel cost, no fire risk, very clean product from cappings and light comb, minimal labor.
- *Disadvantages:* leaves a good deal of wax behind in the slumgum; depends on weather; limited throughput; not suited to dark brood comb.

Method 2: steam or hot-water rendering. Comb is melted in or over hot water. The wax floats, and on cooling forms a cake above the water with the debris settling at the interface.

- *Advantages:* handles larger quantities and darker comb; much better recovery; works in any weather.
- *Disadvantages:* more equipment, more labor, fire and scald risk, and a mess.

Steam wax presses and commercial spinners extend the same principle for larger operations.

The errors that spoil the product:

Error	Consequence
Overheating	Darkens and degrades the wax; destroys aroma; fire risk
Using iron, copper or brass vessels	Discolors wax — iron greys it, copper and brass green it. Use stainless steel, aluminum or plastic
Failing to filter	Slumgum and debris in the block
Cooling too quickly	Traps debris and water; cracks the block
Failing to scrape the dirty underside of the cooled cake	A layer of fine debris that spoils the appearance and contaminates the next melt
Using hard water	Minerals affect color and can emulsify; rainwater or distilled water gives a better block

For a show-quality block: render, let it cool slowly in a clean mold, scrape the underside, and re-melt and re-filter once or twice more through progressively finer material.

11.1.5 Cappings versus brood comb wax

Cappings wax is generally more valuable than wax rendered from old brood comb, and the examination asks why.

Cappings wax is newly secreted by the bees to seal ripened honey and has **never been used for brood rearing**. It is pale, clean, and free of the cocoons, larval faeces, propolis and accumulated debris that darken brood comb. It also carries **substantially lower residues** of miticides and other lipophilic pesticides, which accumulate in comb over years of use.

It therefore renders to a light, clean block suitable for the **highest-value uses**: comb honey foundation, cosmetics, fine candles and show entries. Dark brood comb wax is better suited to lower-value applications.

The practical consequence: keep cappings separate from the start of extraction rather than mixing all wax together. It is a small discipline with a substantial return.

11.1.6 The residue problem

Beeswax is lipophilic and accumulates residues of miticides and other pesticides. Surveys of United States wax have found miticide residues — particularly of the older synthetic products, coumaphos and tau-fluvalinate — among the most frequent and most concentrated contaminants (Mullin et al., 2010).

And here is the part that matters beyond your own operation: **commercial foundation is made from recycled wax**. Residues therefore circulate through the supply chain, from one beekeeper's colonies into another's foundation. A beekeeper who has never applied a synthetic acaricide can be giving their colonies foundation that carries one.

The consequences are several:

- **Cull old brood comb on a regular rotation** — commonly about 20 percent per year, so that no comb stays in use more than about five years (Chapter 15).
- **Render and keep cappings wax separate** for high-value uses.
- **Queen producers in particular** should consider residue-tested or cappings-derived foundation, since sublethal effects of wax residues on queen and drone development are documented.
- **Anyone selling comb honey** must consider the wax, because the wax is eaten.

It is also a useful corrective to a common framing. The residues most reliably found in a hive are usually the ones **the beekeeper put there**. That does not make agricultural pesticide exposure unimportant; it does mean a beekeeper discussing residues should include their own miticides in the accounting.

11.2 Propolis

11.2.1 What it is

Propolis is plant resin, gathered by bees from buds, leaf scars and wounds, worked with wax and glandular enzymes. It is **not** a glandular secretion and it is not made from wax.

Its functions in the nest:

- **Sealing cracks** and reducing the entrance to a defensible size
- **Smoothing and varnishing** interior surfaces
- **Entombing intruders** too large to remove — a mouse or a lizard is propolized over, preventing decay
- **Antimicrobial protection** of the nest environment

The modern view of propolis is markedly more favorable than the older one that treated it as an inconvenience. There is good evidence that a propolis envelope reduces the individual immune investment colonies must make and improves colony health (Simone-Finstrom & Spivak, 2010). Some beekeepers now deliberately encourage it by using rough-textured interior surfaces.

Because propolis is derived from **local plant resins**, its **chemistry varies by region and season**, which matters to anyone marketing it. In the Southeast, sweetgum, pine and poplar are among the common sources. Colonies also vary genetically in how heavily they propolize — a Caucasian-derived colony will glue everything, and an Italian colony rather less.

11.2.2 Propolis traps

A **propolis trap** is a flexible plastic mesh or slotted screen placed above the brood nest under the cover, often with a small gap admitting light. The bees, responding to the gaps as openings that need sealing, fill the mesh with propolis.

To harvest: remove the trap, **chill or freeze it**, which makes the propolis brittle, then flex the mat so the propolis cracks out cleanly in small pieces.

Why the product is cleaner than scraped propolis: it contains no wood fragments, paint chips, wax or hive debris, all of which scraping from frames, boxes and covers inevitably includes and which must otherwise be removed by laborious cleaning or by solvent extraction.

Two cautions. Propolis intended for human products should be collected from colonies whose **treatment history is known**, since propolis is lipophilic and can carry pesticide residues just as wax does. And the trap material should be **food grade**.

11.3 Pollen

11.3.1 Trapping

A **pollen trap** fits at or near the entrance and incorporates a grid or screen through which returning foragers must squeeze, knocking the pollen loads off their corbiculae into a collecting drawer below. Designs mount at the entrance, under the bottom board, or between boxes.

Trapping efficiency varies with design and setting, and it is deliberately imperfect: a trap that removed every load would starve the colony.

11.3.2 Handling

Trapped pollen must be handled promptly, and in the humid Southeastern summer this is a matter of **hours, not days**.

The reason is straightforward: pollen in the trap has **substantial moisture and a natural microbial load**, and it has none of the protection that beebread acquires in the hive. Beebread is preserved by lactic acid fermentation that lowers its pH, together with added sugar and reduced oxygen in a packed cell (Chapter 5). Pollen removed from the hive has none of that and will **mould or ferment within hours in warm weather**.

Standard handling:

- **Empty traps at least daily** — twice daily in hot humid weather.
- **Remove debris and dead bees** by screening or winnowing.
- **Freeze immediately**, or **dry** at a temperature low enough to preserve quality, generally **under about 110 °F**, to a moisture content that will not support mould.
- Store frozen or in sealed containers away from light.

11.3.3 The cost to the colony

Trapping removes pollen the colony needs. Traps should be operated **intermittently** — commonly a few days on and several off — and **never on colonies already under nutritional stress**. Do not trap a colony you are also trying to build, do not trap during a pollen dearth, and do not trap a colony rearing queens.

A further Southeastern caution: a pollen trap creates a restriction at the entrance and a drawer full of protein. Both are of interest to small hive beetles. Traps need the same vigilance as protein patties.

11.4 Royal Jelly

Royal jelly is produced by the hypopharyngeal and mandibular glands of nurse bees. It is the food fed to all young larvae and, in far greater quantity and throughout larval life, to queen larvae.

Commercial harvest is from queen cells started with **grafted larvae**, using a queen rearing system (Chapter 14). Cells are harvested at roughly **72 hours** after grafting, before the larva has consumed the jelly; the larva is removed and the jelly is drawn out with a small spatula or vacuum device.

Storage is the examinable point. Royal jelly is **highly perishable**. It requires **refrigeration for short periods or freezing for longer**, with protection from light and air. Its quality markers — notably **10-HDA** (10-hydroxy-2-decenoic acid) and freshness indicators — decline measurably with warmth and time. The product goes into cold storage **immediately** after harvest.

A commonly examined false statement holds that royal jelly keeps well at room temperature for a year or more if protected from light. It does not.

Royal jelly production is labor-intensive and not a significant enterprise for most American beekeepers, but the biology matters: the same grafting skill and the same cell-builder colonies produce queens, and understanding jelly production is part of understanding queen quality.

11.5 Bee Venom

Collection method: an **electrically charged collecting frame with a glass surface** is placed at the hive. A mild intermittent current stimulates bees landing on it to sting the glass. Because the smooth glass does not grip the barbs as elastic skin does, **the bee withdraws her sting and survives**. The venom dries on the glass and is later scraped off as a powder.

Distractors on this item usually involve bees losing their stings in a latex membrane, or bees being chilled and squeezed individually. Neither is the standard method.

The hazards are real and worth stating:

- The practice makes colonies **markedly more defensive for a period** afterward, because the entire apiary is dosed with alarm pheromone. Do not do it near the public, near neighbors, or where colony temperament matters.
- **Dried venom powder is a serious respiratory and anaphylaxis hazard to the operator.** It is a potent allergen in a form that becomes airborne. Appropriate respiratory protection, eye protection and gloves are required, and anyone with known sensitivity should not do it at all.

11.6 Selling Wax Products and Cosmetics

Suppose a beekeeper wants to make and sell **beeswax candles and lip balm**. The considerations, before anything is sold:

Product classification and labeling. - **Candles** are consumer products with their own safety expectations: wick and container safety, burn warnings, and net contents. - **Lip balm is a cosmetic** and is labeled accordingly: ingredient declaration in descending order using standard (INCI) nomenclature, net contents, and the name and place of business of the manufacturer, packer or distributor. - **A cosmetic that makes a therapeutic claim may be regulated as a drug.** “Soothes chapped lips” is generally acceptable cosmetic language; “heals cold sores” is a drug claim. The same principle as honey health claims (Chapter 9).

Product integrity. - The wax should be **clean, well filtered and of known residue status**. Wax concentrates lipophilic pesticide residues, and a product applied to the lips deserves **cappings wax** rather than dark brood comb wax. This is the point beekeepers most often overlook, and it argues strongly for segregating cappings at the rendering stage.

Production practice. - Clean equipment; controlled melting temperatures; consistent formulation; sanitary handling of anything applied to skin.

Business matters. - **Liability insurance.** - **Lot coding** for traceability. - Applicable **state and local requirements** for cosmetic manufacture or home-based businesses. - For candles: appropriate **safety warnings**.

11.7 Hive Products and Treatment History

The general principle, and a directly examined one:

Wax, propolis and pollen concentrate lipophilic compounds far more than honey does. Honey is largely aqueous and carries comparatively few lipophilic residues; wax and propolis are the opposite. **Rendering at high temperature and drying do not remove residues.**

Therefore **a producer selling those products should know, and be able to state, the treatment history of the colonies behind them.**

This has planning consequences. A beekeeper who intends to sell wax for cosmetics, comb honey, or propolis for human use should design their treatment program with that in mind — favoring products with favorable residue behavior, keeping cappings separate, culling comb on schedule, and **keeping the records** that let them answer the question when a buyer asks.

Numbers to Memorize

Item	Figure
Beeswax melting point	144–149 °F (62–65 °C)
Honey per pound of wax	about 6–8 lb, commonly cited; often more
Wax gland location	ventral abdomen, sterna 4–7 (4 pairs)
Wax gland peak activity	about 12–18 days of adult age
Royal jelly harvest	about 72 hours after grafting
Pollen drying temperature	under about 110 °F
Pollen trap emptying	at least daily; twice daily in heat
Comb rotation	about 20% per year; nothing over about 5 years

Key Terms

Slumgum — the dark residue of cocoons, propolis and debris left after rendering wax.

Cappings wax — newly secreted wax from honey cappings; pale, clean, low-residue, most valuable.

Solar wax melter — glazed insulated box rendering wax by sunlight.

Lipophilic — fat-soluble; the property by which wax and propolis concentrate pesticide residues.

Propolis trap — flexible mesh the bees fill with propolis, harvested by chilling and flexing.

Corbicula — the pollen basket; what a pollen trap knocks the load from.

10-HDA — 10-hydroxy-2-decenoic acid, a marker compound and freshness index for royal jelly.

INCI — International Nomenclature of Cosmetic Ingredients, the naming system required on cosmetic labels.

Self-Check

- 1. (MC)** Beeswax melts at approximately: A) 118–124 °F B) 160–168 °F C) 144–149 °F (62–65 °C) D) 185–190 °F
- 2. (SA)** Describe two methods of rendering beeswax and list the errors that most commonly spoil the finished product.
- 3. (SA)** Explain why cappings wax is generally more valuable than wax rendered from old brood comb.
- 4. (TF)** Beeswax is lipophilic and accumulates residues of miticides and other pesticides, and because commercial foundation is made from recycled wax, residues can circulate from one beekeeper's colonies into another's foundation.
- 5. (MC)** Propolis is: A) A wax secreted by the abdominal glands of young workers, softened with resin B) Plant resin gathered from buds and wounds, worked with wax and enzymes, used to seal cracks, smooth surfaces, entomb intruders and give antimicrobial protection C) A glandular secretion of nurse bees blended with pollen D) Pollen packed into cells with nectar and soured by lactic acid bacteria
- 6. (SA)** Describe how a propolis trap works and why the product is cleaner than scraped propolis.
- 7. (MC)** Pollen collected in a pollen trap must be handled promptly because: A) It carries substantial moisture and a natural microbial load and will mould or ferment within hours in warm weather B) Its pigments oxidize within hours of collection C) It draws humidity and cements into lumps D) Foragers chew through the grid once the drawer fills
- 8. (TF)** Royal jelly keeps well at room temperature for a year or more provided it is protected from light.
- 9. (SA)** A beekeeper wants to make and sell beeswax candles and lip balm. List the considerations they should address before selling.

Answers

- 1. C.** The figure matters because wax must never be melted over direct heat — use a double boiler, solar melter or steam/hot-water system — and because comb softens well below its melting point, which is why a closed vehicle in a Southeastern summer can cause catastrophic comb collapse during a move.
- 2. *Solar wax melter*** — a glazed insulated box that melts wax by direct sunlight into a collecting pan; well suited to the Southeast, produces clean wax from cappings and light comb with no fuel cost, but leaves wax behind in the slumgum and depends on weather. *Steam or hot-water rendering* — comb melted in or over hot water so the wax floats and solidifies as a cake above the water; handles larger quantities and darker comb with better recovery. **Common errors:**

overheating, which darkens and degrades the wax; using iron, copper or brass vessels, which discolor it (use stainless steel, aluminum or plastic); failing to filter, leaving slumgum in the block; cooling too quickly, which traps debris and water; and failing to scrape the dirty layer from the underside of the cooled cake.

3. Cappings wax is newly secreted by the bees to seal ripened honey and has never been used for brood rearing, so it is pale, clean and free of the cocoons, larval faeces, propolis and accumulated debris that darken brood comb. It also carries substantially lower residues of miticides and other lipophilic pesticides, which accumulate in comb over years of use. It therefore renders to a light, clean block suitable for the highest-value uses — comb honey foundation, cosmetics, fine candles and show entries — whereas dark brood comb wax suits lower-value applications. The practical consequence is to keep cappings separate from the start of extraction.

4. True.

5. B.

6. A propolis trap is a flexible plastic mesh or slotted screen placed above the brood nest under the cover, often with a small gap admitting light. The bees, treating the gaps as openings to be sealed, fill the mesh with propolis. The trap is then removed and chilled or frozen, which makes the propolis brittle so it can be flexed out cleanly in small pieces. The product is cleaner than scraped propolis because it contains no wood fragments, paint chips, wax or hive debris, which scraping from frames, boxes and covers inevitably includes. Propolis for human products should come from colonies of known treatment history, since it is lipophilic and can carry residues, and the trap material should be food grade.

7. A. In the humid Southeastern summer this is a matter of hours. Empty traps at least daily, remove debris and dead bees, and freeze or dry at under about 110 °F at once. Trapping also removes pollen the colony needs, so traps should be operated intermittently and never on colonies under nutritional stress.

8. False. Royal jelly is highly perishable and requires refrigeration for short periods or freezing for longer, protected from light and air; its quality markers, notably 10-HDA, decline measurably with warmth and time. Harvest is from grafted queen cells at roughly 72 hours, and the product goes into cold storage immediately.

9. Classification and labeling: candles are consumer products with their own safety expectations and warnings; lip balm is a cosmetic requiring ingredient labeling, net contents and producer identification, and therapeutic claims must be avoided or the product may be regulated as a drug. *Product integrity:* the wax should be clean, well filtered and of known residue status — wax concentrates lipophilic pesticide residues, and a product applied to the lips deserves cappings wax rather than dark brood comb wax. *Production practice:* clean equipment, controlled melting temperatures, consistent formulation. *Business:* liability insurance, lot coding for traceability, and applicable state and local requirements for cosmetic manufacture or home-based businesses. *Safety:* candle wick and container safety and appropriate warnings.

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Chapter 12: Pollination

Learning Objectives

When you have finished this chapter you should be able to:

- Describe the parts of a flower and the mechanics of pollination, at the level required for a practical identification exercise.
 - Distinguish self-pollination, cross-pollination and the crops that require a pollinizer.
 - Explain why honey bees are the dominant managed pollinator despite not being the most efficient pollinator of every crop.
 - Assess and grade colonies for pollination by frame strength and explain why strength rather than count is what a grower is buying.
 - Write the essential terms of a pollination contract.
 - Advise on stocking rates for Southeastern crops, particularly cucurbits and blueberries.
 - Explain when colonies should be moved into a crop and why.
 - Explain the beekeeper's protections against pesticide loss on a pollination contract.
 - Explain the difference between a colony's honey production potential and its pollination value, and the choices that follow.
 - Explain the roles of native and non-*Apis* pollinators in Southeastern crops.
-

12.1 Flower Biology

The practical examination at this level typically includes labeling the parts of a flower, and the vocabulary is also the vocabulary of every conversation you will have with a grower.

The male part, collectively the androecium: - **Stamen** — the male organ, comprising: - **Anther** — produces and holds pollen - **Filament** — the stalk supporting the anther

The female part, collectively the gynoecium or pistil: - **Stigma** — the receptive surface that receives pollen; often sticky or feathery - **Style** — the stalk connecting stigma to ovary, through which the pollen tube grows - **Ovary** — contains the ovules; becomes the fruit - **Ovule** — becomes the seed after fertilization

The surrounding structures: - **Petals**, collectively the **corolla** — usually the advertising apparatus - **Sepals**, collectively the **calyx** — protect the bud - **Receptacle** — the base to which the parts attach - **Peduncle / pedicel** — the flower stalk - **Nectary** — the nectar-secreting gland, usually at the base of the corolla; see also extrafloral nectaries, §20.2.4

The sequence. A bee visiting for nectar or pollen brushes against the anthers, picks up pollen on her branched body hairs, and deposits some of it on the stigma of the next flower. The pollen grain germinates on the stigma and grows a **pollen tube** down the style to the ovary, where fertilization occurs. Fertilization produces seed; the developing seeds produce hormones that drive fruit development.

Two consequences that growers care about:

- **Fruit set and fruit shape depend on the number of ovules fertilized.** A partly pollinated cucurbit produces a misshapen fruit — a bottle-necked cucumber, a lopsided melon — because the unfertilized end fails to develop. That is why cucurbit pollination requires **multiple bee visits per flower**, not merely one.
- **Seed count affects size and shelf life** in several crops, so pollination quality shows up in the grade-out, not only in the yield.

Flower types worth knowing: - **Perfect** — both stamens and pistil in the same flower (most flowers). - **Imperfect** — staminate (male) or pistillate (female) only. Cucurbits are imperfect and **monoecious** (both sexes on the same plant), which is precisely why they need a pollinator to move pollen between flowers. - **Dioecious** — male and female flowers on separate plants: holly, and kiwifruit. - **Self-fertile / self-incompatible** — whether a plant's own pollen can fertilize its ovules.

12.2 Self-Pollination, Cross-Pollination and Pollenizers

Self-pollination transfers pollen within a flower or between flowers on the same plant. Many crops set at least some fruit this way.

Cross-pollination transfers pollen between genetically distinct plants. Many crops set better fruit this way even when self-fertile, and some are **self-incompatible** and set nothing without it.

A **pollenizer** is the plant supplying the pollen; a **pollinator** is the animal moving it. Growers and beekeepers confuse these terms constantly, and getting them right marks you out.

The classic Southeastern cases:

- **Rabbiteye blueberry** requires cross-pollination between compatible cultivars; a solid block of one cultivar sets poorly. The grower must interplant pollenizer rows.
- **Seedless (triploid) watermelon** produces no viable pollen of its own. A **diploid pollenizer** variety must be interplanted, and the bee must move pollen from the pollenizer to the triploid. This roughly doubles the pollination demand and is why stocking rates for seedless melons run at the high end.
- **Apples, pears, most plums, many cherries** require compatible pollenizer varieties.

12.3 Why Honey Bees

Honey bees are not the most efficient pollinator of every crop — often they are not the most efficient of any given crop. They dominate managed pollination for reasons of **logistics**, not efficiency:

- **They can be moved** in large numbers, on trucks, on demand.
- **They are perennial**, so a colony is available at any season.
- **They are populous** — a strong colony deploys tens of thousands of foragers, which no solitary bee species can match per unit.
- **They are generalists**, working almost any crop.
- **They are manageable** — you can build a colony to strength for a target date.
- **They pay for part of their own keep** through honey.

Their limitations are equally real and you should be able to state them: they do not **buzz-pollinate** (Chapter 4); they work in a narrower temperature and weather window than bumble bees; they are strongly attracted to competing bloom; and they will abandon an unattractive crop for something better within flight range.

12.4 Colony Strength and Assessment

Colonies used for pollination of Southeastern crops — blueberries, watermelons, cucumbers, squash — are typically assessed by *frame strength*: the number of frames covered with bees, graded under agreed conditions and written into the contract.

The reason is simple and worth being able to state cleanly: **foraging force scales with adult population**. Fewer strong colonies deliver more pollination than many weak ones. That is why contracts set a **strength standard**, not merely a colony count, and why a beekeeper who cannot meet the standard should renegotiate rather than deliver substandard colonies.

Common alternatives are inferior and appear as examination distractors: - **Brood area** is a leading indicator of future foragers, not of current ones. - **Forager traffic at the entrance** varies enormously with weather, time of day and what else is in bloom. - **Gross hive weight** measures stores and equipment as much as bees.

Assessment conditions matter, and should be specified in the contract. Colonies graded in the middle of a warm day, with the field force out flying, will grade lower than the same colonies graded at dawn or in cool weather. “Eight frames of bees, graded at or before 8 a.m. or at below 55 °F” is a meaningful standard; “eight frames of bees” alone is an argument waiting to happen.

Grading is done by lifting the cover and counting the interframe spaces occupied by bees, or by pulling frames and counting those covered on both sides, depending on the convention agreed. Agree the convention in advance.

12.5 The Pollination Contract

A contract should specify:

Term	Detail
Colony strength standard	Frames of bees; how and when graded ; who grades; what happens if colonies fall short
Number of colonies	And drop-site distribution
Delivery and removal dates	Keyed to bloom stage, with a mechanism for the grower to call them in
Placement	Where in the field, access, ground conditions, whether the beekeeper can drive to the drops
Price and payment terms	Per colony; when due; deposit

Term	Detail
Pesticide notification and application timing	The most important clause, and the one most often omitted — see §12.8
Access	The beekeeper's right to enter to inspect, feed or remove colonies
Water	Whether a source is available
Liability and insurance	Both directions
Security	Vandalism, theft, livestock

The pesticide clause is the provision most often left out and most often regretted. It should require advance notification of any application, specify the notice period, require disclosure of what is being applied including tank-mix partners, and preserve the beekeeper's right to move colonies.

12.6 Stocking Rates and Southeastern Crops

There is no universal number. What determines the rate:

- The crop and cultivar, and whether a **pollenizer** is required
- Field size and shape, and whether colonies can be distributed in **multiple drop sites** rather than concentrated at one edge
- **Competing bloom** in the surrounding landscape
- Presence of other managed or wild pollinators
- Weather during bloom and the length of the bloom window
- Colony strength

General guidance for the principal Southeastern crops. The “average” column gives the averages of published recommendations compiled by the University of Georgia Bee Program; the practical ranges reflect common extension advice.

Crop	Average recommendation	Practical range	Notes
Watermelon (seeded)	1.3 colonies/acre	about 1–2	
Watermelon (seedless, triploid)	—	about 1.5–2 or more	Requires a diploid pollenizer; higher demand
Cucumber	2.1 colonies/acre	about 1–3	Pickling cucumbers (dense plantings) often higher
Cantaloupe	2.4 colonies/acre	about 1–3	
Squash, pumpkin	1 colony/acre	about 1	Squash bees do much of the work unrecognized

Crop	Average recommendation	Practical range	Notes
Blueberry (rabbiteye and highbush)	4 colonies/acre	about 2–5	Often combined with bumble bees and native habitat
Apple	1.2 colonies/acre	about 1–2	
Peach	—	often none rented	Most peach varieties are self-fertile

Worked example. A watermelon grower in south Georgia asks how many colonies to place on a 40-acre field.

What you need to know: the variety, and whether **seedless triploid** melons are being grown, which require a pollenizer variety and generally higher bee density; the field layout and block size, since large blocks need colonies distributed in multiple drop sites; the surrounding landscape and competing bloom; the presence of other managed or wild pollinators; and the grower's pesticide program during bloom.

General guidance: watermelon takes on the order of **one to two strong colonies per acre** (published recommendations average about 1.3), with seedless watermelon at the higher end, so a 40-acre field might take roughly **40 to 80 colonies** distributed across the field.

The point that matters most: **cucurbit flowers are open for a single morning** and require **multiple bee visits** for well-shaped fruit. Timing colonies to bloom and distributing them through the field therefore matter more than raw colony count. Forty colonies well distributed will out-perform sixty stacked at the field edge.

The contract should specify colony strength, placement, dates and pesticide notification.

12.6.1 Blueberry and the mixed-pollinator answer

Rabbiteye blueberry is the Southeastern crop where a beekeeper should be able to give a nuanced answer. Honey bees do not buzz-pollinate, and blueberry pollen is held in **poricidal anthers**. The bees still help — they move pollen, they visit in enormous numbers, and high stocking rates compensate for lower per-visit efficiency — but they are part of a mix.

Georgia growers typically combine: - High honey bee stocking rates - Managed or native **bumble bees** (*Bombus impatiens* is reared commercially) - Habitat supporting the **southeastern blueberry bee**, *Habropoda laboriosa*, a ground-nesting spring specialist tightly synchronized with blueberry bloom - Interplanted compatible **pollenizer cultivars**

A beekeeper offering pollination services should understand where honey bees excel and where they are a supplement rather than the whole answer. Saying so builds credibility with a grower who already knows it.

12.7 Timing and Placement

12.7.1 When to move colonies in

Colonies are usually moved into a crop at the beginning of bloom rather than well before it.

The reason: **bees set out early establish on competing forage nearby and keep working it**, whereas colonies arriving as the crop opens orient onto the most abundant resource at hand. Foragers are conservative; once a field force has learned a resource and is recruiting to it, the colony is slow to switch.

In practice, delivery is timed to roughly **5 to 25 percent bloom** as a compromise, allowing the colonies a short settling period without giving them time to fix on something else.

Exceptions: a crop that is overwhelmingly the dominant forage with no significant competitor; and a site where access becomes impossible later — a field that will be too wet to drive on, or a block that will be under a spray program.

12.7.2 Placement within the field

- **Distribute colonies in multiple drop sites** rather than concentrating them at one edge. Bee density falls off with distance from the drop, and the far corner of a large block will be under-visited.
- Place drops on **firm, accessible ground** where you can get a truck in at night.
- Face entrances away from field roads and work areas.
- Consider **windbreaks** and morning sun.
- Provide or confirm **water**; a field of irrigated melons is not a water source a bee can use safely.

12.8 Pesticides on a Pollination Contract

The beekeeper's principal protections against pesticide loss are:

1. **A written contract setting out pesticide notification and application timing.**
2. **Direct contact with both the grower and the applicator** — the custom applicator is often not the grower, and the grower may not know the schedule.
3. **Knowledge of the spray program** — what, when, and what tank-mix partners.
4. **The ability to move colonies** on short notice.

Beyond the contract, **register apiary locations** with any state or voluntary mapping registry that applicators consult (Chapter 13), and build a working relationship with the grower rather than relying on the contract alone. Enforcement after a loss is slow, uncertain and adversarial; a phone call two days before an application prevents the loss entirely.

Ask about tank mixes specifically. Some fungicides, though of low direct toxicity to bees, substantially increase the toxicity of certain insecticides and in-hive miticides by inhibiting the enzyme systems bees use to detoxify them (Chapter 13). Bloom-time fungicide applications on blueberries and cucurbits are a legitimate topic of conversation with a grower, and one many growers have not considered.

What to advise a grower planning an application near your colonies:

- Follow the label's **pollinator protection statements** — these are enforceable label language, not advisory courtesy.
- **Apply in the evening or at night** when bees are not foraging.
- **Choose a lower-toxicity, shorter-residual product** where the options exist.
- **Keep drift off flowering margins and off open water.**
- **Disclose any tank mix**, including fungicides.
- **Give advance notice** so colonies can be moved or protected.

Note that “apply at midday when the foragers are visible and can be worked around” and “notify the beekeeper after the application” are both wrong, and both appear as examination distractors.

12.9 Honey Production Versus Pollination Value

These are different things and a beekeeper may have to choose between them.

Honey production requires a colony to be at maximum foraging strength during a nectar flow, with ample storage space and minimal disruption, in a location with a heavy nectar source.

Pollination requires a colony to be strong and actively foraging — often for **pollen** — during a specific crop's bloom, often at a different time and in a different place. It involves moving colonies, exposure to pesticides, and forage that may yield little or no surplus. Many pollinated crops are poor honey plants.

The conflict arises because:

- Moving colonies to a contract can mean **missing the local honey flow**.
- Moving **stresses colonies**, and repeated moves compound it.
- Building for an **early contract** may not align with building for a **later flow**.
- Pollination pays reliably; honey pays variably. Which matters more depends on your operation.

The classic Southeastern conflicts:

- An early **blueberry** contract in south Georgia (March–April) against the **tulip poplar and blackberry** flow (April–May).
- A **cucurbit** contract (May–June) against the **gallberry** flow on the coastal plain.
- Chasing pollination income generally against producing a premium varietal such as **sourwood** (late June–July) or **tupelo** (late April–May), both of which demand that the colonies be in a specific place with clean supers at a specific time.

There is no correct answer; there is a decision, and the examination wants to see that you understand what is being traded.

12.10 Native and Non-*Apis* Pollinators in the Southeast

Covered in detail in Chapter 4; summarized here in its pollination-services context.

- **Bumble bees** (*Bombus* spp.) — buzz-pollinate, fly in cooler and poorer weather, longer tongues. *B. impatiens* is reared commercially for greenhouse tomato and for supplementing field crops.
- **Southeastern blueberry bee** (*Habropoda laboriosa*) — a solitary ground-nesting specialist of rabbiteye blueberry, buzz-pollinating and tightly synchronized with bloom.
- **Squash bees** (*Eucera* (*Peponapis*) *pruinosa*) — cucurbit specialists that fly before dawn and finish before honey bees start; they do a substantial share of cucurbit pollination unrecognized, and they nest in the ground in the field, so tillage practice affects them.
- **Mason bees** (*Osmia* spp.) — efficient early orchard pollinators.
- **Carpenter bees** (*Xylocopa virginica*) — frequent **nectar robbers**, slitting long corollas at the base; their pollination value on some crops is limited by this.

A beekeeper who can talk about these accurately is more useful to a grower and more credible to a conservation-minded audience.

Numbers to Memorize

Item	Figure
Timing of delivery to a crop	about 5–25% bloom
Watermelon (seeded / seedless)	about 1.3 average / about 1.5–2+ colonies per acre
Cucumber / cantaloupe	about 2.1 / about 2.4 colonies per acre (averages)
Blueberry (rabbiteye, highbush)	about 4 colonies per acre (average; range about 2–5)
Cucurbit flower	open for a single morning ; needs multiple visits
Colony assessment	frames of bees, graded at agreed conditions
Foraging range	1–2 miles typical; up to 4–5+

Key Terms

Anther / filament / stamen — pollen-bearing organ, its stalk, and the two together.

Stigma / style / ovary / ovule — receptive surface, connecting stalk, seed chamber, and the structure that becomes the seed.

Pollenizer — the plant that supplies pollen. **Pollinator** — the animal that moves it.

Monoecious / dioecious — separate male and female flowers on the same plant / on separate plants.

Self-incompatible — unable to be fertilized by its own pollen.

Triploid — seedless watermelon; produces no viable pollen and requires a diploid pollenizer.

Frame strength — the number of frames covered with bees; the standard measure in pollination contracts.

Drop site — a placement point for a group of colonies within a field.

Poricidal anther — releases pollen through a terminal pore; requires buzz pollination.

Extrafloral nectary — a nectar-secreting structure outside the flower (Chapter 20).

Self-Check

- 1. (MC)** Colonies used for pollination of Southeastern crops are typically assessed by: A) Frame strength — the number of frames covered with bees, graded under agreed conditions and written into the contract with delivery dates and notification terms B) Brood area, graded on arrival C) Forager traffic, counted at midday on the opening day of bloom D) Gross hive weight at delivery and removal
- 2. (SA)** A watermelon grower in south Georgia asks how many colonies to place on a 40-acre field. Explain what you would need to know and what general guidance applies.
- 3. (MC)** Colonies are usually moved into a crop at the beginning of bloom rather than well before it because: A) Bees set out early establish on competing forage nearby and keep working it, whereas colonies arriving as the crop opens orient onto the most abundant resource at hand B) Bees set out early work down the first flowers and then drift to neighboring fields C) Bees set out early draw down their stores while waiting D) Bees set out early lose the older foragers that had learned the home site
- 4. (MC)** When placing colonies for pollination, the beekeeper's principal protections against pesticide loss are: A) A contract assigning the grower liability, an agreed indemnity per colony, and photographs of dead bees B) Placement along the downwind edge, screened entrances on spray days, and feeding C) Apiary registration, a posted notice at the gate, and the label's pollinator statement D) A written contract setting out pesticide notification and application timing, direct contact with grower and applicator, knowledge of the spray program, and the ability to move colonies
- 5. (SA)** Explain the difference between a colony's honey production potential and its pollination value, and why a beekeeper may have to choose between them.
- 6. (MC)** Which describes the correct relationship between colony strength and pollination effectiveness? A) Foraging force is set by crop attractiveness, so weak and strong colonies visit at similar rates B) Foraging force scales with sealed brood area C) Foraging force rises faster than population, so two weak colonies cover more ground than one strong one D) Foraging force scales with adult population, so fewer strong colonies deliver more pollination than many weak ones, which is why contracts set frame strength and not just count
- 7. (SA)** Label the parts of a flower involved in pollination and describe what happens after a pollen grain lands on a stigma.

Answers

1. A.

2. What you need to know: the variety, and in particular whether **seedless triploid** melons are grown, which require a diploid pollenizer variety and generally higher bee density; the field layout and block size, since large blocks need colonies distributed in multiple drop sites rather than concentrated at one edge; the surrounding landscape and competing bloom; the presence of other managed or wild pollinators; and the grower's pesticide program during bloom. *General guidance:* watermelon takes on the order of one to two strong colonies per acre (published recommendations average about 1.3), with seedless watermelon commonly at the higher end, so a 40-acre field might take roughly 40 to 80 colonies distributed across the field. *The key point:* cucurbit flowers are open for a single morning and require multiple bee visits for well-shaped fruit, so timing colonies to bloom and distributing them through the field matter more than raw colony count. The contract should specify colony strength, placement, dates and pesticide notification.

3. A.

4. D.

5. Honey production requires a colony at maximum foraging strength during a nectar flow, with ample storage space, minimal disruption and a heavy nectar source. Pollination requires a colony strong and actively foraging during a specific crop's bloom, often at a different time and place, involving moving colonies, pesticide exposure, and forage that may yield little or no surplus. A beekeeper may have to choose because moving to a contract can mean missing the local honey flow; because moving stresses colonies; and because building for an early contract may not align with building for a later flow. In the Southeast the classic conflicts are an early blueberry or cucurbit contract against the tulip poplar and blackberry flow, and chasing pollination income against producing a premium varietal such as sourwood or tupelo.

6. D. Note also that assessment conditions matter: colonies graded in the middle of a warm day with the field force out will grade lower than the same colonies graded at dawn, so the contract should specify how and when grading is done.

7. Male: stamen, comprising **anther** (produces pollen) and **filament** (the stalk). *Female: pistil/gynoecium*, comprising **stigma** (receptive surface), **style** (connecting stalk) and **ovary** containing **ovules**. Surrounding: **petals** (corolla), **sepals** (calyx), **receptacle**, and the **nectary** at the base of the corolla. When a compatible pollen grain lands on the stigma it germinates and grows a **pollen tube** down through the style to the ovary, where fertilization of an ovule occurs. Each fertilized ovule becomes a seed, and the developing seeds drive fruit development — which is why incompletely pollinated cucurbits produce misshapen fruit and why multiple visits per flower are needed.

References for Further Study

Standard texts - Delaplane, K. S. & Mayer, D. F. *Crop Pollination by Bees*. CABI, 2000. The standard American reference; Delaplane is at UGA. - Free, J. B. *Insect Pollination of Crops*, 2nd ed. Academic Press, 1993. - McGregor, S. E. *Insect Pollination of Cultivated Crop Plants*. USDA

Agriculture Handbook 496, 1976. Free online; still useful. - Graham, J. (ed.) *The Hive and the Honey Bee*. Dadant, 2015.

Regional and extension - University of Georgia Bee Program, pollination stocking-rate recommendations (averages of published recommendations): bees.caes.uga.edu - UGA
Extension pollination publications, including blueberry and cucurbit pollination - UF/IFAS
EDIS pollination publications - NC State Extension, apiculture and horticulture pollination materials

Contracts and policy - US EPA, Managed Pollinator Protection Plan guidance - Project Apis m. and ABF model pollination agreement materials

Primary literature - Cane, J. H. & Payne, J. A. "Foraging ecology of the bee *Habropoda laboriosa* (Hymenoptera: Anthophoridae), an oligolege of blueberries (Ericaceae: *Vaccinium*) in the southeastern United States." *Ann. Entomol. Soc. Am.* 81:419–427 (1988). - Delaplane, K. S. et al. "Standard methods for pollination research with *Apis mellifera*." *J. Apic. Res.* 52:1–28 (2013).

Chapter 13: Pesticides

Learning Objectives

When you have finished this chapter you should be able to:

- Name the routes by which honey bees are exposed to pesticides.
 - Distinguish acute from sublethal effects and give examples of each.
 - Read a pesticide label and identify the sections that govern bee safety, and explain the legal status of the label.
 - Explain why pollinator protection statements are enforceable and not advisory.
 - Recognize the field signs of acute organophosphate or carbamate poisoning and distinguish them from disease.
 - Describe the correct response to a suspected pesticide kill, step by step and in the correct order.
 - Explain why neonicotinoids raise a different exposure question from contact insecticides.
 - Explain the fungicide synergy problem.
 - Explain apiary registration and how it protects colonies.
 - Advise a grower on a bloom-time application.
 - Protect colonies during a nearby daytime application without killing them by confinement.
 - Explain why chronic decline near intensive agriculture is difficult to attribute and what else must be considered.
 - Account honestly for the residues the beekeeper contributes.
-

13.1 Routes of Exposure

Honey bees are exposed to pesticides by **more routes than most beekeepers list**, and the multiplicity is the reason a colony cannot be protected simply by closing it during an application.

1. **Direct contact with spray** — bees in the field when an application is made.
2. **Contact with drift** — from an adjacent field, often at lower dose but over a wider area and onto flowering margins.
3. **Contact with residues on foliage and bloom** — for as long as the residual persists, which for some products is days to weeks.
4. **Ingestion of contaminated nectar** — brought home, stored, and fed out over time.
5. **Ingestion of contaminated pollen** — brought home as beebread and fed to nurse bees, and through them to brood, **for weeks after the application.**
6. **Contaminated water** — puddles, irrigation runoff, ditches, and treated standing water.
7. **Guttation fluid** — droplets exuded at leaf margins by some plants, which in systemically treated crops can carry high concentrations.
8. **Planting dust** — abrasion of insecticide-treated seed coatings during planting, blown onto flowering weeds and onto foraging bees.

9. **In-hive miticides** — applied by the beekeeper (§13.13).

Two implications follow that the examination cares about:

- **Contaminated pollen continues to expose nurse bees and brood for weeks** after the application, long after the visible incident is over.
- **A colony foraging two miles away can be exposed to an application the beekeeper never saw**, on land the beekeeper does not control.

13.2 Acute Versus Sublethal Effects

Acute effects are rapid mortality following exposure. Examples:

- Piles of dead and dying bees at the entrance within hours of an application.
- Sudden loss of the foraging force, leaving a hive of young bees and brood with almost no field bees.

Sublethal effects occur at doses below those that kill outright, and impair function rather than causing immediate death. Examples:

- **Impaired navigation and homing**, so that foragers fail to return — which removes bees from the colony without leaving a body to find.
- **Impaired learning and memory**, reducing foraging efficiency and recruitment.
- **Reduced brood rearing.**
- **Queen supersedure and reduced queen quality**, including reduced sperm viability.
- **Increased susceptibility to disease and parasites**, through immune suppression.
- **Altered thermoregulation and development.**

The practical importance: a colony can be seriously harmed with no dead bees to show for it. That makes chronic exposure far harder to demonstrate than an acute kill, and very easy for a beekeeper to misattribute to disease, queen failure or bad luck. It also makes it easy for others to dismiss.

13.3 Reading the Label

In the United States, the pesticide label is a legally enforceable document. Under FIFRA (the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. §136 et seq.), **use inconsistent with the labeling is unlawful.**

That applies to the beekeeper as much as to the farmer. A beekeeper applying a miticide is a **pesticide applicator**, and using a dose or timing other than the label's, or leaving supers on contrary to it, is a violation of federal law.

The restrictions are not arbitrary: **dose limits define the margin between mite efficacy and bee harm**, and **super restrictions define the conditions under which residues stay within tolerance.** Honey containing residues in excess of tolerance is an adulterated food.

13.3.1 The sections that matter

A practical examination may hand you a label and ask whether a product may lawfully be applied in stated conditions. Know where to look:

Section	What it tells you
Signal word	DANGER / WARNING / CAUTION — acute toxicity to the applicator
Precautionary Statements > Hazards to Humans and Domestic Animals	Required PPE
Environmental Hazards	The pollinator protection language and the Bee Advisory Box where present
Directions for Use	The binding instruction: “It is a violation of Federal law to use this product in a manner inconsistent with its labeling”
Restricted-entry interval (REI)	When people may re-enter
Pre-harvest interval (PHI)	When the crop may be harvested
Application timing / bloom restrictions	Whether it may be applied to a blooming crop, and when
Rate and frequency	Dose, interval, maximum applications per season
Storage and disposal	—
Restricted Use Pesticide (RUP) designation	Whether a certified applicator is required

For an in-hive miticide, add: **temperature range, brood status requirements, whether honey supers may be present, treatment duration, and the interval before supers may be replaced.**

13.3.2 Pollinator protection statements are enforceable

A frequently examined false statement holds that pollinator protection statements are advisory guidance, so that an application to a blooming crop while bees are foraging is a matter of courtesy rather than law.

They are part of the label. Applying a product contrary to them is **use inconsistent with the labeling** and a violation of federal law.

The distinction matters in practice, because it is what allows a beekeeper to raise a bee kill with the **state lead agency** rather than only with the grower.

That said — and this belongs in the same breath — **courtesy has its own place.** Advance notice, registered apiary locations and a working understanding with neighboring growers prevent far more losses than enforcement ever will. Enforcement is slow, uncertain and adversarial. A phone call is neither.

13.4 Recognizing a Pesticide Kill

13.4.1 Acute organophosphate or carbamate poisoning

The classic picture:

- **Large numbers of dead and dying bees at the entrance** and on the ground in front of the hive.
- **Proboscis extended** — the “tongue out” posture — in many of the dead.
- **Trembling, disorientation, uncoordinated movement, paralysis** before death.
- Often **multiple colonies in the yard affected simultaneously**.
- The colony left with **young bees and brood but no field force**.

The mechanism is **acetylcholinesterase inhibition**: the enzyme that clears the neurotransmitter acetylcholine is blocked, so nerve signalling runs away, producing tremor, paralysis and death.

It is not conclusive. Chronic bee paralysis virus produces trembling, crawling adults and dead piles at the entrance, and certain bacterial infections can produce superficially similar adult mortality (Chapter 15). The field impression should prompt **sample collection and investigation**, not a firm conclusion.

13.4.2 Differential

A June morning with many dead and dying adults in front of several hives, some trembling and disoriented on the ground, has several possible causes:

- **Acute pesticide poisoning**, most likely from a nearby application
- **Chronic bee paralysis virus**
- **Nosema** combined with other stressors
- **Spiroplasma** infection, which produces a similar seasonal adult crawling mortality
- **Robbing-related fighting mortality**
- Less commonly, **poisoning from a toxic plant**

The things that discriminate: whether **multiple colonies** and **multiple apiaries** are affected; whether the onset was **sudden**; whether the bees show **extended proboscis** and tremor; whether anything has been **applied nearby** and when; and whether the colony has lost specifically its **field force**.

13.5 Responding to a Suspected Kill

Act quickly, because residues degrade. Many insecticides are no longer detectable in dead bees after a few days. The two most common failures are **waiting** and **not reporting at all**, which forecloses any formal determination or remedy.

The sequence:

1. **Photograph the scene** — piles of dead bees at the entrances, the apiary, the adjacent land. Record date, time, weather and your observations in writing.

2. **Collect a substantial sample of dead bees** — ideally several hundred per hive, from multiple affected colonies, taken from the ground in front of the hives and from the bottom boards. Place them in clean containers as the laboratory directs — typically clean glass or a sealed plastic bag, not a container that has held anything else.
3. **Freeze the samples immediately.**
4. **Collect samples of pollen or beebread** and of suspect plant material where relevant, and freeze those too.
5. **Determine what was applied nearby and when**, if you can — ask the grower, the applicator, the neighbor.
6. **Notify the state apiary inspector and the state lead pesticide agency**, usually the department of agriculture.
7. **Follow their chain-of-custody instructions** rather than sending samples independently to a private laboratory in the first instance. A sample collected outside a documented chain of custody may be useless for enforcement even if the analysis is correct.

Which agency: the **state lead pesticide agency**, together with the state apiary inspector. **Pesticide enforcement is carried out by the states under cooperative agreements with EPA** — not by EPA regional offices directly, not by FDA, and not by the county extension agent, who has no statutory authority to draw legal samples.

13.6 Systemic Insecticides and Neonicotinoids

Neonicotinoids — imidacloprid, clothianidin, thiamethoxam, acetamiprid, dinotefuran and relatives — are **systemic**: the plant takes them up and translocates them through its tissues.

That is what makes the exposure pattern different from a contact insecticide:

- The residue is **inside the plant tissue the bee eats** — nectar and pollen — rather than on the surface, so timing an application away from bee activity does **not** eliminate exposure.
- They can appear in **guttation fluid**.
- **Treated seed can throw off dust at planting**, which drifts onto flowering weeds and onto bees.

Their acute toxicity to bees is high, and both acute and sublethal effects are documented in the laboratory and in semi-field work. **Field-realistic exposure and its population-level consequences remain the subject of active scientific debate**, and a Journeyman beekeeper should represent that honestly: the mechanism is not in doubt, the laboratory effects are not in doubt, and the magnitude of the field effect relative to *Varroa*, nutrition and other stressors is genuinely contested.

Distractors to recognize: neonicotinoids are **not** contact materials with long foliar residuals; they are **not** systemic only in leaves and stems; and they do **not** break down fast in the plant while binding tightly in beeswax (that description fits the older synthetic acaricides).

13.7 The Fungicide Problem

Some fungicides, though of low direct toxicity to bees, can substantially increase the toxicity of certain insecticides and in-hive miticides when bees are exposed to both.

The mechanism: certain fungicides — notably the **sterol biosynthesis inhibitors (SBI)**, the triazoles and imidazoles — **inhibit cytochrome P450 monooxygenases**, the enzyme systems bees use to detoxify other compounds. A combination can therefore harm bees at doses that each would tolerate separately. This is a genuine **synergy**, demonstrated repeatedly (Johnson et al., 2013).

The practical consequences:

- **A beekeeper discussing a spray program with a grower should ask about everything being applied, not just the insecticide.**
- **Tank mixes deserve specific inquiry.**
- **Bloom-time fungicide applications** on crops such as blueberries and cucurbits are a legitimate topic of conversation, and many growers consider fungicides inherently bee-safe because the label toxicity is low.
- It also bears on **in-hive miticides**: a colony carrying fungicide residues in its beebread may be more susceptible to a miticide applied at the label rate.

13.8 Mosquito Control

Mosquito control spraying is a significant concern in the coastal and low-country Southeast, and the management answer is not the obvious one.

Most mosquito adulticiding is done at night, specifically because target mosquitoes are active then and non-target pollinators are not. That timing greatly reduces the risk, and a well-run program is not a major hazard to colonies.

Problems arise with: - **Daytime applications - Aerial applications after storms and flooding**, when programs run at unusual hours and over wide areas - **Programs that do not know an apiary is present**

The practical protections are therefore administrative rather than physical:

- **Register apiary sites with the county mosquito control district** and with the state registry.
- **Learn the spray schedule and method** — ULV ground fogging, aerial, larviciding.
- **Close colonies on notice** if a daytime application is unavoidable, briefly and with full ventilation (§13.9).
- **Rely on night application** where the program uses it.

Wrong answers that appear as distractors: screening entrances for the whole mosquito season (colonies would overheat and the residual does not persist that way); moving colonies out of the county for the season; and the claim that a state apiarist must obtain a beekeeper's written consent before any application near a registered apiary, which no state provides.

13.9 Protecting Colonies During an Application

If a beekeeper must protect colonies during a nearby **daytime** application, the safest approach is:

1. **Move the colonies out of the area** if that is practical.
2. If it is not, **confine them as briefly as possible behind screens that preserve full ventilation**, give water, and do it **overnight or in cool weather**.

Confinement is a last resort with real hazards. A confined colony generates metabolic heat it cannot shed, and **overheating kills colonies faster than most pesticide exposures**. A plastic sheet over a hive in Southeastern sun is lethal within hours. Bees do not breathe through their hemolymph; they depend on air movement through spiracles and tracheae, and a closed box has no air movement (Chapter 3).

So: screens, not solid blocks. Ventilation space. Water. Brief. Cool. And preferably, move them or arrange a night application instead.

Distractors: wet burlap across hive fronts with entrances open (does not exclude drift and does not hold bees in); confining from dawn to the following morning with solid entrance blocks (lethal in Southeastern heat, and the “empty super for air space” does not fix it); and moving colonies a quarter mile downwind (a quarter mile is well within foraging range, and downwind is the wrong direction).

13.10 Apiary Registration

Registration puts your apiary’s location into a database that applicators, growers and state or county spray programs consult before an application, so that they know bees are present and can adjust timing, product choice or buffer distances, or notify you.

The general type of system is an **apiary registry**, in several forms:

- **State department of agriculture apiary registration**, mandatory in some states (Florida) and voluntary in others.
- **County mosquito control notification lists**.
- **Voluntary online mapping registries** used by applicators to identify sensitive sites — the best known is **DriftWatch / BeeCheck**, operated by FieldWatch and adopted by many states.

Registration is only effective if:

- You **keep the entry current** — locations move, and a registry full of stale pins is ignored.
- You **provide working contact information** and answer when called.
- You **respond** when notified, rather than demanding that an application not happen.

It **complements rather than replaces** direct communication with immediate neighbors and growers. The registry tells an applicator you exist; the phone call tells them what to do about it.

13.11 Advising a Grower

The standard mitigation package, and the correct answer to several examination items:

1. **Follow the label's pollinator protection statements.** They are enforceable.
2. **Apply in the evening or at night**, when bees are not foraging.
3. **Choose a lower-toxicity, shorter-residual product** where a choice exists.
4. **Keep drift off flowering margins and off open water.**
5. **Disclose any tank mix, including fungicides.**
6. **Give the beekeeper advance notice**, so colonies can be moved or protected.

And, separately: **do not assume a non-flowering crop is safe.** Flowering weeds beneath and around the crop may be worked heavily, and some crops have **extrafloral nectaries** — cotton is the classic Southeastern example — that draw bees outside the bloom period entirely (Chapter 20). Corn is another case: wind-pollinated, no nectar, but a **major pollen source** worked heavily by bees, and therefore treated without pollinator precautions while bees are in it.

Build the relationship before an incident. It is far more effective than pursuing a complaint afterward, and growers in general are not hostile to bees; they are busy, and they will accommodate a beekeeper who has made himself known and made the request easy to honor.

13.12 The Hard Case: Chronic Decline

Suppose a beekeeper suspects that gradual colony decline across an apiary near intensive row-crop agriculture is due to pesticides.

Why this is difficult to establish:

- **Chronic exposure produces no discrete event** to date, photograph or sample.
- **Residues degrade**, and the exposure may have occurred weeks before the effect is visible.
- The effects — **poor build-up, spotty brood, queen supersedure, reduced longevity** — are **non-specific** and overlap with many other causes.
- Establishing causation would require **residue analysis of beebread and wax interpreted against toxicity benchmarks** rather than treated as simple presence or absence. Almost every wax sample contains something; that fact alone proves nothing.

What else must be considered, seriously:

- **Varroa and virus load** — measure it
- **Nosema**
- **Queen quality** and source
- **Nutritional stress** from a landscape offering narrow, seasonally exhausted forage — which is itself a consequence of intensive row-crop agriculture, and may be the real mechanism
- **Management factors** — including the beekeeper's own miticide use

A practical discriminating step: move a subset of colonies to a contrasting location and compare their performance against matched colonies left in place. It is the closest thing to a controlled experiment available to a working beekeeper, and it is genuinely informative.

The honest position: a beekeeper can **document exposure** and can **rule other causes in or out**, but should not assert causation from a pattern alone. Doing so weakens the credibility of beekeepers in pesticide discussions generally — and beekeepers need that credibility, because the cases where the evidence *is* strong deserve to be heard.

13.13 The Beekeeper's Own Residues

A frequently examined false statement holds that beekeeper-applied miticide residues are seldom found in beeswax because these compounds are water-soluble and leave with the honey crop.

The opposite is true. The common synthetic acaricides are **lipophilic**, and wax surveys routinely find them — along with their breakdown products — at levels that persist for years. In North American surveys, miticides applied by beekeepers have been among the most frequent and most concentrated contaminants found in hive matrices (Mullin et al., 2010).

Consequences:

- That accumulation is a **principal reason for rotating comb out on a planned cycle** (Chapter 15), and it interacts with disease as a second reason rather than being separate from it.
- Because commercial foundation is made from recycled wax, residues **circulate through the supply chain** (Chapter 11).
- Sublethal effects on **queen and drone quality** from wax residues are documented, which matters particularly to queen producers.

And it is a reminder worth stating plainly: **the beekeeper is a pesticide applicator, and the residues most reliably found in a hive are usually the ones the beekeeper put there.** That does not make agricultural exposure unimportant. It does mean that a beekeeper who talks about pesticides without including their own miticides in the accounting is not giving a complete picture, and an examiner will notice.

Numbers to Memorize

Item	Figure
Governing statute	FIFRA, 7 U.S.C. §136 et seq.
Enforcement	State lead agency under cooperative agreement with EPA
Signal words	DANGER / WARNING / CAUTION
Sample for residue analysis	several hundred dead bees per hive, frozen immediately
Timing of sampling	immediately — residues degrade in days
OP/carbamate mechanism	acetylcholinesterase inhibition
SBI fungicide mechanism	cytochrome P450 inhibition > synergy
Best application timing	evening or night

Key Terms

FIFRA — Federal Insecticide, Fungicide, and Rodenticide Act; makes label use legally binding.

Use inconsistent with the labeling — the statutory phrase for an unlawful application.

Bee Advisory Box — the pollinator protection panel on certain labels.

REI / PHI — restricted-entry interval / pre-harvest interval.

RUP — Restricted Use Pesticide, requiring a certified applicator.

Acute / sublethal — rapid mortality / functional impairment below the lethal dose.

Systemic — taken up and translocated by the plant, appearing in nectar, pollen and guttation.

Guttation — droplets exuded at leaf margins, which can carry systemic residues.

Synergy — one compound increasing the toxicity of another; SBI fungicides with insecticides and miticides.

Chain of custody — the documented handling of a sample that makes it usable for enforcement.

DriftWatch / BeeCheck — voluntary online apiary and sensitive-site mapping registries.

Self-Check

- 1. (MC)** Honey bees are exposed to pesticides through which routes? A) Contact with drift, tainted nectar and pollen, and residues moving out of treated soil into wax B) Contact with spray and drift and with residues on foliage and bloom, ingestion of tainted nectar and pollen, contaminated water and guttation, and planting dust C) Direct contact with spray and planting dust only D) Contact with spray, drift, foliage residues and tainted nectar and pollen, water being a minor route
- 2. (SA)** Distinguish acute from sublethal pesticide effects and give two examples of each.
- 3. (TF)** Pollinator protection statements on a pesticide label are advisory guidance rather than enforceable label language.
- 4. (SA)** Describe what you should do immediately upon discovering a suspected pesticide kill at your apiary.
- 5. (MC)** Symptoms suggesting acute organophosphate or carbamate poisoning include: A) Dead larvae and pupae dragged to the entrance by dark greasy adults, with a sour odor B) Large numbers of dead and dying bees at the entrance, many with the proboscis extended, with trembling, disorientation and paralysis before death C) Crawling bees with disjointed wings and swollen abdomens piling up over a week or two D) Sudden loss of the adult population with few dead bodies, leaving capped brood and stores
- 6. (MC)** Neonicotinoid insecticides are of particular concern because they: A) Are systemic, so the plant takes them up and they can appear in nectar, pollen and guttation fluid, and treated

seed can throw off dust at planting B) Are systemic in leaves and stems only C) Break down fast in the plant but bind tightly in beeswax D) Are contact materials with a long foliar residual

7. (TF) Some fungicides, though of low direct toxicity to bees, can substantially increase the toxicity of certain insecticides and in-hive miticides when bees are exposed to both.

8. (MC) To protect colonies during a nearby daytime application, the safest approach is: A) Staple wet burlap across hive fronts with entrances open B) Move the colonies out of the area if practical; if not, confine them as briefly as possible behind screens preserving full ventilation, give water, and do it overnight or in cool weather C) Confine from dawn until the following morning with solid entrance blocks and an empty super for air space D) Move the colonies a quarter mile downwind for the day

9. (SA) A beekeeper suspects that gradual colony decline near intensive row-crop agriculture is due to pesticides. Explain why this is difficult to establish and what else should be considered.

Answers

1. B.

2. Acute effects are rapid mortality following exposure: piles of dead bees at the entrance after an application; and the sudden loss of a colony's foraging force so that the hive is left with only young bees and brood. **Sublethal** effects occur below the lethal dose and impair function rather than killing outright: impaired navigation and homing so that foragers fail to return; impaired learning and memory; reduced brood rearing; queen supersedure and reduced queen quality; and increased susceptibility to disease. The practical importance is that a colony can be seriously harmed with no dead bees to show for it, which makes chronic exposure much harder to demonstrate than an acute kill and easy to misattribute.

3. False. Those statements are part of the label, and applying a product contrary to them is use inconsistent with the labeling and a violation of federal law. That matters in practice because it is what allows a beekeeper to raise a bee kill with the state lead agency rather than only with the grower. Courtesy still has its place: advance notice, registered apiary locations and a working relationship prevent far more losses than enforcement ever will.

4. Act quickly, because residues degrade. Photograph the scene, including piles of dead bees, and record date, time, weather and observations. Collect a substantial sample of dead bees — ideally several hundred per hive from multiple affected colonies, from the ground in front of the hives and from the bottom boards — in clean containers as the laboratory directs, and **freeze them immediately**. Collect samples of pollen or beebread and of suspect plant material where relevant. Determine what was applied nearby and when, if you can. Notify the **state apiary inspector and the state lead pesticide agency**, usually the department of agriculture, and follow their chain-of-custody instructions rather than sending samples independently. The two most common failures are waiting several days, by which time many insecticides are no longer detectable, and not reporting at all.

5. B. Not conclusive, however: chronic bee paralysis virus and certain bacterial infections can produce superficially similar adult mortality, so the field impression should prompt sample collection and investigation rather than a firm conclusion.

6. A.

7. True. The mechanism is inhibition of the cytochrome P450 enzyme systems bees use to detoxify other compounds, so a combination harms bees at doses each would tolerate separately. Ask growers about everything being applied, including tank-mix partners and bloom-time fungicides.

8. B. Confinement is a last resort with real hazards: overheating kills colonies faster than most pesticide exposures, and a colony in a closed box in Southeastern sun dies within hours.

9. Chronic exposure produces no discrete event to date or sample; residues degrade; and the effects — poor build-up, spotty brood, queen supersedure, reduced longevity — are non-specific and overlap with many other causes. Establishing causation would require residue analysis of beebread and wax interpreted against toxicity benchmarks rather than treated as simple presence or absence, together with systematic exclusion of alternatives. Those alternatives must be considered seriously: *Varroa* and virus load, *Nosema*, queen quality, nutritional stress from a landscape offering a narrow and seasonally exhausted forage supply, and management factors including the beekeeper's own miticide use. A practical discriminating step is to move a subset of colonies to a contrasting location and compare performance. The honest position is that a beekeeper can document exposure and rule other causes in or out, but should not assert causation from a pattern alone — doing so weakens beekeepers' credibility in pesticide discussions generally.

References for Further Study

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Regulatory and guidance - 7 U.S.C. §136 et seq. (FIFRA); US EPA pesticide labeling requirements and the Bee Advisory Box. - US EPA, Managed Pollinator Protection Plan (MP3) guidance. - State lead agency pesticide incident investigation procedures (state departments of agriculture). - FieldWatch (DriftWatch / BeeCheck): fieldwatch.com

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Chapter 14: Queen Rearing

Learning Objectives

When you have finished this chapter you should be able to:

- Describe queen mating — where, how, with how many drones, and what follows from open mating.
 - State the timetable from graft to laying queen and use it to schedule work.
 - Distinguish swarm, supersedure and emergency cells in the field by position and context.
 - Explain why larval age at grafting is the single most important variable in queen quality.
 - Set up a cell builder and explain the queenright/queenless trade-off.
 - Time the transfer of ripe cells and explain why.
 - Design and manage a mating nucleus for Southeastern conditions.
 - Introduce a caged mated queen correctly and name the two errors that most often cause rejection.
 - Diagnose queenlessness, a drone-laying queen and laying workers, and treat each correctly.
 - Judge whether a laying queen is performing well, and know the traps in that judgment.
 - Use the international queen marking colors.
 - Requeen a defensive colony correctly.
 - Explain how long a queen should head a colony and on what basis to replace her.
-

14.1 Queen Mating

14.1.1 Where and how

A virgin queen matures for about **5 to 6 days** after emergence, then flies on suitable warm afternoons to a **drone congregation area (DCA)** — a location in the open air, typically **30 to 100 feet above the ground**, where drones from many colonies within a radius of several miles gather. DCAs are remarkably stable, recurring in the same places year after year, and their positions appear to be determined by landscape features not yet fully understood.

She mates **in flight** with **a dozen to twenty or more drones**, often over **one to several flights across a few days**, and stores their sperm in her **spermatheca** for the rest of her life. Mating drones **die in the act**, the endophallus everting and detaching.

After the final mating flight there is a **preoviposition period** of a few days before she begins to lay.

14.1.2 The timetable and what it means for inspection

A virgin queen emerging on 1 June in middle Georgia should be expected to be laying **roughly 10 to 14 days after emergence under favorable weather (up to 3 weeks in poor weather)** — maturation, mating flights, and preoviposition together.

The practical rule: mark the calendar and check once at about three weeks, and again a week later before concluding failure.

Repeated disturbance during this period is a **recognized cause of queen loss** — the queen may be injured, or may fail to return from a flight after a disruption. The colony should be left undisturbed in the interim. A beekeeper who opens a mating nuc every three days is the reason that nuc has no queen.

14.1.3 Two consequences of open mating

First, open mating cannot be controlled. Her daughters' fathers come from every colony within several miles — including feral colonies, including your neighbor's untreated bees, and in parts of the Southeast including colonies with African-derived genetics. This is why **purchased breeder genetics do not persist in open-mated daughters**: a beekeeper who buys a VSH queen, raises daughters from her and lets them open-mate locally will find the resistance diluted toward the local average within a generation, because half the genetic contribution to each worker comes from unselected drones (Chapter 19).

The options for controlling paternity: buy replacement queens from the selected source on a schedule; participate in a program with **instrumental insemination** or **isolated mating yards**; or **saturate the local area with drone-producing colonies** from selected stock, which shifts but does not determine paternity.

Second, weather matters enormously. Extended cool or rainy weather during the mating window produces **poorly mated queens** that fail early — drone layers, or queens that lay well for a few weeks and then go patchy. In the Southeast this presentation is common in queens that mated during a cool, wet spring spell, and it is a reason to be cautious about the earliest spring queens in a bad year.

14.2 Reading Queen Cells

	Swarm cells	Supersedure cells	Emergency cells
Number	Many — often a dozen or more	Few — typically 1 to 5	Variable, often several
Position	Bottom bars and lower comb margins	Comb face, mid-comb	Comb face, wherever suitable larvae were
Colony state	Crowded, populous, queenright , building	Average population, failing or aging queen	Recently queenless
Appearance	Well provisioned, built from cups	Well provisioned	Often built out from a worker cell , so the base is set in the comb face
Season (SE)	Feb–May principally	Any	Any

Position is suggestive; context is decisive. Colony population, congestion, queen condition, season and the presence of a laying queen all inform the reading.

The worked example: **a dozen cells on the bottom bars of a packed colony in early March in middle Georgia is a swarm signal.** Two cells on the face of an average colony in September is more likely supersedure.

A common examination distractor holds that position alone identifies the type, or that they cannot be told apart at all. Neither is right.

Piping. A high-pitched sound from within a hive — described as **tooting** from a free virgin and **quacking** from mature virgins still confined in their cells — indicates that virgin queens are present. In June, that normally means the colony has **already cast a primary swarm** and that afterswarms may follow as successive virgins are released. Management should shift from swarm prevention, which is now too late, to **reducing the remaining cells to a single good cell** to prevent repeated afterswarms from stripping the colony, or to removing all cells and introducing a mated queen. Continuing with a Demaree on a colony that has already swarmed wastes effort and may leave it too weak to make a crop.

14.3 Grafting

14.3.1 Larval age is everything

The correct target is the youngest larva that can be handled, ideally under 24 hours from hatching.

The reason is developmental: a longer period of queen-type feeding yields more ovarioles and a larger spermatheca. Queens reared from older larvae are **smaller, carry fewer ovarioles and smaller spermathecae, and are more likely to be superseded.** A larva at three or four days is easier to see and easier to transfer — which is exactly why the wrong answer is tempting — and produces a worse queen.

Practical aids:

- **Confine the breeder queen** on a comb — with a push-in cage or a Cloake-board-style confinement frame — to synchronize larval age, then graft from that comb at a known interval.
- **Graft in good light with magnification.** A headlamp and reading glasses or a visor loupe make an enormous difference.
- **Keep the larvae from chilling or drying** during transfer. Work quickly, in a warm, humid, draft-free place; a damp towel over the frame helps.
- **Wet or dry graft.** A dry graft transfers the larva alone into a clean cup; a wet graft places a tiny amount of diluted royal jelly in the cup first. Wet grafting is more forgiving for a beginner.
- **Use a good tool.** A Chinese grafting tool with a flexible tongue, or a fine sable brush, or a proper stainless grafting needle.

14.3.2 Alternatives to grafting

Not every beekeeper needs to graft, and the examination recognizes several non-grafting methods:

- **Cell punch** — a plug of comb containing a young larva is punched out and mounted in a cell bar.
- **Miller method** — a frame of foundation cut into a zigzag is given to a breeder colony; the bees draw comb, the queen lays at the edges, and the resulting young larvae along the cut edge are used.
- **Hopkins method** — a comb of very young larvae is laid horizontally over a queenless colony, with most cells destroyed so the remainder are well spaced; the bees build queen cells downward from the remaining larvae.
- **Nicot / Jenter systems** — a caged laying box in which the queen lays directly into removable cell cups, eliminating grafting entirely.
- **Harvesting natural swarm or supersedure cells** — usable, but you get the genetics the colony chose and the timing the colony chose, and swarm cells carry the swarming tendency of their source.

14.4 The Cell Builder

A cell builder colony should be strong, well fed and rich in young bees. The reason is glandular: **queen cells are provisioned by nurse bees from their brood food glands** (Chapter 3), so the colony must contain a large population of **young bees with well-developed hypopharyngeal glands**, abundant incoming or supplied pollen and nectar, and enough bees to hold the cells at brood nest temperature.

14.4.1 Queenright or queenless? The trade-off

This is the examinable point, and an answer that picks only one has missed it.

- A **queenless** colony **accepts grafts at a much higher rate**, because the absence of queen pheromone releases the impulse to rear queens.
- A **queenright** colony **feeds and finishes cells better**, because it is stable, well provisioned and not disorganized.

The common practice is therefore to do both: start cells in a **queenless starter** and finish them in a **queenright finisher** above a queen excluder. Or use a **Cloake board** arrangement, which achieves the same thing in one colony: a sliding insert above an excluder makes the top box functionally queenless for the graft, and the insert is then withdrawn so the cells are finished queenright.

Other builder arrangements: the **swarm box** (a heavily stocked queenless box of young bees, fed, used as a starter for 24 hours); the **queenright finisher** above an excluder; and the **Nicot/full-colony** arrangements of larger producers.

In all cases: feed. A cell builder should be on syrup and pollen, or a substitute, whether or not there is a flow. Cells started in a builder that runs short are poorly provisioned.

14.5 Handling Ripe Cells

Ripe queen cells should be moved to mating nuclei or an incubator about one to two days before expected emergence.

Two reasons, and you need both:

- **Queen pupae are vulnerable to chilling and jarring earlier** in their development. A cell moved at capping or shortly after is easily damaged.
- **The first queen to emerge destroys the rest.** If cells are left together past emergence, you lose all but one.

The timetable, from a graft of a larva about one day old:

Day	Event
0	Graft
about 4–5	Cells capped
about 10	Move cells to mating nuclei or incubator
about 11–12	Emergence
about 5–6 days later	Queen mature enough to fly
about 10–14 days from emergence (up to 3 weeks in poor weather)	Laying

So: graft, wait ten days, distribute cells; expect a laying queen roughly three to four weeks after the graft.

Handling ripe cells: keep them **upright, warm** and **out of direct sun** during transfer. In a Southeastern summer this means never leaving them on a truck seat — the interior of a parked vehicle will kill them within minutes. A cell transport box with a heat source, or simply a cooler with a warm water bottle, works.

14.6 The Mating Nucleus

A good mating nucleus is a small colony with emerging brood, adequate stores, a substantial population of young bees and protection from robbing, sized to hold temperature and defend itself.

It is a balance: **large enough to be viable and to care for the queen, small enough to be economical.** A full two-story colony wastes resources; a frame of honey with no bees is not a colony at all; and a queenright colony with a laying queen already present defeats the purpose.

14.6.1 The Southeastern hazards

Mating nuclei in the Southeast face three specific problems, and they shape how the work is done here:

1. **Robbing during dearth.** Small units are the obvious target. Reduce entrances, use robbing screens, do not spill syrup, do not work them in the open during a dearth.
2. **Small hive beetle.** A nuc has few adult bees relative to its comb area and cannot patrol it. A beetle population a full colony would contain will overwhelm a nuc **within days**,

leading to slimed comb and absconding. This is one of the most consistent practical differences between Southeastern and northern queen rearing.

3. **Summer heat.** Small units have limited thermoregulatory capacity. Shade matters.

Precautions for nucs and mating nuclei:

- **Size the unit tightly** so the bees cover all the comb. Use follower boards or smaller boxes rather than a partly filled full box.
- **Reduce entrances.**
- **Install and maintain beetle traps**, and refresh the oil.
- **Avoid pollen patties**, or use only small pieces (Chapter 5).
- **Place in sun** rather than deep shade.
- **Inspect frequently** — a nuc can be lost between weekly visits — but not during the mating window, which is the tension the beekeeper has to manage.
- **Combine or build up** any nuc that is losing ground rather than hoping it recovers.

14.6.2 Formats

Standard nuc — a 5-frame box on standard frames; interchangeable with production equipment, which is its great advantage.

Divided box / double nuc — a standard box partitioned into two or more compartments with separate entrances on different sides. The compartments share heat, which is a real advantage for overwintering, and a Southeastern beekeeper can winter two small colonies this way rather than combining them (Chapter 17).

Mini-mating nucs (Apidea, Kieler, baby nucs) — small units on half- or quarter-size frames, economical in bees, used by commercial queen producers. They need careful management and are less forgiving in heat and beetle pressure, and their frames do not interchange with production equipment.

14.7 Introducing a Mated Queen

14.7.1 The standard procedure

1. **Confirm the colony is genuinely queenless and destroy every queen cell present.**
2. **Place the cage between two brood frames near the center of the cluster**, screen side accessible to the bees, with the **candy plug end positioned so the bees can eat through it**. Hang or wedge it so it cannot fall and so the bees can reach it.
3. **Leave the colony undisturbed for several days.**
4. **Check after about four to seven days** to confirm release.
5. **Check a week later** to confirm laying.
6. Do not disturb the colony in between.

14.7.2 The two errors that most often cause rejection

First: failing to confirm true queenlessness, or leaving a queen cell present. A colony that has a queen — or that is about to have one from a cell you missed — will kill an introduced queen. Search carefully, and remember that a virgin is small and fast and easily missed.

Second: opening the colony too soon or too often, which disrupts acceptance.

14.7.3 Conditions that affect acceptance

Acceptance is poorer during dearth and under robbing pressure. In the Southeast this means **late summer introductions benefit from feeding and from reduced entrances.** Acceptance is also poorer in a colony that has been queenless a long time, in a colony with laying workers (§14.9), in very large colonies, and in colonies with a lot of old bees.

Handling queens in transit. Queens shipped by mail can be damaged by temperature extremes — and this cuts both ways.

Do not refrigerate queens on arrival. Refrigeration is itself a temperature extreme.

Chilling damages stored sperm just as overheating does, and the damage leaves no outward sign, so an affected queen may be accepted, lay well briefly, and then go patchy or drone-heavy or be superseded. Hold queens at **moderate room temperature**, out of direct sun, with the attendants able to reach the candy, and introduce them without long delay. The same reasoning is why a queen should never be left in a mailbox or a closed vehicle.

14.8 Judging a Laying Queen

Indicators of good performance:

- A **solid, compact brood pattern** with few skipped cells, **across several frames**
- **Brood of all stages** present in the expected proportions, indicating continuous laying
- A brood area that **expands appropriately for the season**
- **Population building**, temperament calm
- **Abundant eggs, one per cell, centered at the base**
- **Absence of supersedure cells**

Poor indicators: a spotty pattern; drone brood in worker cells; repeated supersedure attempts; a shrinking brood nest in a season when it should expand.

14.8.1 The trap

A spotty brood pattern is not automatically a queen problem. This is the single most frequently repeated diagnostic error in beekeeping, and the examination tests it several ways.

Conditions that produce a spotty or irregular pattern (with a sound queen present, except where noted):

- Heavy **Varroa** infestation and associated viruses
- **Chilled brood**
- **European foulbrood**

- **American foulbrood**
- **Chalkbrood**
- **Inbreeding**, producing diploid drones removed by nurse bees (“shot brood” or “pepperbox” — scattered empty cells — commonly up to about a quarter, depending on how many of the queen’s mates share a sex allele with her — in an otherwise healthy nest, with no disease signs and negligible mite counts)
- **Pollen-bound or honey-bound** brood nest restricting laying
- **Laying workers (no queen present)**
- Too few nurse bees, or a colony too small to cover its comb

The professional habit is to **examine the cells themselves** — capping appearance, contents, ropiness, scale, odor — **assess mite levels**, and consider colony history and season, **before** concluding what the pattern means. A beekeeper who automatically requeens on seeing spotty brood may be replacing a sound queen while leaving a foulbrood infection or a mite problem untouched.

14.8.2 Queen marking

The **international queen marking colors** run on a five-year cycle:

Year ending in	Color
1 or 6	White
2 or 7	Yellow
3 or 8	Red
4 or 9	Green
5 or 0	Blue

The mnemonic: “**Will You Raise Good Bees**” — White, Yellow, Red, Green, Blue.

So a queen introduced in **2026** is marked **white** (2026 ends in 6).

Marking is worth the trouble. It records the introduction year; it makes supersedure immediately obvious when an unmarked queen turns up; and it speeds queen finding during splits and requeening — which in a defensive colony on a hot day is worth a great deal.

14.9 Queen Problems and Their Diagnosis

14.9.1 Queenlessness

Signs, several days after loss:

- A distinctive rising, roaring or **wailing sound** — the “queenless roar”
- **Agitated, disorganized behavior**, bees running on the combs rather than working calmly
- **Absence of eggs and young larvae**, with the youngest brood progressively older on successive visits
- **Emergency queen cells** built on the comb face over worker larvae
- Often a **more defensive temperament**
- **Stored pollen accumulating** as brood rearing ceases

No single sign is conclusive. The definitive test is the presence or absence of **eggs**, examined in good light with the sun over your shoulder. If that is inconclusive:

The test frame. Give the colony a frame of **eggs and larvae under about three days old** from a colony of **known good health**. A colony with no queen and no means to make one will **build emergency cells on it within a few days**; a queenright colony simply rears the brood.

This is a definite answer when repeated searching has failed, it costs one frame of brood, and it gives the colony the means of requeening itself if it is indeed queenless.

14.9.2 Drone-laying queen versus laying workers

This distinction is examined repeatedly, and it matters because the remedies differ completely.

	Drone-laying queen	Laying workers
Eggs	Single, centered at the cell base	Multiple per cell, placed erratically on the cell walls
Pattern	Normal-looking laying pattern	Scattered, erratic
Brood	Drone brood with domed cappings in worker cells	Drone brood with domed cappings in worker cells
Queen	Present — and looks normal	Absent
Cause	Poor mating, or exhausted spermatheca	Prolonged queenlessness with no young larvae
Remedy	Find and remove her, then introduce a new queen	See below — much harder

The key discriminator is the eggs: single and centered versus multiple and off-center.

A drone-laying queen must be found and removed before a new queen can be introduced, and beekeepers frequently fail to find her because they are looking for something abnormal rather than for a normal-looking queen going about her business.

14.9.3 Laying workers

Laying workers develop when a colony has been queenless for an extended period with no young larvae remaining. Worker ovaries, normally suppressed by queen and brood pheromone, activate. They cannot mate, so all their eggs are unfertilized and produce **drones**.

Why introducing a mated queen usually fails: laying workers with activated ovaries behave in some respects as though the colony were queenright, and they and the colony's remaining bees typically **ball and kill** an introduced queen.

Approaches that improve the odds:

1. **Combine the laying-worker colony with a strong queenright colony over newspaper.** This is the **most reliable remedy**, and it recovers the bees and equipment with the least trouble.
2. **Give repeated frames of open brood** from a healthy colony at intervals of about a week, for three weeks. Brood pheromone suppresses laying-worker ovary development, and the colony may then rear its own queen or accept one.
3. **Shake all the bees out** some distance from the hive, on the theory that the heavier laying workers are less able to return, then reassemble the equipment and introduce a queen. This works less reliably than it is claimed to, and is best combined with one of the above.

The practical judgment, and the one an examiner is looking for: a laying-worker colony is often **not worth the effort of rescuing**, and combining it into a sound colony is usually the best use of the beekeeper's time.

14.10 Requeening

14.10.1 The sequence

To requeen a colony — for instance, one that has become defensive:

1. **Locate and remove the old queen.**
2. **Wait a few hours**, so that the colony registers her absence.
3. **Destroy any cells started.**
4. **Introduce the new queen caged.**
5. **Check for cells again about a week later.**

Step 5 is the step most often skipped and the most common reason a requeening fails. The colony starts emergency cells from the old queen's larvae, a virgin emerges, and she kills the queen you paid for.

Do not let the colony rear its own replacement when the object is to change temperament or genetics: an emergency queen from that colony carries the **same maternal genetics** and will mate with the **same local drones**.

Bear in mind also that requeening changes the workforce only gradually, over about **six weeks**, as the old workers are replaced by the new queen's daughters (Chapter 6). The colony must be handled with appropriate precautions in the interim.

14.10.2 When to requeen

A productive queen typically heads a colony for one to two years before replacement becomes advisable. A queen may live several years, but her **productive prime is shorter**, and colonies with older queens **swarm more and dwindle sooner** as pheromone output and laying rate decline.

Systematic requeening on a one- or two-year cycle gives predictability and an opportunity to improve stock. The counterpoint worth stating: a **demonstrably excellent queen can be worth keeping**, and requeening always carries an acceptance risk. **Performance rather than age should decide.**

14.10.3 The Southeastern timing point

Late summer and early fall requeening is widely recommended in the Southeast, and the examination tests this as a true/false item with the claim reversed.

The long warm season is what makes it practical: **there are drones flying and time for a young queen to mate and prove herself before winter.** A young queen produces a better cohort of long-lived winter bees, and she carries a much lower swarming impulse into the following spring — which matters a great deal in a region where swarm season opens in late February or March.

The objection sometimes raised — that a young queen keeps the colony rearing brood through the winter and so consumes stores — misreads the situation. **Winter brood rearing in this region is a fact of the climate, not a penalty of a young queen** (Chapter 20).

14.11 Packages, Nucs and Splits

14.11.1 Package versus nucleus colony

	Package	Nucleus colony (nuc)
What it is	A screened box of loose bees , typically 2–3 lb, with a caged queen unrelated to them ; no comb, no brood	A small but complete functioning colony on drawn frames: laying queen, brood of all stages, stores, adhering bees
Advantage	Cheaper; more widely available early in the season; carries no comb , so less risk of importing disease or small hive beetle	Already a working colony with brood and drawn comb; builds faster with less risk of failure
Drawback	Must draw comb from nothing; needs continuous feeding; higher failure rate; bees are unrelated to their queen	More expensive; comes with comb of someone else's history; usually available later

Timing matters for a Southeastern beginner: a package installed in **March** has the whole spring flow ahead of it; a nuc bought in **May** may miss the main flow but is better positioned to survive the summer dearth.

14.11.2 Installing a package

The standard practice is to install the package and suspend the caged queen between frames with the candy available, letting the bees release her over a few days, then confirm laying.

The reason for the delayed release: **the bees in a package come from multiple colonies and are not related to the queen**, and have not accepted her. A direct release at installation risks their killing her.

Additional standard practice:

- **Feed syrup continuously** until the bees are drawing comb and foraging well. A package on foundation cannot draw comb without a flow or feed, and slow comb drawing in a new package almost always means inadequate feeding.
- **Provide drawn comb** where available; it transforms the establishment period.
- **Reduce the entrance** to prevent robbing — a real risk in the Southeast even in spring.

14.11.3 Worked example: the failing package

A colony installed as a package on 1 April is inspected on 20 April. The queen was released, but there are no eggs, no larvae and no queen cells, and the bees have drawn only two frames of comb.

Diagnosis. The likely possibilities are that the queen was lost or killed after release; that she is present but not laying or failing; or that the colony is too small and underfed to build.

The informative detail is the absence of queen cells. A queenless colony that had eggs or young larvae would normally have started cells. Their absence, combined with no brood at all, suggests the colony **never had eggs to work with** — consistent with the queen never having laid.

Next steps:

1. **Search carefully for the queen.**
2. If she is not found, **insert a test frame of eggs and young brood** from a healthy colony and check in three to four days for **emergency cells**, which confirms queenlessness.
3. Meanwhile, **feed 1:1 syrup continuously** and **reduce the entrance**.
4. If queenless, **introduce a mated queen promptly** rather than letting the package dwindle.

Note the second finding: **comb drawing has been slow**, which points to inadequate feeding independently of the queen problem. Both need fixing.

Numbers to Memorize

Item	Figure
Virgin maturation before mating flights	about 5–6 days
Drone congregation area altitude	about 30–100 ft
Matings per queen	a dozen to 20+ drones
Emergence to laying	about 10–14 days (up to 3 weeks in poor weather)

Item	Figure
Graft to capped cell	about 4–5 days
Graft to cell transfer	about day 10
Graft to emergence	about 11–12 days
Graft to laying queen	about 3–4 weeks
Grafting larval age	under 24 hours
Queen productive life	1–2 years in a production colony
Requeening: temperament change	about 6 weeks (two brood cycles)
Queen marking, 2026	White
Package size	2–3 lb of bees

Key Terms

Drone congregation area (DCA) — an aerial site where drones gather and mating occurs.

Spermatheca — the organ in which the queen stores sperm for life.

Preoviposition period — the interval between final mating and the start of laying.

Polyandry — mating with many males; in honey bees, a dozen to twenty or more.

Cell builder / starter / finisher — the colony or colonies that accept, provision and complete queen cells.

Cloake board — a divider allowing a colony to be made functionally queenless for the graft and queenright for finishing.

Ripe cell — a queen cell one to two days from emergence, ready to move.

Mating nucleus — a small colony used to house a virgin queen through mating.

Test frame — a frame of eggs and young larvae given to confirm queenlessness.

Balling — workers clustering tightly around and killing an introduced or foreign queen.

Shot brood / pepperbox — the regular scattered empty cells of inbreeding, from removal of diploid drones.

Piping (tooting and quacking) — sounds from free and confined virgin queens.

Self-Check

- (SA)** Describe where and how a queen mates, including approximately how many drones she mates with.
- (MC)** In grafting for queen rearing, the correct target larval age is: A) The youngest larva that can be handled, ideally under 24 hours from hatching B) A larva just about to be capped, at about 8 days from the egg C) A larva 3 to 4 days old, easier to see and robust enough to transfer D) Any age, provided royal jelly is supplied after grafting

3. (SA) Explain why a cell builder colony should be strong, well fed and rich in young bees, and state whether it should be queenright or queenless.
4. (MC) Ripe queen cells should be moved to mating nuclei or an incubator: A) After all queens have emerged B) Immediately after grafting C) At the moment the cells are capped D) About one to two days before expected emergence, since queen pupae are vulnerable to chilling and jarring earlier and the first to emerge destroys the rest
5. (SA) Describe the standard procedure for introducing a caged mated queen into a queenless colony, and state the two errors that most commonly cause rejection.
6. (MC) A colony shows single eggs centered in worker cells and a normal laying pattern, but essentially all sealed brood is drone brood with domed cappings in worker cells. The likely diagnosis is: A) Chalkbrood B) A drone-laying queen C) Early American foulbrood D) Laying workers
7. (TF) Queens shipped by mail should be refrigerated at around 40 °F on arrival until they are introduced.
8. (MC) The international queen marking color for a queen introduced in 2026 is: A) Red B) Yellow C) White D) Green
9. (SA) Explain why introducing a mated queen into a colony containing laying workers usually fails, and describe two approaches that improve the odds.
10. (TF) Late summer and early fall requeening is generally avoided in the southeastern US because a young queen keeps the colony rearing brood through the cold months.

Answers

1. A virgin queen flies to a **drone congregation area**, a location in the open air typically 30 to 100 feet above the ground where drones from many colonies over a radius of several miles gather on warm afternoons. She mates **in flight** with a dozen to twenty or more drones, often over one to several flights across a few days, and stores their sperm in her **spermatheca** for the rest of her life. Mating drones die in the act. Two practical consequences: open mating cannot be controlled, since her daughters' fathers come from every colony within several miles including feral ones — which is why purchased breeder genetics do not persist in open-mated daughters; and extended cool or rainy weather during the mating window produces poorly mated queens that fail early.
2. A. Queens reared from older larvae are smaller, carry fewer ovarioles and smaller spermathecae, and are more often superseded. Practical aids: confine the breeder queen to synchronize larval age, graft in good light with magnification, and keep larvae from chilling or drying.
3. Queen cells are provisioned by nurse bees from their brood food glands, so the colony must contain a large population of young bees with well-developed glands, abundant incoming or supplied pollen and nectar, and enough bees to hold the cells at brood nest temperature. **Both states have an advantage and the good answer states the trade-off: a queenless colony accepts grafts at a much higher rate, because the absence of queen pheromone releases the impulse to rear queens; a queenright colony feeds and finishes cells better, because it is stable and well provisioned. The common practice is therefore to start cells in a queenless**

starter and finish them in a queenright finisher above an excluder, or to use a Cloake board arrangement achieving both in one colony.

4. D. With a graft of a larva about one day old, cells are capped roughly four to five days later and emerge roughly eleven to twelve days after grafting, so the move is usually made about day ten. Keep cells upright, warm and out of direct sun — in a Southeastern summer, never on a truck seat.

5. Confirm the colony is genuinely queenless and **destroy every queen cell present**. Place the cage between two brood frames near the center of the cluster, screen side accessible to the bees, with the candy plug end positioned so bees can eat through it, and leave the colony undisturbed for several days. Check after about four to seven days to confirm release, and a week later to confirm laying, without disturbing the colony in between. **The two most common errors are failing to confirm true queenlessness or leaving a queen cell present, and opening the colony too soon or too often.** Acceptance is poorer during dearth and robbing pressure, so late-summer introductions in the Southeast benefit from feeding and reduced entrances.

6. B. The single, centered eggs are the key — laying workers place multiple eggs erratically on cell walls. A drone-laying queen must be found and removed before a new queen can be introduced, and beekeepers frequently fail to find her because they are looking for abnormal behavior rather than a normal-looking queen.

7. False. Refrigeration is itself a temperature extreme, and chilling damages stored sperm just as overheating does. The damage leaves no outward sign, so an affected queen may be accepted, lay well briefly, then go patchy or drone-heavy or be superseded. Hold queens at moderate room temperature, out of direct sun, with the attendants able to reach the candy, and introduce them without long delay — and never leave a queen in a mailbox or a closed vehicle.

8. C. White. The cycle runs white for years ending in 1 or 6, yellow for 2 or 7, red for 3 or 8, green for 4 or 9, blue for 5 or 0. Mnemonic: “Will You Raise Good Bees.”

9. Laying workers with activated ovaries behave in some respects as though the colony were queenright, and they and the remaining bees typically ball and kill an introduced queen. Approaches that improve the odds: **combine the laying-worker colony with a strong queenright colony over newspaper**, which is the most reliable remedy; **give repeated frames of open brood** from a healthy colony at weekly intervals, since brood pheromone suppresses laying-worker ovary development and the colony may then rear its own queen or accept one; or **shake all the bees out** some distance from the hive, on the weakly supported theory that laying workers are less able to return, then reassemble and introduce a queen — a method that works less reliably than claimed. The practical judgment is often that a laying-worker colony is not worth rescuing, and that combining it into a sound colony recovers its bees and equipment with the least trouble.

10. False — the regional practice is the reverse. Late summer and early fall requeening is widely recommended in the Southeast, and the long warm season is what makes it practical: there are drones flying and time for a young queen to mate and prove herself before winter. A young queen produces a better cohort of long-lived winter bees and carries a much lower swarming impulse into the following spring. Winter brood rearing in this region is a fact of the climate rather than a penalty of a young queen.

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Chapter 15: Pests and Diseases

Learning Objectives

When you have finished this chapter you should be able to:

- Work a differential diagnosis from a sign rather than jumping to a conclusion.
 - Recognize American foulbrood in the field, state the immediate containment steps, and explain why destruction is prescribed.
 - Distinguish European foulbrood from American foulbrood and explain why the management differs.
 - Recognize chalkbrood, stonebrood, sacbrood and chilled brood.
 - Recognize the plant-toxin brood disorders of the Southeast.
 - Explain the role of *Varroa* in viral disease and recognize the principal viral presentations.
 - Explain *Nosema*: what it is, how it is diagnosed, and what can be done about it now.
 - Collect and submit a diagnostic sample correctly.
 - Describe the small hive beetle's life cycle and manage it by IPM principles.
 - Manage wax moth, and recognize it as a symptom rather than a cause.
 - Manage fire ants, skunks, bears, mice, yellowjackets and hornets.
 - Describe an apiary and honey house sanitation program.
 - Explain comb rotation and equipment sterilization.
 - State the current regulatory position on antibiotics in beekeeping.
-

15.1 Diagnosis Before Treatment

Before the catalogue, the method — because the method is what the examination is really testing.

A sign is not a diagnosis. The recurring structure of the applied-scenario items is a sign with several possible causes, offered in a way that invites a jump to the most familiar one.

15.1.1 The spotty brood pattern differential

At least nine conditions produce spotty brood:

Cause	Discriminating evidence
American foulbrood	Sunken, greasy, perforated cappings; ropiness; adherent scale; glue-pot odor
European foulbrood	Larvae dying uncapped , twisted, yellow-brown; remains lift out easily; sour odor
Varroa and viruses	Deformed wings, mite counts above threshold, white mite faeces in cells

Cause	Discriminating evidence
Chilled brood	Sharply bounded dead patch at comb margins or on an exposed comb; all stages dead
Chalkbrood	Chalky mummies in cells, on the bottom board, at the entrance
Failing / poorly mated queen	Drone brood in worker cells, supersedure cells, declining laying
Laying workers	Multiple off-center eggs, drone brood, no queen
Inbreeding	Up to about 25% empty in an otherwise healthy nest; no disease signs; negligible mites
Pollen- or honey-bound nest	Combs packed; queen restricted; no disease signs

Why it matters: a beekeeper who automatically requeens on seeing spotty brood may replace a sound queen while leaving a mite infestation or a foulbrood infection running.

15.1.2 The pattern-reading rule

Chilling kills whatever happens to be in the chilled zone irrespective of stage or age, giving a **sharply bounded patch** at the margins of the nest or on comb that was exposed or separated.

Infectious disease produces mortality **scattered according to susceptibility and stage**.

A commonly examined false statement reverses these. Reading the pattern backwards sends a beekeeper hunting a pathogen when the real cause was a long inspection in cool weather or a colony left too weak to cover its brood.

15.1.3 The adult mortality differential

Many dead and dying adults in front of several hives, some trembling on the ground:

- Acute **pesticide** poisoning (Chapter 13)
- **Chronic bee paralysis virus**
- *Nosema* with other stressors
- **Spiroplasma** infection
- **Robbing**-related fighting mortality
- **Toxic plant** poisoning

Discriminators: how many colonies and apiaries affected; suddenness of onset; extended proboscis and tremor; what has been applied nearby; whether it is specifically the **field force** that is gone.

15.2 American Foulbrood

15.2.1 The organism

American foulbrood (AFB) is caused by *Paenibacillus larvae*, a spore-forming bacterium whose spores are the infective stage and which remain viable in comb, honey and equipment for decades — commonly cited as 35 years or more, and possibly indefinitely.

The spore-forming character is what makes AFB **categorically different** from every other brood disease. Understand these facts and everything else follows:

- **Only the spore is infective.** The vegetative rods do not spread the disease.
- **Only very young larvae are susceptible** — roughly the first day or two after hatching. As few as about **ten spores** can infect a larva of that age.
- **A single diseased larva produces on the order of a billion or more spores.**
- **Adults are not susceptible**, but carry spores throughout the colony as they clean out infected cells.
- **Spores survive normal cleaning, freezing, and honey processing.**

That last point has a corollary examined directly: **freezing comb at 0 °F kills wax moth and small hive beetle but does nothing to AFB spores.** It is not a foulbrood control.

15.2.2 Field signs

Look for, in a careful cell-by-cell examination in good light:

1. **A spotty, irregular brood pattern** — scattered capped cells among empty ones.
2. **Cappings sunken, darkened, greasy or moist** in appearance, and often **perforated with irregular holes** (not the neat round hole of an emerging bee).
3. **A foul, glue-pot odor** — the characteristic AFB smell, described as like a hot glue pot or dirty socks.
4. **Larvae that died after capping**, discolored from creamy white through tan to coffee-brown.
5. **A ropy strand of one inch or more** drawn out when a matchstick or twig is inserted into a diseased larva and slowly withdrawn.
6. **Hard, dark, brittle scales lying flat along the lower cell wall**, adhering so tightly they cannot be removed intact.
7. Sometimes **a fine tongue-like projection** — the pupal proboscis — extending from the scale across the cell.

The two most useful discriminators from EFB are the ropy strand and the adherent scale.

15.2.3 The ropiness (matchstick) test

Insert a small stick into a **discolored, sunken-capped** cell, stir, and **draw it out slowly**. If the remains rope out in a strand of an inch or more, that is highly suggestive of AFB.

It is presumptive, not confirmatory. Decomposing larvae from other causes can occasionally produce a short, weak string, and a negative result does not exclude AFB in early or atypical cases. Confirmation comes from a laboratory. **The beekeeper's job in the field is to recognize the possibility and contain it.**

15.2.4 Why a strong colony can be infected

Adults are not susceptible and only young larvae are infected, so the adult population looks normal until brood losses build over weeks.

This is why AFB inspection is a careful, cell-by-cell examination of the brood in good light, and why an assessment based on colony vigor or entrance activity is worthless for this disease. It is also why **regular brood inspection, rather than occasional glances, is a genuine biosecurity practice.**

15.2.5 What to do first

You suspect AFB in one colony of a twelve-colony apiary. Before anything else:

1. **Stop moving frames, bees or tools between colonies.**
2. **Close the hive.**
3. **Disinfect your hive tool and gloves.**
4. **Call the state apiary inspector.**

Most apiary-wide AFB outbreaks are created by the beekeeper's own equipment sharing during the interval between suspicion and diagnosis. Isolation plus notification is the correct behavior.

Wrong answers, all of which appear as distractors: moving the suspect colony to an isolation yard some miles off (you have just moved the disease and its robbers); feeding antibiotics to the other eleven as a precaution; feeding an antibiotic to hold the infection while you re-inspect in a month; or burning and scorching on the spot and reporting later.

Antibiotic feeding suppresses signs without eliminating spores, masking the infection and allowing it to spread. And in the United States such use now requires **veterinary oversight** (§15.11).

15.2.6 Why burning

A single diseased larva produces on the order of a billion or more spores, and those spores remain viable in comb, honey and woodenware for decades and are not removed by any practical cleaning. Infected comb and bees therefore constitute a **permanent reservoir** capable of infecting an entire apiary or region.

Burning the bees, brood, frames and comb, and burying the ashes, destroys that reservoir.

Alternatives permitted in some jurisdictions:

- **Gamma irradiation** of equipment, offered commercially in some regions.
- **Salvage of the hive bodies alone,** by **scorching** the scraped interior surfaces until charred, or by **paraffin dipping** at high temperature — with the **comb and frames still destroyed.**

Local law governs, and in many states the inspector's direction is legally binding. AFB is a **notifiable or reportable condition in many states** (Chapter 9), and the state may have authority to order destruction. The rationale is that the disease is a community problem, not a private one.

Note for equipment planning: **scorching cannot be used on polystyrene equipment**, which is a consideration when choosing hive materials in an AFB region.

15.2.7 Scorching correctly

Scrape the interior clean of wax and propolis first, then char the wood evenly.

Wax and propolis **insulate the wood** and prevent the surface reaching the temperature needed to destroy spores, which is why scraping first is essential. **The visible standard is uniform charring**, not scorching to a light brown.

Scorching serves boxes, covers and bottom boards. **Comb must burn.**

15.2.8 The highest-risk activity in beekeeping

Buying or accepting used beekeeping equipment, especially drawn comb of unknown history, is one of the highest-risk things a beekeeper can do, precisely because AFB spores persist for decades.

Used comb of unknown origin is the classic route by which a beekeeper destroys their own apiary. Reasonable precautions:

- Establish the seller's health history and ask directly.
- **Inspect comb carefully in good light** for scale and perforated cappings.
- **Prefer equipment without comb.**
- **Sterilize woodenware** by scorching or irradiation before use.
- Check whether your state requires an **inspection or certificate** for a transfer of used equipment.

15.3 European Foulbrood

15.3.1 The organism and the mechanism

European foulbrood (EFB) is caused by *Melissococcus plutonius*, a bacterium that does not form spores.

The mechanism is different from AFB, and everything about the management follows from it: *M. plutonius* **competes with the larva for food in the larval midgut**. The larva starves rather than being killed by a toxin.

Consequences:

- **Larvae die uncapped**, before the cell is sealed.
- They **lie twisted or displaced** in the cell rather than stretched along the lower wall.
- They discolor **yellow to brown**.
- Remains **lift out easily** and do not adhere.

- Remains **rarely rope**.
- The odor is **sour**, not glue-pot.

Because the mechanism is competition for larval food, EFB is strongly associated with nutritional stress, rapid brood expansion and colony weakness. In the Southeast it is frequently seen during rapid March and April expansion and in colonies on pollination contracts with limited forage.

15.3.2 Management

Colonies frequently recover when the flow improves, when requeening provides a brood break, or when comb is replaced. That is why management options exist for EFB that do not exist for AFB:

- **Improve nutrition** — feed syrup and protein.
- **Requeen**, which provides a brood break and may introduce better genetics.
- **Replace comb.**
- **Shook swarm** — shake all adult bees onto new foundation and destroy the old comb. Used in strong colonies on a flow or with feeding, since it strips the reservoir in comb and brood at the cost of all the colony's brood and stores. This is recognized in several inspection services as an option for EFB. It is **not** an accepted substitute for destruction in confirmed AFB.
- **Antibiotics** where prescribed by a veterinarian — oxytetracycline is the only approved antibiotic labeled for EFB — though the underlying nutritional and management issues must still be addressed, and controlled work suggests many colonies recover without them (§15.11).

Recovery does not mean the organism has been eliminated, since it persists in the colony environment. Recurrence is common, and comb replacement is worthwhile.

15.3.3 The discrimination

	AFB	EFB
Organism	<i>Paenibacillus larvae</i> — spore-forming	<i>Melissococcus plutonius</i> — no spores
Persistence	Decades in comb and equipment	Seasons; does not persist like AFB
When larvae die	After capping	Before capping
Position	Stretched along lower cell wall	Twisted, displaced
Ropiness	Yes , an inch or more	Rarely
Scale	Hard, dark, adheres tightly	Lifts out easily, rubbery or dry
Odor	Glue pot	Sour
Cappings	Sunken, greasy, perforated	Fewer capped cells affected
Association	None particular	Nutritional stress, rapid build-up

	AFB	EFB
Management	Destruction; notify	Nutrition, requeening, comb replacement

Because field discrimination is imperfect and the regulatory consequences differ enormously, any suspicion of AFB should trigger containment and laboratory confirmation.

15.4 Fungal Brood Diseases

15.4.1 Chalkbrood

Caused by *Ascosphaera apis*, a fungus.

Recognition: hard, chalky white to grey or black mummified larvae in the cells, on the bottom board, and scattered at the hive entrance. Mummies at the entrance are frequently the first sign, since bees remove them, and a scattering of chalky white objects on the landing board is diagnostic enough to send you into the brood nest.

The **color difference** reflects whether both fungal mating types are present and spore cysts have formed: **white mummies** are vegetative; **grey to black mummies indicate sporulation and a heavier spore load.**

Predisposing conditions: cool, damp conditions; chilled brood; poor ventilation; colony weakness; nutritional stress. These point directly to the management response.

Management — a shaded, low-lying Alabama yard with persistent chalkbrood each spring:

Address the **predisposing conditions** rather than looking for a treatment, since **no chemical control is registered.**

- **Improve ventilation and reduce moisture:** relocate to a better-drained, sunnier site with morning sun; raise the hive on a stand; tip it slightly forward for drainage; ensure adequate top and entrance ventilation.
- **Strengthen the colony** so it can maintain brood nest temperature.
- **Avoid chilling brood** — keep cool-weather inspections brief.
- **Requeen with hygienic stock.** Hygienic behavior confers real resistance to chalkbrood.
- **Replace heavily affected comb.**
- **Ensure adequate nutrition.**

Requeening with hygienic stock and correcting the site are the two interventions with the best evidence behind them, and both are within reach of an ordinary beekeeper.

15.4.2 Stonebrood

Caused by *Aspergillus flavus* and related species — a different fungus from chalkbrood.

Distinguished from chalkbrood by its mummies being hard and, once sporulating, dusted green to yellow-green. Chalkbrood mummies are white, grey or black; stonebrood mummies are green.

Stonebrood is uncommon, but it warrants a **specific safety caution**: *Aspergillus flavus* and its relatives are **opportunistic human pathogens** and produce **mycotoxins** (aflatoxins). Gloves and respiratory protection are prudent when handling heavily affected material, and particularly so for anyone immunocompromised. Adult bees can also be affected.

15.4.3 Sacbrood

Caused by sacbrood virus.

Appearance: an affected larva **fails to pupate after capping**, lies **extended on its back with the head raised toward the cell opening**, changes from pearly white to pale yellow and then brown, and **when lifted out forms a fluid-filled sac** — because the larva failed to shed its final skin, and the fluid accumulates between the old cuticle and the body.

Dried remains form a **brittle, gondola-shaped scale with the head end curled up**, which **comes out of the cell easily** — unlike an AFB scale.

Distinguishing features from AFB: the scale is easily removed; there is **no ropiness**; and the affected larvae have the characteristic sac appearance and raised head.

Management: there is no specific treatment. Sacbrood is usually **self-limiting**. Maintain colony strength and nutrition, and requeen if the problem persists. It is most often seen in spring during rapid build-up.

15.4.4 Chilled brood

Not a disease. Brood killed by exposure to cold, whether from a long inspection on a cool day, a colony too weak to cover its brood, a brood nest split across boxes in cold weather, or an equipment failure.

The pattern is sharply bounded — a defined dead patch, typically at the margins of the nest or on a comb that was exposed or separated — and **all stages present in the chilled zone are killed** irrespective of age.

Prevention: keep cool-weather inspections brief; do not split the brood nest across boxes in cold weather (Chapter 20 on reversing); do not leave frames out of the hive; and do not give a colony more space than it can cover.

15.4.5 Plant-toxin brood disorders

Two Southeastern disorders that are **not infectious** and for which **no treatment exists**:

Purple brood — attributed to larvae being **fed nectar or pollen from summer or swamp titi (*Cyrilla racemiflora*)** while it blooms (about May–June), which turns the brood purple to blue-purple and kills much of it. The association with titi bloom is strong, but the toxin has not been identified, so extension sources describe titi as the suspected rather than proven cause (LSU AgCenter). It is confined to the titi bloom period in areas where the plant is abundant.

Recognizing it prevents unnecessary antibiotic use and misdiagnosis as foulbrood. Where the problem is severe, the response is to **move colonies away from heavy titi during bloom**.

Buckeye poisoning — spring nectar and pollen from *Aesculus* species are linked to brood mortality and deformed adult bees where the plant is abundant. Like purple brood, it is a plant-toxin disorder rather than a disease. The diagnostic clues are the **coincidence with a specific bloom period**, the **absence of infectious disease signs**, and the **local abundance of the plant**. The management response is relocation during bloom where the problem is significant.

15.5 Viruses

15.5.1 The central point

There are no registered treatments for honey bee viruses. Therefore:

Virus management is mite management.

Controlling *Varroa*, maintaining good nutrition, requeening failing queens and reducing colony stress are the practical means of managing viral disease. The most useful specific action is **mite control**, because *Varroa* is the vector that turns low-level covert infections into colony-lethal disease.

15.5.2 Covert and overt infection

Most honey bee viruses are present in most colonies at low levels without producing any visible sign — a **covert** infection. An **overt** infection is a high-level infection producing visible symptoms and colony damage.

The transition is driven principally by *Varroa*, which:

- **Injects virus directly into the bee, bypassing the gut** and the defenses that keep such infections harmless in a mite-free colony
- **Suppresses immune function** by feeding on the fat body
- **Amplifies** viral titers by orders of magnitude

Why this matters for management:

- **Testing positive for a virus is not by itself informative**, since almost every colony would.
- **The practical lever is not the virus but the mite.** Keeping mite levels low keeps infections covert.
- It explains why colonies at similar mite levels can differ in outcome, and why **late mite treatment sometimes fails to save a colony** whose winter bees were already reared under high viral load.

15.5.3 Deformed wing virus (DWV)

The one every beekeeper meets. *Varroa* transmits and greatly amplifies it, so deformed wings in emerging bees usually signal a serious mite problem, not a separate disease.

Presentation: emerging bees with **shriveled, useless wings** and **shortened, bloated abdomens**, crawling at the entrance, often ejected by the colony. DWV-A and DWV-B are distinct variants; DWV-B has become dominant in many regions and was among the viruses implicated in the record 2024–25 US losses.

What to do when you see it: go straight to a **mite count**, and almost always to a **treatment decision**. DWV persists at low levels without visible harm, so its visible expression marks a colony that is **already in trouble**.

15.5.4 Chronic bee paralysis virus (CBPV)

Two presentations, both CBPV, and the examination asks for both:

1. **Trembling, bloated, flightless adults** crawling at the entrance and on the ground, with **piles of dead outside**.
2. **Hairless, dark, shiny (“greasy”) bees** that guards reject and drive from the entrance.

Outbreaks are associated with crowding and confinement. Worth recognizing because it can be **mistaken for pesticide poisoning** (Chapter 13). There is no treatment; requeening and reducing crowding are the usual responses.

15.5.5 Parasitic mite syndrome (PMS)

Not a distinct disease. **A descriptive label for the mixed brood and adult symptoms of heavy *Varroa* infestation and its viruses**, which can **mimic foulbrood** and which resolves, on investigation, into viral disease.

Heavily infested colonies present with scattered brood, discolored and sunken cells, larvae dying in odd positions, and adult symptoms — a picture matching no single classical disease description.

The practical value of recognizing the pattern is that the correct response is a mite count and treatment, together with exclusion of foulbrood, rather than a search for an exotic pathogen.

15.5.6 Colony Collapse Disorder

Defined 2007–2010 as: **sudden loss of the adult bees with few dead in or near the hive, a laying queen and brood still present, and stores left unrobbed by pests** for an unusually long period.

No single cause was established; the consensus treats it as multifactorial. Reported incidence declined afterward, and **most current colony loss does not meet the case definition**. Use the term precisely.

15.6 *Nosema*

15.6.1 The organism

***Nosema* is caused by a microsporidian — *Nosema apis* or *Nosema ceranae* — infecting the adult midgut lining**, spread by spores in feces, comb and food, and shortening the life of infected bees.

Microsporidia are fungus-like intracellular parasites, not bacteria. Therefore **antibacterial antibiotics do nothing.** (Some authorities now place these species in the genus *Vairimorpha*; both names appear in current literature.)

Two species affect *Apis mellifera*, and ***N. ceranae* has become widespread in the United States.** The important clinical difference: ***N. ceranae* frequently causes no visible dysentery**, so a colony can carry a heavy infection with no outward sign.

15.6.2 Diagnosis

Fecal spotting is a sign, not a diagnosis. Brown spotting on the hive front and top bars follows from *Nosema* — but equally from unsuitable or fermented stores, excess moisture in the hive, or a long spell of confinement without a cleansing flight.

And the converse error matters just as much: *N. ceranae* often produces no dysentery at all, so a colony can carry a heavy infection behind a perfectly clean hive front.

Confirmation requires microscopy of a bee sample:

1. **Collect about 30 to 60 older bees**, preferably foragers or bees from the hive entrance rather than young house bees, since infection is concentrated in older bees.
2. **Crush the sample in a measured volume of water**, typically **1 mL per bee**.
3. **Examine a drop of the suspension under a compound microscope at about 400×**, where *Nosema* spores appear as **uniform, rice-grain-shaped, refractile bodies**.
4. **Quantify** by loading the suspension into a **hemocytometer** and counting, expressing the result as **spores per bee**. Values above roughly **one million spores per bee** are generally regarded as significant.

Two limitations to state: light microscopy gives a spore count but **does not distinguish *N. apis* from *N. ceranae***, which requires PCR; and a composite count is a **colony average** that does not establish that *Nosema* is the cause of an observed problem.

15.6.3 Management now

Fumagillin is the only drug marketed in the United States for *Nosema*. Supply was interrupted in 2018, when the manufacturer then serving the US market ceased production, but it is sold again as **Fumagilin-B** (Can-Vet Animal Health Supplies; US label revised July 2024). Points to know:

- **Its legal status is unusual.** The US product is listed by FDA as an “unapproved drug” marketed for honey bees, not a drug approved through a new animal drug application; its label indication is “an aid in the prevention of *Nosema*.” Follow the label exactly.

- **Timing and residues.** It is fed in sugar syrup (label rate 25 mg fumagillin per litre of syrup), the course must be **finished at least four weeks before the main honey flow**, and honey from the brood nest of treated colonies must not be harvested for human consumption.
- **Efficacy against *N. ceranae* is doubtful.** Fumagillin was developed against *N. apis*. Huang et al. (*PLoS Pathogens*, 2013) found that *N. ceranae* escapes fumagillin control and that the low residual concentrations left as the drug degrades can actually increase spore production; a 2024 review describes its efficacy, safety and availability as uncertain.
- **It does not touch spores in comb**, and it **degrades in stored syrup**, so it must be paired with comb replacement in any case.

Because of those limits, management rests chiefly on:

- **Comb sanitation.** Spores hold on comb and are re-ingested, so **replacing comb** — or treating it with **acetic acid fumigation** or **irradiation** — cuts the reservoir that reinfects bees. For a small beekeeper, simply **culling and replacing the oldest comb on a regular schedule** is the practical version, since irradiation services are not universally available and acetic acid requires careful handling and corrodes metal fittings.
- **Maintaining strong, well-fed colonies.**
- **Requeening failing queens.**
- **Avoiding the stresses that predispose colonies to infection** — confinement, poor nutrition, excessive moisture, and mite and virus load.

A common examination distractor holds that fumagillin kills spores in stored comb and that one autumn dose clears an apiary. It does neither. (Older texts and some examination keys also state that fumagillin is no longer sold in the United States; that was true during the post-2018 supply gap but is not true now.)

15.7 Submitting a Diagnostic Sample

Correct submission matters because a badly packed sample is a wasted sample, and the most common reason samples are returned as undiagnosable is one specific error.

For suspected foulbrood — a brood comb sample:

1. **Cut a piece of comb at least 2 × 2 inches** (the USDA Bee Research Laboratory's minimum; a larger piece is fine), containing as much of the dead or discolored suspect brood as possible, ideally including cells with **sunken or perforated cappings** and any **scale**.
2. **Do not include honey.**
3. **Wrap the sample in paper** — newspaper or a paper bag.
4. **Never wrap it in plastic, aluminum foil, waxed paper, or a tin or glass container.** Trapped moisture promotes mold that makes the sample unreadable. **This is the detail most often missed.**
5. Place it in a **sturdy cardboard box**.
6. Include a note with the **sender's name and address, hive identification, date, location and a description of what was observed.**

7. Mail it to the **USDA Bee Research Laboratory** (Beltsville) or the state's designated diagnostic laboratory.
8. **Notify the state apiary inspector.**

For *Nosema*, *Varroa* or tracheal mites — an adult bee sample: collect **at least 100 bees** into **70 percent alcohol** (ethyl, methyl or isopropyl) in a leak-proof container, and follow the laboratory's current instructions. The Beltsville diagnostic service is free to beekeepers in the United States and its territories.

For a suspected pesticide kill: see Chapter 13 — several hundred dead bees per hive, frozen immediately, with chain of custody through the state lead agency.

15.8 Small Hive Beetle

15.8.1 Arrival and significance

Aethina tumida was identified in the United States in Florida in 1998, with a 1996 South Carolina specimen later recognized as the first record for the country. The beetle is native to sub-Saharan Africa.

It spread rapidly through the Southeast and beyond and is now a **major pest across the region, far more damaging here than in cooler, drier states.**

The African origin matters biologically: in its native range it is a minor pest of colonies that are **more defensive and more prone to abscond**, whereas **European-derived colonies in the humid Southeast are poorly equipped to contain it.**

15.8.2 Life cycle

1. **Adults enter colonies** and are herded by the bees into cracks and corners, where they may be fed by trophallaxis (they solicit food from bees) or feed on pollen, honey and brood.
2. **Females lay eggs** in cracks, crevices and in brood comb.
3. **Larvae feed** on pollen, honey, brood and comb, **tunneling through the combs and defecating in the honey**, introducing a **yeast (*Kodamaea ohmeri*)** that ferments it and produces the characteristic **slimed, frothy, orange, foul-smelling mass.**
4. **Mature “wandering” larvae leave the hive and burrow into the soil near the hive**, generally within a few feet and at shallow depth.
5. **They pupate in the soil — this is the stage that occurs outside the hive —** and emerge as adults to seek a colony.

The soil pupation stage is the principal out-of-hive control opportunity, addressed where registered by a **labeled soil drench**. It is influenced by soil type and moisture: **moist, shaded soils (sandy soils especially, when kept damp) favor pupation**; hard, dry or well-drained ground is less favorable.

15.8.3 The single most important control

Keep a strong colony with enough adult bees to patrol and defend all of the comb, and give the bees no more space than they can cover.

Bees control beetles by confining and harassing them; a colony that cannot patrol its comb cannot do this. Every practical recommendation follows from that principle:

- **Do not over-super weak colonies.**
- **Reduce entrances.**
- **Avoid oversized protein patties** (Chapter 5).
- **Combine failing colonies** rather than letting them dwindle.
- **Remove supers promptly** after the flow.
- **Use follower boards** or smaller boxes so small colonies cover all their comb.

Traps and chemical controls are supplements to colony strength, not substitutes for it.

15.8.4 Traps

Three types, and the **common principle** behind them:

1. **Oil-filled tray traps beneath a screened bottom board** — beetles fall through and drown.
2. **Slotted plastic in-hive traps** placed between top bars or hung on frame ends, filled with oil or a diatomaceous-earth-and-oil mixture — beetles enter to escape the bees and cannot leave.
3. **Corrugated or grooved boards and cardboard** placed on the bottom board, where beetles hide and can be crushed or removed.

Entrance-mounted and bottom-board oil traps work similarly.

The common principle: exploit the beetles' behavior of seeking refuge in narrow spaces where bees cannot reach them, and make those refuges lethal.

Traps must be maintained. Oil must be refreshed; a neglected trap becomes useless or a nuisance. And traps reduce beetle numbers but **will not save a colony too weak to defend itself.**

15.8.5 Soil drench

A product registered and labeled for that use, applied per label to the soil around the hives to target the wandering larvae and pupae — and never inside the hive.

It targets the out-of-hive life stage and is one of the few chemical tools available. Because it is an **insecticide applied near colonies**, label compliance and careful application are essential, and it should be **one component of a program built on colony strength, trapping and sanitation** rather than the primary control.

Not acceptable: any broad-spectrum lawn insecticide; application across the bottom board or inner cover; and the idea that a drench controls flying adults.

15.8.6 Nucs, splits and mating nuclei

Small units are especially vulnerable, and this is one of the most consistent practical differences between Southeastern and northern beekeeping.

Why: small units have **few adult bees relative to their comb area**, so they cannot patrol and confine beetles effectively. A beetle population that a full colony would contain **can overwhelm a nuc within days**, leading to slimed comb and absconding.

Precautions:

- **Keep nucs tightly sized** so the bees cover all the comb; use follower boards or smaller boxes.
- **Reduce entrances.**
- **Install and maintain beetle traps.**
- **Avoid pollen patties**, or use only small pieces.
- **Place nucs in sun** rather than deep shade.
- **Inspect frequently** — a nuc can be lost between weekly visits.
- **Combine or build up** any nuc that is losing ground rather than hoping it recovers.

15.8.7 Slime-out

Several frames covered in a foul-smelling, frothy orange mass, cream-colored larvae crawling through the comb, few adult bees remaining.

Diagnosis: small hive beetle slime-out. The larvae have destroyed the comb and the introduced yeast has fermented the honey.

What to do with the colony: it is effectively lost. If a queen and a worthwhile cluster of bees remain, they can be shaken onto clean equipment and combined with a strong colony, though this is often not worth doing.

What to do with the equipment and the apiary:

1. **Remove the hive from the apiary promptly** so it does not seed beetles into neighboring colonies.
2. **Destroy the slimed comb.** Scrape and render frames only if damage is limited; heavily slimed comb should be discarded.
3. **Wash and scrape the boxes, bottom board and covers, and dry them thoroughly in sunlight** before reuse.
4. **Consider a labeled soil drench** at that hive position where pressure is high.
5. **Inspect the remaining colonies in the yard.**

Do not feed slimed honey back to the bees. It carries the yeast and the odor that attract further beetles, so returning it to the apiary propagates the problem — and bees will generally refuse it in any case.

And the step that separates a competent response from a merely tidy one: ask **why** the colony became weak enough to be overwhelmed. Slime-out is an **end point**, almost always of an earlier problem — queen failure, mite damage, or being given too much space. Look for that cause in the rest of the yard.

15.8.8 The honey house

A honey house that holds supers for a week in hot weather will find small hive beetle larvae developing unchecked in the undefended comb, sliming the supers and ruining the crop before it reaches the extractor.

Extract within one to two days; hold supers in a beetle-tight and preferably cooled or dehumidified room; freeze comb where practical; and handle cappings and wet comb immediately (Chapter 8).

15.9 Wax Moth

15.9.1 The damage

The greater wax moth (*Galleria mellonella*) causes damage principally by larvae tunneling through comb for pollen, cocoons and debris, leaving silk galleries and frass and ruining comb — worst on **old dark comb** and in **stored comb or weak colonies**. The lesser wax moth (*Achroia grisella*) does the same on a smaller scale.

The key biological fact: **the larvae depend on the protein in pollen and cocoon residue rather than on pure wax**. That is why **old dark brood comb is destroyed rapidly while clean new comb is comparatively resistant** — and why culled dark comb must be rendered promptly rather than stored.

15.9.2 Wax moth is a symptom

Wax moth damage in an occupied colony signals that something else has weakened the colony. A strong colony keeps it in check. The same is true of small hive beetle.

Both are **principally secondary, opportunistic pests**. Damage inside an occupied hive is a symptom asking a question: **why has this colony become too weak to defend itself?** The answer is usually queen failure, *Varroa* and its viruses, disease, starvation, or simply too much space for the bees present.

Treating the pest alone leaves the cause running. The one qualification worth adding: heavy beetle pressure in this region can push a colony that is **already faltering** over the edge very quickly, so the two are not strictly sequential.

15.9.3 Protecting stored comb

Covered in Chapter 7. In summary: **freeze at 0 °F for 24–48 hours** then store moth-tight; **store in light and moving air**; treat with a *Bacillus thuringiensis* subsp. *aizawai* product registered and labeled for stored comb; or use cold storage. **Naphthalene is never acceptable**. **Paradichlorobenzene** is EPA-registered for empty stored comb only and is lawful only as its label directs (never on comb with honey or on comb honey; air combs out before reuse); because it leaves residues in wax, non-chemical methods are preferred. And because Southeastern winters are mild, **wax moth remains active far longer than in the North**, so stacking comb in an unheated shed does not work here.

15.10 Predators and Other Pests

Imported fire ants (*Solenopsis invicta*) — overwhelm weak colonies, nucs and newly hived swarms, taking brood and stores, harassing the bees, and making the apiary **hazardous for the beekeeper**. Controls in Chapter 7: stands with oil or grease barriers, cleared vegetation, strong colonies, and approved bait applied to mounds at a distance from the hives per label.

Skunks — indicated by **nighttime scratching at the entrance, trampled or matted grass in front of the hive, scratch marks on the hive front, and a colony that has become unusually defensive during the day**. The skunk scratches at the entrance night after night and eats the bees that come out, depleting the colony and leaving it chronically agitated. Controls: raise hives on stands so the skunk must expose its underside; tack strips or hardware cloth in front of the entrance; and, where legal and appropriate, trapping. Opossums and raccoons cause similar damage.

Black bears — the correct primary response in a north Georgia or western North Carolina apiary is **a well-built and maintained electric fence with adequate output, good grounding, cleared vegetation and baited wires, ideally installed before any damage occurs**. Prevention precedes damage: once a bear associates an apiary with food, the problem is much harder to solve. Fence effectiveness depends on energizer output, grounding, wire spacing and vegetation clearance, and on **baiting the wires** so the bear touches them with its nose. Bears are protected game animals, so any other response is governed by **state wildlife law**, and some states require a functioning fence before compensation is available. Strapping hives down, feeding the bear elsewhere and moving the apiary after each raid are all wrong answers.

Mice — fit an entrance reducer or mouse guard of roughly 3/8-inch openings **in autumn, before cold weather drives mice to seek shelter and while the colony is still defending its entrance** (Chapter 7).

Yellowjackets and hornets — **reduce the entrance so the colony can defend it, keep colonies strong, remove nearby nests where safe and lawful, and bait traps away from the hives**. Wasp pressure peaks in late summer and autumn, coinciding with the Southeastern dearth when colonies are already stressed and robbing pressure is high. **Do not spray insecticide at a hive entrance**; it kills bees and contaminates the colony. See Chapter 4 for identification, including the **yellow-legged hornet**, *Vespa velutina*, confirmed in Georgia in 2023 and reportable to the Georgia Department of Agriculture.

Dragonflies, birds, toads, lizards — minor, generally not worth managing.

15.11 Antibiotics: the Current Position

The antibiotics approved for honey bees — oxytetracycline, tylosin and lincomycin — all require veterinary oversight, and preventive use is discouraged since it masks disease, breeds resistance and leaves residues.

The 2017 change in FDA policy (Guidance for Industry 213 and the Veterinary Feed Directive rule) brought **medically important antimicrobials for honey bees under veterinary oversight**, aligning apiculture with other livestock sectors; Guidance for Industry 263 (2023)

completed the move by ending over-the-counter sale of the remaining forms. Oxytetracycline in feed now requires a **veterinary feed directive (VFD)**, and tylosin, lincomycin and the other oxytetracycline forms require a **prescription**.

Know which drug is labeled for which disease. Oxytetracycline is the only one of the three labeled for **European foulbrood** as well as American foulbrood; **tylosin (approved 2005) and lincomycin (approved 2012) are labeled for American foulbrood only**. A recent controlled trial (Jose et al., *Journal of Insect Science*, 2026) found that all three improved EFB-affected colonies but that sham-treated controls also recovered, a reminder that EFB is often self-limiting once the colony's stress is relieved.

The substantive point behind the rule is more important than the rule: **antibiotics treat vegetative bacteria and do nothing about spores**. A treated AFB colony **remains infectious and its equipment remains contaminated**. The antibiotic suppresses the visible signs, which is worse than useless, because it allows an undiagnosed reservoir to persist and spread.

Practically:

- **Establish a relationship with a veterinarian willing to work with bees before an emergency arises.** Not every veterinarian will, and the time to find out is not the day you find ropy brood.
- **Keep records** that support a diagnosis.
- Understand that the **veterinarian's role complements rather than replaces the state apiary inspector**, whose statutory functions concern notifiable disease and movement control.

15.12 Comb Rotation

Comb rotation is the systematic culling and replacement of the oldest brood combs, commonly about 20 percent per year, so that no comb remains in use for more than about five years.

Three reasons:

1. **Accumulation of pesticide and miticide residues in beeswax**, which is lipophilic and holds them for years (Chapters 11, 13).
2. **Accumulation of pathogen spores and disease organisms** in old comb, including chalkbrood and *Nosema*.
3. **Progressive narrowing of cell diameter** from accumulated cocoons and debris, together with darkening and structural deterioration.

Old comb is also **more attractive to wax moth** and **more difficult to inspect** — you cannot see eggs against a black comb in poor light.

Implementation: mark frames with the year they are drawn. Move the oldest frames to the outside of the box as the season progresses, so the queen lays in them last, then remove them at the end of the season. In the Southeast, **render culled dark comb promptly** rather than storing it, since it is prime wax moth and beetle substrate.

15.13 Equalizing and Biosecurity

Moving frames of brood between hives moves whatever the donor colony carries — AFB and EFB, chalkbrood spores, *Nosema*, viruses and *Varroa*. Blind equalization can distribute a disease through an entire apiary in one afternoon.

To do it responsibly:

- **First determine why the recipient is weak.** Adding brood does not fix a failing queen or a mite problem.
- **Take brood only from colonies you have inspected carefully** and believe to be healthy.
- **Do not weaken a productive donor** below its own requirements.
- **Avoid moving comb between apiaries** or from colonies of unknown history.

Two habits that limit what equalization can move: clean the hive tool between colonies (a scrape and a flame, or a wipe with a suitable disinfectant), and **work known or suspect colonies last.**

15.13.1 Hygienic behavior

Hygienic behavior is the ability of workers to detect, uncap and remove diseased, dead or parasitized brood from sealed cells. It confers **real resistance to AFB, chalkbrood and, to a degree, *Varroa*** — **though not immunity.** It reduces incidence and severity rather than eliminating disease, so it complements rather than replaces inspection and good management.

A simple field test — the freeze-killed brood assay: kill a measured patch of sealed brood, commonly about 100 cells, by pouring **liquid nitrogen** into a cylinder pressed over the comb, or by **cutting a section of sealed brood, freezing it and returning it** to the colony. Return **24 hours later** and score the percentage removed. **Removal of about 95 percent or more indicates a hygienic colony.**

A **pin-kill test**, piercing a counted number of capped cells with a needle, is a lower-cost approximation.

Do not confuse general hygienic behavior with Varroa Sensitive Hygiene (VSH), which is a related but separately measured trait (Chapters 16, 19).

Selecting hygienic stock is one of the few genetic tools available to an ordinary beekeeper, and the test is well within the reach of a sideline operation.

15.14 Apiary and Honey House Sanitation

In the apiary:

- Keep colonies **strong and correctly sized** for their population.
- **Reduce entrances** on weak colonies and during dearth.
- **Maintain and service beetle traps.**
- **Remove burr comb, scrapings and dead-out equipment** from the yard rather than leaving it.

- **Deal promptly with failing or collapsing colonies.**
- Keep **vegetation cleared** and hives on **stands**.
- **Avoid spilling syrup** or leaving exposed comb.
- **Clean hive tools** between colonies; work suspect colonies last.

In the honey house:

- **Extract promptly**, within a day or two of removing supers.
- Keep the building **beetle-tight** and, where possible, **cooled or dehumidified**.
- **Process or freeze cappings and wet comb** rather than leaving them standing.
- **Return wet supers to colonies promptly** or store them properly (Chapter 8).
- **Clean up spills and debris the same day.**

Sanitation is unglamorous, but it is the practice that most reliably distinguishes apiaries that **manage** small hive beetle from apiaries that are **managed by it**.

Numbers to Memorize

Item	Figure
AFB spore viability	decades (35+ years)
AFB infective dose for a young larva	about 10 spores
Spores from one diseased larva	about 1 billion or more
AFB susceptible larval age	first about 1–2 days after hatching
AFB ropiness	strand of 1 inch or more
Foulbrood comb sample	at least 2 × 2 in, no honey, wrapped in paper
<i>Nosema</i> sample	30–60 older bees; 1 mL water per bee; 400×
<i>Nosema</i> significance threshold	about 1 million spores per bee
Freeze-killed brood assay	about 100 cells; score at 24 h; at least 95% = hygienic
SHB identified in US	Florida 1998 (1996 SC specimen)
Comb rotation	about 20% per year; nothing over about 5 years
Mouse guard opening	about 3/8 in
Freezing comb	0 °F, 24–48 h (does not kill AFB spores)

Key Terms

Ropiness test — drawing a stick slowly from a diseased cell to see whether the remains form a strand; presumptive for AFB.

Scale — the dried remains of a dead larva; hard and adherent in AFB, easily removed in EFB and sacbrood.

Shook swarm — shaking all adults onto new foundation and destroying the old comb; an option for EFB, not for AFB.

Scorching — charring scraped interior wood surfaces to destroy spores.

Slime-out — the fermented, frothy destruction of comb by small hive beetle larvae.

Wandering larva — the mature SHB larva leaving the hive to pupate in soil.

Covert / overt infection — virus present without visible signs / at levels causing visible disease.

Parasitic mite syndrome (PMS) — the mixed presentation of heavy *Varroa* infestation and its viruses.

Hygienic behavior — detection and removal of diseased or parasitized sealed brood.

Veterinary Feed Directive (VFD) — the written authorization from a licensed veterinarian required to feed medicated feed to bees since 2017. Other forms of medically important antimicrobials require a veterinary prescription.

Self-Check

- 1. (SA)** Describe the classic field signs of American foulbrood, including at least five observations.
- 2. (MC)** You suspect AFB in one colony of a twelve-colony apiary. Before anything else you should: A) Stop moving frames, bees or tools between colonies, close the hive, disinfect your hive tool and gloves, and call the state apiary inspector B) Move the suspect colony to an isolation yard and treat the others with antibiotic C) Pull frames for a lab test, feed antibiotic, and re-inspect in a month D) Shake the bees onto foundation, burn the comb on the spot, and report later
- 3. (SA)** Explain why burning is the standard prescribed response to confirmed AFB in most states, and name two alternatives that may be permitted.
- 4. (MC)** Which observation most strongly suggests European rather than American foulbrood? A) Dark scales adhering hard to the lower cell wall under sunken perforated cappings, with a pupal tongue B) Larvae dying after capping and slumping to the lower cell wall, roping out with a glue-pot odor C) Larvae dying uncapped, twisted in the cell and yellow to brown, remains lifting out easily, with a sour odor D) Larvae drying into hard chalky mummies dragged out onto the bottom board
- 5. (TF)** Chilled brood produces dead brood scattered through the nest according to individual susceptibility, whereas infectious brood disease kills all stages within a sharply bounded area.
- 6. (SA)** Explain how a beekeeper or laboratory determines whether a colony has a significant *Nosema* infection, and state two limitations of the method.
- 7. (SA)** Describe the life cycle of the small hive beetle, identifying the stage that occurs outside the hive.

- 8. (MC)** The single most important factor in preventing small hive beetle damage is: A) Keeping the brood nest open with spare drawn supers B) Keeping a strong colony with enough adult bees to patrol and defend all the comb, and giving the bees no more space than they can cover C) Keeping an oil tray under a screened bottom board at all times D) Keeping pollen patties on year round so beetles feed on the patty
- 9. (TF)** Wax moth or small hive beetle damage found in an occupied colony should be treated as the primary problem.
- 10. (SA)** Describe how to collect and send a brood sample to a diagnostic laboratory for foulbrood confirmation.
- 11. (MC)** The current status of antibiotic use in United States beekeeping is that: A) Federal rules bar antibiotic use in hives outright B) Veterinary oversight covers tylosin alone C) The approved antibiotics remain over-the-counter, with preventive dosing standard D) The approved antibiotics (oxytetracycline, tylosin, lincomycin) require veterinary oversight, and preventive use is discouraged since it masks disease, breeds resistance and leaves residues
- 12. (SA)** List five conditions that can produce a spotty brood pattern, and explain why this matters.

Answers

- 1.** A spotty, irregular brood pattern with scattered capped cells among empty ones; cappings that are sunken, darkened, greasy or moist and often perforated with irregular holes; a foul glue-pot odor; larvae that died after capping, discolored from creamy white through tan to dark brown; a ropy strand of an inch or more drawn out when a matchstick is inserted into a diseased larva and slowly withdrawn; and hard, dark, brittle scales lying flat along the lower cell wall, adhering so tightly they cannot be removed intact, sometimes with a fine tongue-like projection of the pupal proboscis across the cell. The scale adherence and the ropy strand are the two most useful discriminators from EFB. Any suspicion should be confirmed by the state apiary inspector or an approved laboratory rather than settled by field impression.
- 2. A.** Most apiary-wide outbreaks are created by the beekeeper's own equipment sharing between suspicion and diagnosis. Antibiotic feeding suppresses signs without eliminating spores, masking the infection, and such use now requires veterinary oversight.
- 3.** A single diseased larva produces on the order of a billion or more spores, and those spores remain viable in comb, honey and woodenware for decades and are not removed by any practical cleaning, so infected comb and bees constitute a permanent reservoir capable of infecting an entire apiary or region. Burning the bees, brood, frames and comb, and burying the ashes, destroys that reservoir. Permitted alternatives in some jurisdictions include **gamma irradiation** of equipment and **salvage of the hive bodies alone** by scorching the scraped interior surfaces until charred or by paraffin dipping, with the comb and frames still destroyed. Local law governs, and in many states the inspector's direction is legally binding. Note that scorching cannot be used on polystyrene equipment.
- 4. C.**
- 5. False** — the two patterns are reversed. Chilling kills whatever is in the chilled zone irrespective of stage or age, giving a sharply bounded patch at the margins of the nest or on comb that was exposed or separated. Infectious disease produces mortality scattered according

to susceptibility and stage. Reading it backwards sends a beekeeper hunting a pathogen when the real cause was a long inspection in cool weather or a colony too weak to cover its brood.

6. Collect about 30 to 60 **older** bees — foragers or bees from the entrance, since infection concentrates in older bees. Crush the sample in a measured volume of water, typically 1 mL per bee, and examine a drop under a compound microscope at about 400×, where *Nosema* spores appear as uniform, rice-grain-shaped refractile bodies. Quantify with a **hemocytometer**, expressing the result as spores per bee, with values above roughly one million per bee generally regarded as significant. **Limitations:** light microscopy gives a spore count but does not distinguish *N. apis* from *N. ceranae*, which requires PCR; and a composite count is a colony average that does not establish that *Nosema* is the cause of an observed problem. Note also that fecal spotting is not diagnostic, and *N. ceranae* often produces none at all.

7. Adults enter colonies and are herded into cracks and corners by the bees, where they may be fed by trophallaxis or feed on pollen, honey and brood. Females lay eggs in cracks, crevices and in brood comb. Larvae feed on pollen, honey, brood and comb, tunneling through the combs and defecating in the honey, introducing a yeast that ferments it and produces the characteristic slimed, frothy, orange, foul-smelling mass. Mature **wandering larvae leave the hive and burrow into the soil near the hive**, generally within a few feet and at shallow depth, where they **pupate** before emerging as adults. **The soil pupation stage is the one that occurs outside the hive**, and it is the principal out-of-hive control opportunity, addressed where registered by a labeled soil drench; moist, shaded soils (sandy soils especially, when kept damp) favor pupation.

8. B.

9. False. Both are principally secondary, opportunistic pests. A populous colony patrols its comb and keeps them in check, so damage inside an occupied hive is a symptom asking why the colony became too weak to defend itself — usually queen failure, *Varroa* and its viruses, disease, starvation, or too much space for the bees present. Treating the pest alone leaves the cause running, though heavy beetle pressure in this region can push an already faltering colony over the edge very quickly.

10. Cut a piece of comb at least 2 × 2 inches (the USDA laboratory's minimum; larger is fine) containing as much suspect brood as possible, ideally including cells with sunken or perforated cappings and any scale. **Do not include honey.** Wrap the sample in **paper** — newspaper or a paper bag — **never in plastic, foil, waxed paper, or a tin or glass container**, because trapped moisture promotes mold that makes the sample unreadable. This is the detail most often missed and the commonest reason samples are returned undiagnosable. Place it in a sturdy cardboard box, include a note with sender's name and address, hive identification, date, location and a description of what was observed, and mail it to the USDA Bee Research Laboratory or the state's designated diagnostic laboratory. Notify the state apiary inspector.

11. D. The substantive point behind the rule is that antibiotics treat vegetative bacteria and do nothing about spores, so a treated AFB colony remains infectious and its equipment remains contaminated.

12. Any five of: American foulbrood; European foulbrood; heavy *Varroa* infestation with associated viruses; chilled brood; a failing or poorly mated queen; laying workers; chalkbrood; inbreeding producing diploid drone removal; and a pollen- or honey-bound brood nest restricting laying. It matters because **spotty brood is a sign, not a diagnosis**: a beekeeper

who automatically requeens on seeing a spotty pattern may be replacing a sound queen while leaving the real problem — a mite infestation or a foulbrood infection — untouched. The professional habit is to examine the cells themselves, check capping appearance, test suspicious larvae, assess mite levels, and consider colony history and season before concluding.

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Chapter 16: *Varroa destructor*

Learning Objectives

When you have finished this chapter you should be able to:

- Explain why *Varroa* matters far more than the mites themselves would suggest, in terms a beginner can follow.
 - Describe the mite's reproductive biology and derive the management implications from it.
 - Explain the drone brood preference and use it as a management tool.
 - Perform an alcohol wash correctly, calculate an infestation rate, and compare the monitoring methods.
 - State when to monitor and why the late-summer count is decisive.
 - Define an action threshold, state the current seasonal thresholds, and explain why the late-summer threshold is the one that decides winter survival.
 - Compare the principal treatment classes by mode of action, temperature constraint, brood penetration and super restrictions.
 - Create and use a brood break.
 - Verify treatment efficacy and distinguish failure from reinvasion.
 - Work through the diagnostic sequence before concluding resistance.
 - Rotate treatments meaningfully.
 - Build an integrated year-round *Varroa* plan for a Southeastern sideline operation.
 - Read a *Varroa*-caused dead-out.
 - Explain tracheal mites and why they are less prominent today.
 - Describe *Tropilaelaps* and why it matters now.
-

16.1 Why *Varroa* Matters

This is the explanation a Journeyman beekeeper must be able to give to a beginner, and it is examined directly.

The mites feed on developing and adult bees, damaging the **fat body** — the tissue that supports immunity, food processing and the long life of winter bees. But their greater harm is that they act as a **hypodermic needle for viruses**, particularly deformed wing virus, injecting virus directly into the bee's body and bypassing the defenses that keep such infections harmless in a mite-free colony. A colony can therefore be destroyed by a mite population that seems small, because the real damage is **viral disease amplified by the mite**. That is why beekeepers monitor mite levels and act at thresholds of a few mites per hundred bees rather than waiting to see obvious damage.

Two refinements worth holding.

Fat body as well as hemolymph — depending on the stage. For decades it was taught that *Varroa* feeds simply on hemolymph. Ramsey et al. (2019, *PNAS*) showed that mites on

adult bees feed **primarily on fat body tissue**, reached through the membranes between the abdominal segments. Later work (Han et al. 2024, *Nature Communications*) refined the picture: mites in the **dispersal phase on adult bees** feed mainly on fat body, while mites **reproducing on pupae** inside sealed cells consume **mainly hemolymph**. Either way the damage lands on the tissues that matter most. The fat body is exactly the organ that determines whether an autumn-reared bee becomes a long-lived winter bee (Chapter 3), so the mite is not merely draining a bee; it is attacking the specific tissue the colony's overwintering depends on.

The virus is the killer. *Varroa* transmits and greatly amplifies DWV and several other viruses, converting covert infections into overt disease (Chapter 15). There are no registered treatments for bee viruses. **Virus management is mite management.**

And the failure mode that follows: **the most common failure in small-scale beekeeping is a beekeeper who believes their colonies look fine and does not monitor.** Being able to explain why that reasoning fails, clearly and without condescension, is a core Journeyman competency.

16.2 Reproductive Biology

***Varroa destructor* reproduces inside sealed brood cells.** A foundress mite enters a cell containing a larva **just before capping**, hides in the brood food beneath the larva, and after capping begins feeding on the developing bee. About **60–70 hours after capping** she lays a first, unfertilized **male** egg, then a series of **female** eggs at roughly **30-hour intervals** (reported range about 20–32 hours) — up to about six eggs in a worker cell and seven in a drone cell (Roth et al. 2020). The offspring mature and **mate with their brother inside the cell**, and the mated daughters emerge with the adult bee.

Every management tool follows from this single fact. Work through it:

Fact	Consequence
Reproduction occurs only in sealed brood	A brood break halts mite reproduction entirely
Mites in sealed cells are shielded by the capping	Treatments that do not penetrate cappings reach only mites on adult bees
Drone brood is capped about 2–3 days longer	More mite offspring mature per foundress › drone brood is both a mite amplifier and a trapping opportunity
Mites ride adults between cells	Mites move with drifting and robbing bees between colonies
Population grows multiplicatively	Mite numbers climb through the season ; a low spring count does not predict a safe autumn

The phase spent riding adult bees is traditionally called the **phoretic** phase; the current literature increasingly prefers **dispersal phase**, because the mite is feeding on the adult bee during it, not merely hitching a ride.

16.3 The Drone Brood Preference

Drone brood remains capped roughly two to three days longer than worker brood, which allows more mite offspring to complete development and mate before emergence. A foundress entering a drone cell produces more mature daughters than one entering a worker cell, and mites are correspondingly **more attracted to drone cells** — in a classic study the infestation per cell averaged about **8 times** higher in drone brood (Fuchs 1990: 8.3×), and figures of 8 to 10 times are commonly quoted.

Drone brood trapping exploits this:

1. Place a frame of **drone comb**, or a drone-comb section, in the brood nest.
2. Allow the queen to lay it up and the mites to concentrate in it.
3. **Remove the frame after it is capped but before the drones emerge** — typically by freezing it, then returning it for the bees to clean and reuse.
4. Repeat on a strict schedule.

The critical caution: a drone frame left too long becomes a mite amplifier rather than a trap. If the drones emerge, you have reared a bumper crop of mites and released them into the colony. The schedule is not optional. Mark your calendar; use a green frame so it is unmistakable.

The technique is labor-intensive and removes drones, so it suits **smaller operations**, and it should be **combined with monitoring** rather than relied on alone.

16.4 Monitoring

16.4.1 The alcohol wash

The standard sample is about 300 bees — roughly half a cup — taken from a brood frame so that nurse bees are sampled, after confirming the queen is not on that frame.

Three elements matter and all three are examined:

1. **The 300-bee sample size**, which allows the result to be converted to **mites per hundred bees**.
2. **The source.** Mites are concentrated on **nurse bees**; a sample of foragers or of bees from a super will **underestimate** infestation.
3. **Checking for the queen** before shaking bees into the container.

Method: shake bees from a brood frame into a tub or dishpan; scoop half a cup (about 300 bees) into the wash container; add alcohol (windshield washer fluid or isopropyl); shake vigorously for a minute or more; and count the mites released through the screen. Purpose-built shaker jars and commercial washers make this quick.

Consistency across time matters as much as the absolute number, because the value is used to detect change.

16.4.2 Calculating the rate

Mites ÷ bees × 100 = mites per 100 bees (percent infestation).

Worked example: an alcohol wash of 300 bees yields **9 mites**.

$$9 \div 300 = 0.03 \times 100 = \mathbf{3 \text{ mites per 100 bees} = 3 \text{ percent}}$$

In **early August in the Southeast** this is above the current late-summer action threshold (2 percent; Honey Bee Health Coalition, 9th ed., 2026), and **treatment is indicated promptly**, because the bees reared beginning in August–September, depending on location, become the colony’s winter population. A follow-up count after treatment should be taken to confirm it worked.

Second example: 300 bees, **15 mites**.

$$15 \div 300 = 0.05 \times 100 = \mathbf{5 \text{ mites per 100 bees} = 5 \text{ percent}}$$
 — well above the 2 percent late-summer threshold.

16.4.3 Comparing the methods

Method	What it measures	Assessment
Alcohol wash	Mites per 100 bees	Recovers mites most completely; the reference method. Kills the sample (about 300 bees, a negligible fraction of a colony)
Powdered sugar roll	Mites per 100 bees	Spares the bees but recovers a smaller and more variable share . Accuracy falls in humid conditions — a real consideration in the Southeast
Sticky board / natural fall	Mites per day	A different quantity , tied to colony size and brood status and hard to convert to a rate . Useful for tracking trends and for observing mite drop during a treatment

The practical implication: choose one method, use it consistently, and know its limitations. A count of natural fall should **not** be compared against a wash-based threshold.

Two distractors to recognize: the sugar roll does **not** recover more mites than the wash, and a sticky board count does **not** convert to an infestation rate by a fixed factor.

16.4.4 When to monitor

A single late-summer count is not sufficient, though it is the decisive one.

Timing	Purpose
Late winter / early spring	Is the colony starting the year loaded?
After each treatment	Did it work? — the single most neglected count
Mid-season (June)	Trajectory; is reinvasion occurring?
Late summer (late July–August)	The decisive count. Treat if above threshold
Autumn	Verify the late-summer treatment worked

The Southeastern argument for monitoring more, not less: the long brood-rearing season allows **more mite generations per year** than in the North, so populations can compound further within a single season.

A **post-treatment count** is equally important: **an unverified treatment is an assumption, not a management action.**

16.5 Thresholds

An action threshold is the measured pest level at which the beekeeper must intervene in order to prevent the pest population from reaching a level that causes economic or colony damage.

The current reference is the Honey Bee Health Coalition’s *Tools for Varroa Management* (9th ed., 2026), which ties the threshold to the colony’s seasonal phase. Its figures are for an alcohol wash of about 300 bees from the brood nest:

Colony phase	Treat promptly at (mites per 100 bees)
Dormant (little or no brood)	1% or more
Population increase (spring build-up)	1% or more
Peak population (main flow, early summer)	2% or more
Population decrease (late summer–autumn, winter bees being reared)	2% or more

The older, widely quoted figure of “about 3 percent” is now regarded as **too permissive**. Treat the thresholds as action points, not targets: the goal is to keep counts **well below** them all year, and the colony phases, not calendar dates, set which figure applies. In the Southeast, where brood rearing runs most of the year, a colony can move between phases quickly, so read the colony, not the calendar.

16.5.1 Why the late-summer threshold matters most

Because the bees being reared in late summer become the long-lived winter population, and mite feeding and virus transmission during their **development** shortens their lives and compromises the colony’s ability to survive winter.

A note on how the question is often put. Older schemes quoted a higher mid-season figure (about 3 percent) and a lower late-summer one (about 2 percent), and exam questions sometimes ask why “the late-summer threshold is lower.” The reasoning they want is the winter-bee argument above. Under the current Honey Bee Health Coalition scheme, however, the **lowest** numbers (1 percent) apply during dormancy and spring build-up — for a different reason: a small mite population early in the year has the whole brood season ahead of it to multiply. Know both the numbers and the reasons.

Damage is therefore done before it becomes visible, so the threshold must be set low enough that intervention still protects that cohort.

This also explains why **waiting to see deformed wings or a dwindling population is too late**: those signs indicate that the injury level has already been passed.

16.5.2 The most critical timing in the beekeeping year

Late summer into early autumn is when *Varroa* must be under control, and this is arguably the single most important timing concept in modern colony management.

A colony can look populous and productive in August and die in January because the bees reared in August and September were compromised while they were pupae.

Two corollaries:

- **Measurement, not observation, drives the decision.**
- **Treatment must be completed before the autumn bees are reared**, not after.

And a restraint corollary: a June count well below threshold means **do not treat, log the count, and set the next monitoring date**. Treating unnecessarily costs money, exposes bees to an acaricide, adds residue to the wax and accelerates resistance. But a low count in June does **not** license neglect — the essential follow-up is the late-summer count, and skipping it is the commonest way beekeepers lose colonies over winter.

16.6 Treatments

16.6.1 The classes

The table groups the products on the US EPA’s list of registered *Varroa* treatments (updated September 2026) by active ingredient. Temperature ranges and super rules are summarized from the Honey Bee Health Coalition’s *Tools for Varroa Management* (9th ed., 2026); the product label is always the final word.

Class	US examples	Supers on?	Brood, temperature and notes
Formic acid	Formic Pro; Mite-Away Quick Strips	Yes	Penetrates cappings , so it reaches mites in sealed brood. Strong upper temperature limit (Formic Pro about 50–85 °F), a serious Southeastern constraint; costs brood and queens if applied too warm

Class	US examples	Supers on?	Brood, temperature and notes
Oxalic acid	Api-Bioxal, Api-Bioxal RTU, EZ-OX (dribble or vapor); VarroXSan (extended-release strip)	Yes	Does not penetrate cappings: dribble and vapor work well only when broodless or nearly so . The extended-release strip stays in the colony about 6–8 weeks and so spans brood cycles. Few temperature limits
Thymol / essential oils	Apiguard; Api Life Var	No	Vapor and contact. Efficacy falls when cool; damage rises when hot (Apiguard about 60–105 °F; Api Life Var about 64–95 °F). Can taint honey; temporary brood and laying reduction is normal
Hop beta acids	HopGuard 3	Yes	Contact activity, short residual; about 55–100 °F; repeated applications often needed when brood is present
Sucrose octanoate	OrganiShield	Yes	Sugar-ester contact product; about 55 °F and above
L-glutamic acid	MGB2X5G Strips	Yes	No stated temperature restriction; newer registration with little independent field data yet
dsRNA (RNA interference)	Vadescana — the EP15 formulations sold as Norroa	No	First RNAi varroacide (EPA registration September 2025). Fed to the colony in syrup; mites take up the dsRNA through feeding; needs open brood present to work
Amitraz	Apivar; Amiflex	No	Does not reach mites in sealed brood; forgiving of temperature. Resistance is now widespread — see §16.6.5
Pyrethroid	tau-fluvalinate (Apistan)	No	Above about 50 °F. Widespread resistance ; lipophilic, accumulates in wax. (Flumethrin products are used abroad but are not registered in the US.)
Organophosphate	coumaphos (CheckMite+)	No	Resistance; heavy wax accumulation; largely superseded
Biotechnical	brood break, drone trapping, comb culling, apiary layout	n/a	No residue, no resistance; labor-intensive, insufficient alone

Always read the current label of the specific product. Formulations change, registrations change, and label conditions change.

16.6.2 Formic acid

Formic acid differs from most other treatments in that it penetrates brood cappings as a vapor and so kills mites in the reproductive phase as well as on adults.

That cap penetration is its unique advantage and makes it valuable in a **brood-right** colony — which, in the Southeast, is most of the year.

The corresponding cost is a narrow margin. Applied above the label temperature range it **kills brood and queens and can cause absconding.** This is a serious constraint in the Southeastern summer, where daytime highs frequently exceed the label limit. **Reading and following the temperature range on the label is not optional.**

Formic acid is also a **genuinely hazardous material** for the applicator: concentrated formic acid causes severe skin and eye burns and its vapor damages the respiratory tract. The label's PPE section is part of the legally binding label.

16.6.3 Oxalic acid

Oxalic acid, applied by dribble or vaporization, is most effective when the colony is broodless or nearly so, because **oxalic acid does not pass through cappings** and reaches only the mites riding on adult bees.

This is why northern beekeepers rely on a midwinter application into a reliably broodless cluster — and why **Southeastern beekeepers must do something else:**

- **Verify a broodless window** before relying on it. In much of the region the window is short, unpredictable or absent (Chapter 20).
- **Create one deliberately** through a split or queen caging (§16.7).
- **Use repeated applications**, accepting lower per-application efficacy.
- **Use an extended-release formulation.** EPA has registered an extended-release oxalic acid strip (VarroXSan) that remains in the colony for about six to eight weeks and so spans brood cycles, changing what is possible in a brood-right colony; the Honey Bee Health Coalition reports efficacy in the 92–98 percent range. (Homemade oxalic acid–glycerin towels or strips are **not** a registered product; using them is off-label.) Check the current label.

Vaporization requires proper respiratory protection — an appropriately rated respirator, not a dust mask. Oxalic acid vapor is a serious respiratory hazard. And **repeated dribble applications damage bees**, so dribble is not a treatment to repeat freely.

16.6.4 Thymol

Thymol-based products act as a vapor and by contact, with efficacy falling in cool weather and brood damage, queen loss, absconding and honey tainting rising in hot weather.

Temperature dependence is the recurring theme across the volatile treatments and a central constraint on Southeastern summer treatment.

Thymol commonly causes a **temporary reduction in laying and some brood removal**, which alarms beekeepers who have not read the label. **Honey tainting** is why labels restrict use when supers are present.

16.6.5 Amitraz and the resistance problem

Amitraz strips have been the backbone of commercial *Varroa* control in the United States for years — effective, forgiving of temperature, easy to apply.

That is changing, and a 2026 candidate should know it. Following the record commercial colony losses of winter 2024–25, USDA-ARS scientists (Lamas et al., *PLOS Pathogens*, 2026) found acute bee paralysis virus and deformed wing virus A and B at high levels in bees from every collapsing apiary sampled, and **the amitraz-resistance mutation (Y215H in the mite’s octopamine receptor gene) in 100 percent of the mites screened**. The authors identified mite-vectored viruses as the likely end-stage cause of death and noted that nutritional stress and agrochemicals may also have contributed; resistance was not established as the sole driver, but the finding was universal across the operations sampled. The Honey Bee Health Coalition now flags reports of amitraz resistance on its product pages and advises testing efficacy before and after use.

The practical guidance issued afterward:

- Keep *Varroa* **below the current thresholds** (1 percent early in the season, 2 percent from peak season on) through regular monitoring.
- **Rotate between different miticide types rather than relying solely on amitraz.**
- **Verify efficacy** with post-treatment counts.
- Isolate sick colonies, clean equipment between yards, avoid moving material from struggling colonies.
- Maintain healthy queens, adequate stores, and replace old comb regularly.
- Use mite-resistant stock from reliable lineages.

A candidate who can describe this event and its implications is demonstrating exactly the currency the Journeyman rank expects.

16.6.6 What does not work as a control

Screened bottom boards, small cell foundation and powdered sugar dusting have all been evaluated and found to produce at most modest reductions. None should be relied upon as a stand-alone control.

- **Screened bottoms** produce a small reduction; their real value is **monitoring and ventilation**.
- **Small cell foundation** — controlled trials have **not** found a significant reduction in mite population growth (Berry, Owens & Delaplane, 2010).
- **Powdered sugar dusting** knocks down some phoretic mites but does not reach mites in sealed brood and has not been shown to control populations.

Presenting any of these as a control is one of the more consequential errors in circulating beekeeping advice.

16.6.7 Choosing among treatments

The relevant considerations:

- **Ambient temperature over the treatment window** — not today's temperature, the whole window
- **Whether supers are on**
- **Brood status**
- **Past treatments and any suspected resistance**
- **PPE and labor required**
- **Residue behavior**

There is no single best treatment; there is a best treatment for a given colony at a given time. In the Southeast, temperature constrains the volatile products for much of the year and brood status constrains oxalic acid, which is why a beekeeper needs **more than one option** and a plan for when each is appropriate.

16.6.8 The label is the law

Many Varroa products are labeled for use only with honey supers removed — the synthetic acaricides (amitraz, tau-fluvalinate, coumaphos), the thymol products and the new dsRNA product among them — because **label limits define when residues stay within tolerance**, and off-label use violates federal law under FIFRA (Chapter 13).

Other products **are** labeled for use with supers present: the formic acid products, the oxalic acid products (including the extended-release strip), hop beta acids, sucrose octanoate and the L-glutamic acid strip (§16.6.1). A beekeeper must read the **current label of the specific product** rather than relying on general knowledge or past practice.

Two associated false statements to recognize:

- That supers may be left on when the label does not provide for it, provided honey is extracted promptly, because residues partition into wax. **The label is binding regardless**, and the chemistry does not rescue it either: while the common synthetic acaricides are lipophilic and concentrate in wax, residues are measurable in honey as well, and the organic acids behave differently again.
- That applying a **higher dose** than the label specifies to overcome suspected resistance is illegal but effective. It is **neither**. Raising the dose does not reliably kill mites carrying a resistance trait, and it selects still harder for them while killing the susceptible mites that would otherwise dilute the resistant population. Meanwhile the bees take the extra dose too, with queen loss, brood damage and wax residues as the consequences.

16.6.9 PPE

Personal protective equipment specified on a product label — chemical-resistant gloves, eye protection, and in some cases a respirator — must be used when handling concentrated formic acid or when vaporizing oxalic acid.

These are genuinely hazardous materials. Oxalic acid vapor requires an **appropriately rated respirator, not a dust mask**. The label's PPE section is part of the legally binding label, and

the safety data sheet gives further detail. **Working outdoors and upwind does not substitute for the specified equipment.**

16.7 The Brood Break

A brood break is a period during which the colony has no sealed brood.

Why it helps: the mite can **only reproduce inside sealed brood**, so a break **halts reproduction** and **forces the entire mite population onto the adult bees**, where contact treatments such as oxalic acid are highly effective.

How to create one:

- **Cage the queen** for a period (queen cages designed for this hold her on a comb or in a small cage within the cluster).
- **Make a split**, so that one portion is queenless while it rears a new queen.
- **Requeen** after a queenless interval.
- **Remove all sealed brood** (and deal with it separately).

A complete break requires roughly three weeks, so that all existing sealed brood emerges and none is newly capped.

The trade-off is lost brood production and therefore population, so the timing must be chosen with the honey flow and the autumn bee cohort in mind. **In the Southeast a late-spring or post-flow break often fits the calendar well** — after the main flow, before the winter bees are reared.

Note the related point: **a colony that swarms gets a brood break, and the swarm leaves with a reduced mite load per bee** — but swarming is **not** an acceptable *Varroa* strategy. The parent colony retains a heavy mite population, the swarm still carries mites and viruses, the beekeeper loses the crop and much of the population, and escaped swarms become feral colonies that spread mites and disease and create nuisance problems in settled areas. The legitimate application of the same principle is the **deliberate** brood break above.

16.8 Verifying and Troubleshooting

16.8.1 After treating

Take a second mite count at the end of the treatment period and compare it with the pre-treatment count. Only a **paired figure** shows whether the product worked.

A post-treatment count taken promptly — before mites can immigrate from neighboring colonies — **distinguishes treatment failure from reinvasion:**

- **High count immediately after treatment** › treatment **failure**
- **Low count immediately after, rising weeks later** › **reinvasion**

Record both figures with the **product, lot, dose and dates**. This builds the operation's resistance history and is the basis for future product choices.

16.8.2 Reinvasion

Mites move into a treated colony from collapsing colonies nearby through robbing and drifting, so a rise in mite counts weeks after an effective treatment does **not** necessarily mean the treatment failed or that the mites are resistant.

Reinvasion is a real and often large effect, particularly in areas with many colonies or with untreated collapsing colonies within flight range.

The “mite bomb.” A colony that collapses from *Varroa* in September **poses a risk to neighboring colonies because, as it collapses, its stores are robbed out, and the robbers carry mites home.** The failing colony becomes a mite source for every hive within flight range.

This is why leaving a collapsing colony to die untended **imposes costs on neighbors.** The responsible action is to **monitor, identify colonies in collapse, and remove, treat or combine them before they become a source.** It is also a strong argument for **area-wide coordination** among beekeepers in a locality.

The response to reinvasion is area-wide rather than colony-level — which is a frustrating answer, and the correct one.

16.8.3 Before concluding resistance

A beekeeper reports that a treatment did not work. Check these **in order**:

1. **Was a valid pre-treatment count taken, with correct methodology?** A wrong starting figure invalidates the comparison.
2. **Application.** Correct dose for the colony size? Correct placement in or near the cluster? Correct number of applications and duration? Product within shelf life and stored properly?
3. **Environmental conditions**, particularly temperature relative to the label window for volatile products such as formic acid and thymol.
4. **Brood status.** Treatments that do not penetrate cappings leave a large share of the mite population untouched in a brood-right colony.
5. **Reinvasion** from nearby collapsing colonies.
6. **Only then** does resistance become the leading explanation — and it should be confirmed by testing a product with a **different mode of action.**

Application and timing errors are far more common than resistance, so attributing failure to resistance prematurely causes a beekeeper to abandon a product that would still serve.

16.8.4 How resistance develops

Repeated use of one mode of action selects the few mites carrying a heritable trait that lets them survive, and their descendants come to dominate.

It is **selection**, not learning, not product degradation, and not an induced change in individual mites. Understanding that makes the management response obvious:

- **Reduce selection pressure** by using non-chemical tools.
- **Rotate among genuinely different modes of action.**

- **Treat only when thresholds are exceeded**, not on a calendar.
- **Never use a sub-label dose** that kills only the most susceptible mites.

16.8.5 Meaningful rotation

Rotation means alternating products with genuinely different modes of action, because products within one chemical class share a resistance mechanism and rotating inside it buys nothing.

Tau-fluvalinate and flumethrin are both pyrethroids acting on the same target, so alternating between them is not rotation. (Only tau-fluvalinate is registered in the US, but the principle applies to any two products in one chemical class — the two amitraz products, for example.)

A defensible rotation moves among **distinct modes of action**: an organic acid, a thymol-based product, hop beta acids, a different synthetic acaricide, and — since its registration in 2025 — the dsRNA product, which works by silencing a gene the mite needs rather than as a conventional toxin, together with **biotechnical methods** such as brood interruption — **with efficacy verified after each treatment**.

Distractors: alternating where strips hang; alternating two brands within one class; and alternating one product between spring and autumn.

16.8.6 The commonest reason beekeepers lose colonies despite treating

Treating too late — after the winter bee cohort was reared under heavy mite pressure — and not confirming efficacy with a post-treatment count.

A treatment applied in October, after the bees reared from August–September onward have already been damaged, may leave the colony with low mite numbers and a compromised winter population. **The calendar for mite management is set by the biology of the winter bee, not by the beekeeper's convenience.**

16.9 An Integrated Year: Southeastern Sideline Operation

Late winter to early spring. Assess mite levels as brood rearing begins. Treat if thresholds are exceeded, using a product suited to the temperature and to the absence of supers.

Spring. Make **splits** for increase and swarm control, taking advantage of the resulting **brood breaks**. Continue monitoring. Keep supers on during the flow and **apply nothing not labeled for use with supers on**.

After the main flow (late May–June). Remove and extract supers, then **monitor and treat as needed before the dearth**. This is a good window for a deliberate brood break.

Late summer (late July–August). **The critical monitoring point**, since winter-bee rearing begins in August–September, depending on location. Treat promptly if thresholds are exceeded, with attention to the **temperature limits** of the chosen product.

Autumn. Verify efficacy with a follow-up count. Requeen failing colonies. Consolidate weak units.

Winter. If a **broodless period occurs**, an oxalic acid application is highly effective — **verify broodlessness first**, since in much of the Southeast the window is short, unpredictable or absent.

Throughout the year. Keep records. Use stock with **resistance traits** where available. **Cull old comb.** Control **drift and reinvasion** by apiary layout (Chapter 7). Address **collapsing colonies** promptly.

The examinable habits: monitoring before and after every intervention; planning treatments around the supers and the temperature; and recognizing **late summer as the decisive point in the year.**

16.10 Records

Treatment records should include:

- **Product name and lot number**
- **Dose**
- **Application and removal dates**
- **Colonies treated**
- **Ambient temperature** over the treatment window
- **Paired pre- and post-treatment mite counts**

Three purposes:

1. They reveal **declining efficacy over seasons**, the only practical way to detect emerging resistance before it causes losses.
2. They demonstrate **label-compliant use** and support residue traceability for buyers and regulators.
3. They let you **distinguish treatment failure from wrong timing or reinvasion** when colonies fail.

Temperature and lot number cannot be reconstructed later from memory. Write them down at the time.

16.11 Reading a Dead-Out

Post-mortem findings that suggest **Varroa** and associated viruses:

- **Deformed wings and shortened abdomens** on dead bees
- **Mites** on the bees and in cells
- **White mite faeces on the upper inner walls of vacated brood cells** — the guanine deposits are especially useful because they **persist after the mites themselves are gone**
- **Stores left unconsumed**, indicating the population died out rather than ran out of food

Contrast with:

Finding	Diagnosis
Tight cluster, heads in cells, no stores left nearby	True starvation
Tight cluster, heads in cells, abundant honey two frames away	Isolation starvation — and ask <i>why</i> the cluster was too small to bridge to its stores
Ropy coffee-colored remains, sunken punctured cappings, glue-pot smell	American foulbrood
Chalky white mummies on the bottom board and at the entrance	Chalkbrood

16.11.1 The worked dead-out

A colony that looked strong in September is found dead in late January. There is capped honey on the outer frames, a small cluster of dead bees with heads in cells, a few dead bees with deformed wings, and white specks on the upper inner walls of empty brood cells.

The immediate cause of death is isolation starvation: the small cluster consumed the stores immediately around it and could not move to the remaining honey during cold weather.

The underlying cause is *Varroa* and deformed wing virus: the deformed wings and the white mite faecal deposits in vacated brood cells show that the **autumn brood was reared under heavy mite pressure**, so the winter bees were short-lived and the cluster dwindled below the size needed to reach its stores.

The management change is to complete effective mite control **before** the autumn bees are reared — monitor in late July or August and treat promptly if thresholds are exceeded — and to **verify efficacy with a post-treatment count** rather than assuming it.

A candidate who reports only starvation has stopped at the proximate cause and would respond by feeding more, which would not prevent a recurrence. This is the most instructive single scenario on the examination.

16.12 Tracheal Mites

***Acarapis woodi* lives inside the prothoracic tracheae of adult bees, entering through the first thoracic spiracle of young adults**, so diagnosis requires dissection or laboratory work.

That internal, microscopic habit is the key distinction from *Varroa*, which is external and visible. **A beekeeper cannot diagnose tracheal mites by looking at bees.** Signs such as crawling bees with disjointed wings — sometimes called **K-wing** — are suggestive but not specific.

Historical control measures:

- **Menthol crystals** placed in the hive, which sublime at warm temperatures to produce a vapor that kills the mites. They therefore require ambient temperatures roughly in the

60s to 80s °F to work, with placement at the top or bottom of the hive depending on temperature.

- **Vegetable shortening and sugar grease patties**, thought to interfere with the mites' ability to locate and transfer to young host bees.

Why the problem is less prominent today: largely because **commercially available stock has been selected, deliberately and incidentally, for resistance**, and because **treatments applied for *Varroa* also suppress tracheal mites**.

The general lesson worth carrying forward: a volatile treatment's efficacy depends on **temperature, ventilation and placement** — which is equally true of formic acid and thymol used against *Varroa*.

16.13 *Tropilaelaps*: the Next One

Tropilaelaps mercedesae and related species are mites whose natural hosts are the **giant honey bees of Asia** (*Apis dorsata* and relatives). *T. mercedesae* has spread out of Asia to the edge of Europe: it has been present in southern **Russia** (Krasnodar and Rostov regions) since at least 2021 and in the **country of Georgia** since at least 2023, with a reported detection in **Azerbaijan** in 2025; the European Union remained free as of 2025 (EU Reference Laboratory, ANSES). It has **not been detected in the United States**, and preventing or delaying its arrival is the subject of active preparedness work.

The threat is not hypothetical. On 24 July 2025 a swarm of the giant honey bee *Apis dorsata* was found aboard a cargo vessel bound for Port Elizabeth, New Jersey; it carried 28 *T. mercedesae*. The swarm was intercepted in the North Atlantic, roughly 3,600 nautical miles from port, frozen and destroyed — the first detection of *Tropilaelaps* on a US-bound vessel (Ramirez et al., *Frontiers in Insect Science*, 2026). Port inspection caught it; beekeeper vigilance is the next line of defense.

Why they are a serious threat:

- They **already carry deformed wing virus and black queen cell virus**, so there would be no grace period in which to study management before infestations became lethal.
- Their **populations grow faster than *Varroa***.
- They spend only a **short time on adult bees** — classically one to two days, compared with *Varroa*'s several days to weeks — which makes the **treatment window for contact acaricides extremely narrow**.

The one hopeful asymmetry: *Tropilaelaps* **cannot survive outside brood cells for more than a few days** (about 3 to 6 days on adult bees or hive materials), because it cannot feed on adult bees the way *Varroa* does. That means a well-timed **brood interruption** could in principle control it without chemicals — which puts a premium on the biotechnical skills this chapter has already described.

What a beekeeper should do now:

- **Monitor routinely**, and know that delayed detection dramatically worsens outcomes.
- **Learn to recognize it:** smaller and faster-moving than *Varroa*, elongated rather than crab-shaped, and found in brood.

- **Support movement restrictions** on hives and bee shipments; understand why the Honey Bee Act's importation restrictions exist (Chapter 1).
 - **Report anything suspicious** to the state department of agriculture and USDA APHIS.
 - Attend **identification and surveillance training** where it is offered.
-

Numbers to Memorize

Item	Figure
Alcohol wash sample	about 300 bees (1/2 cup) from a brood frame
Infestation rate	mites ÷ bees × 100
<i>Varroa</i> action thresholds (HBHC 9th ed., 2026)	1% dormant and spring build-up; 2% peak and late summer–autumn
Drone brood capped longer than worker	about 2–3 days
Drone brood mite preference	roughly 8–10×
Complete brood break	about 3 weeks
Most critical control timing	late summer into early autumn
<i>Varroa</i> detected in US	1987
<i>V. destructor</i> described as distinct species	2000
Tracheal mite detected in US	1984
<i>Tropilaelaps</i> survival away from brood	about 3–6 days (typically 1–2 days on adult bees before re-entering brood)

Key Terms

Foundress — the adult female mite that enters a cell and reproduces.

Phoretic / dispersal phase — the period a mite spends on an adult bee.

Fat body — the tissue *Varroa* feed on while riding adult bees (mites reproducing on pupae feed mainly on hemolymph); central to immunity and winter bee longevity.

Action threshold — the measured pest level at which intervention is required.

Brood break — a period with no sealed brood, halting mite reproduction.

Drone brood trapping — using drone comb as a mite trap, removed before emergence.

Reinvasion — mites entering a treated colony from collapsing colonies nearby.

Mite bomb — a collapsing colony whose stores are robbed out, distributing its mites.

Mode of action — the biochemical mechanism by which an acaricide kills; the unit of meaningful rotation.

Paired counts — pre- and post-treatment mite counts; the only way to verify efficacy.

K-wing — the disjointed wing posture suggestive, but not diagnostic, of tracheal mites.

Self-Check

- 1. (MC)** *Varroa destructor* reproduces: A) In cells of open larval brood B) Inside sealed brood cells, where a foundress enters just before capping, feeds on the pupa, and produces offspring that mature and mate before the bee emerges C) In pollen stored beside the brood nest D) On adult nurse bees
- 2. (SA)** Explain why *Varroa* mites prefer drone brood and how a beekeeper can use that preference as a management tool.
- 3. (SA)** An alcohol wash of 300 bees yields 9 mites. Calculate the infestation rate and state what action is indicated in early August in Georgia.
- 4. (MC)** Comparing the alcohol wash, sugar roll and sticky board: A) The sugar roll recovers most completely; the sticky board yields an infestation rate directly B) The alcohol wash recovers most completely and is the reference method; the sugar roll spares the bees but recovers a smaller and more variable share; the sticky board measures natural daily fall, a different quantity tied to colony size and brood status and hard to convert to a rate C) The sticky board is the reference method D) Wash and roll return identical results; the sticky board converts by a fixed factor of 100
- 5. (SA)** Define an action threshold and explain why the late-summer *Varroa* threshold is set low and treated as decisive.
- 6. (MC)** Oxalic acid is most effective when: A) The colony is rearing brood heavily in spring B) The colony is broodless or nearly so, since oxalic acid does not pass through cappings and reaches only mites on adult bees C) The winter cluster is tight below 20 °F D) Honey supers are in place
- 7. (SA)** Explain what a brood break is, how a beekeeper can create one, and why it helps with *Varroa*.
- 8. (SA)** A beekeeper reports that a treatment did not work. List, in the order you would check them, the explanations to consider before concluding that the mites are resistant.
- 9. (TF)** Screened bottom boards, small cell foundation and powdered sugar dusting have all been evaluated and found to produce at most modest reductions, so none should be relied upon as a stand-alone control.
- 10. (SA)** Outline an integrated *Varroa* management plan for a Southeastern sideline beekeeper across a full year.
- 11. (MC)** Which post-mortem findings suggest *Varroa* and associated viruses caused a colony's death? A) Ropy coffee-colored remains under sunken punctured cappings and a glue-pot smell B) Deformed wings and shortened abdomens on dead bees, mites on the bees and in cells, white mite faeces on the upper walls of vacated cells, and stores left unconsumed C) A tight cluster with heads in empty cells, fecal spotting, and no capped stores anywhere D) Chalky white mummies on the bottom board and at the entrance

12. (SA) Explain in plain terms, as you would to a new beekeeper, why *Varroa* matters so much more than the mites themselves would suggest.

Answers

1. B.

2. Drone brood remains capped roughly two to three days longer than worker brood, which allows more mite offspring to complete development and mate before emergence, so a foundress entering a drone cell produces more mature daughters than one entering a worker cell — and mites are correspondingly more attracted to drone cells. A beekeeper can exploit this by placing a frame of drone comb in the brood nest, allowing the mites to concentrate in it, then removing the frame after it is capped but before the drones emerge and freezing it, after which the bees clean it and it can be reused. **The critical caution is that a drone frame left too long becomes a mite amplifier rather than a trap**, so the removal schedule is not optional. The technique is labor-intensive and removes drones, suits smaller operations, and should be combined with monitoring rather than relied on alone.

3. $9 \div 300 = 0.03 > 3$ **mites per 100 bees, a 3 percent infestation rate.** In early August in the Southeast this is above the current late-summer action threshold of 2 percent (Honey Bee Health Coalition, 9th ed.), and **treatment is indicated promptly**, because the bees reared beginning in August–September, depending on location, become the colony’s winter population. A follow-up count after treatment should be taken to confirm efficacy. The reasoning matters as much as the arithmetic: the late-summer count is decisive precisely because of the winter bee cohort, and a beekeeper who treats without verifying has not completed the management cycle.

4. B. Choose one method and use it consistently. Sugar roll accuracy falls in humid conditions, a real consideration in the Southeast; sticky boards are useful for trends and for watching mite drop during a treatment, but a natural-fall count should not be read against a wash-based threshold.

5. An action threshold is the measured pest level at which the beekeeper must intervene to prevent the pest population from reaching a level that causes economic or colony damage. The late-summer threshold is set low (2 percent under the current Honey Bee Health Coalition scheme) and is decisive because **the bees being reared in late summer become the long-lived winter population**, and mite feeding and virus transmission during their development shortens their lives and compromises the colony’s ability to survive winter. Damage is therefore done before it becomes visible, so the threshold must be set low enough that intervention still protects that cohort. This also explains why waiting to see deformed wings or a dwindling population is too late. (The current scheme sets an even lower figure, 1 percent, for dormancy and spring build-up, because a small early population has a whole season to multiply.)

6. B. Southeastern beekeepers must therefore verify a broodless window, create one deliberately through a split or queen caging, use repeated applications, or use an extended-release formulation. Vaporization requires an appropriately rated respirator.

7. A brood break is a period during which the colony has no sealed brood. It helps because the mite can only reproduce inside sealed brood, so a break **halts reproduction and forces the entire mite population onto the adult bees**, where contact treatments such as oxalic acid are highly effective. A beekeeper can create one by **caging the queen**, by **making a split** so one portion is queenless while it rears a new queen, by **requeening after a queenless**

interval, or by **removing all sealed brood**. A complete break requires roughly **three weeks** so that all existing sealed brood emerges and none is newly capped. The trade-off is lost brood production and population, so timing must account for the honey flow and the autumn bee cohort; in the Southeast a late-spring or post-flow break often fits well.

8. First, whether a **valid pre-treatment count** was taken with correct methodology, since a wrong starting figure invalidates the comparison. Second, **application**: correct dose for the colony size, correct placement, correct number of applications and duration, product within shelf life and stored properly. Third, **environmental conditions**, particularly temperature relative to the label window for volatile products such as formic acid and thymol. Fourth, **brood status**, since treatments that do not penetrate cappings leave a large share of the mite population untouched in a brood-right colony. Fifth, **reinvansion** from nearby collapsing colonies. Only after excluding these does **resistance** become the leading explanation, and it should be confirmed by testing a product with a different mode of action. Application and timing errors are far more common than resistance.

9. True.

10. *Late winter to early spring*: assess mite levels as brood rearing begins and treat if thresholds are exceeded, using a product suited to the temperature and the absence of supers. *Spring*: make splits for increase and swarm control, taking advantage of the resulting brood breaks; continue monitoring; keep supers on during the flow and apply nothing not labeled for use with supers on. *After the main flow (late May–June)*: remove and extract supers, then monitor and treat as needed before the dearth. *Late summer (late July–August)*: the critical monitoring point, since the bees reared now become the winter population — treat promptly if thresholds are exceeded, with attention to the temperature limits of the chosen product. *Autumn*: verify efficacy with a follow-up count and requeen failing colonies. *Winter*: if a broodless period occurs, an oxalic acid application is highly effective — verify broodlessness first. *Throughout*: keep records, use stock with resistance traits where available, cull old comb, control drift and reinvansion through apiary layout, and address collapsing colonies promptly.

11. B. The white guanine deposits in vacated cells are especially useful because they persist after the mites are gone, and abundant remaining stores indicate a population that died out rather than one that ran out of food.

12. See §16.1 — the fat body damage, the virus injection bypassing the bee’s defenses, and the consequence that a small-seeming mite population destroys colonies, which is why beekeepers act at thresholds of a few mites per hundred bees rather than waiting for visible damage.

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Chapter 17: Making Splits and Nucs

Learning Objectives

When you have finished this chapter you should be able to:

- State the purposes a split serves and explain why spring splitting is central to Southeastern management.
 - Perform a walk-away split correctly and state what must be verified before walking away.
 - Choose between letting a split rear its own queen, giving a ripe cell, and giving a mated queen, and state the cost of each.
 - Perform the principal split variants — even, weak-side, nuc, shook, and the swarm-control manipulations.
 - Manage the timing of a split against the flow, the dearth and the mite calendar.
 - Protect a new split from robbing, small hive beetle, ants and heat.
 - Judge when to combine rather than divide, and combine correctly over newspaper.
 - Winter small colonies in the Southeast, including as a paired double nucleus.
 - Support a colony that has swarmed and is behind.
 - Understand the disease risk in moving brood between colonies.
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17.1 Why Split

A split — dividing one colony into two or more — is the most versatile manipulation in beekeeping, and in the Southeast it is central to management rather than occasional.

Splitting in the Southeast is most commonly done March through May, and it accomplishes several purposes at once:

1. **Swarm control.** Removing brood and bees relieves congestion and removes the nurse-bee surplus that drives the swarming impulse (Chapter 18).
2. **Increase.** Making more colonies, at the cost of your own labor rather than a purchase.
3. **Replacing expected losses.** Every operation loses colonies. Splits in spring are how you get back to your target number by autumn.
4. **A brood break for mite management.** The queenless half has no sealed brood for roughly a week or more once the brood it was given has emerged and before the new queen's brood is capped, halting mite reproduction and creating a window in which oxalic acid is highly effective (Chapter 16).
5. **Requeening,** since the split gives you a natural place to introduce new genetics.
6. **Preserving the genetics** of a colony you value, before it swarms and you lose half of it to a tree.

Why March through May. Splits made in early spring have **the whole season to build**. Splits made during the July–August dearth need feeding and beetle protection and are far more likely to fail. Splits made in autumn rarely reach a viable wintering size.

The trade-off: splitting during the flow **costs surplus honey**, because it divides the foraging force. Which is why some beekeepers split **after** the main flow, and why others use manipulations such as the **Demaree** that preserve the foraging force while achieving swarm control (Chapter 18).

17.2 The Walk-Away Split

The basic operation, and the one an examination is most likely to ask you to describe.

17.2.1 The procedure

Divide the colony's resources between the original hive and a new box. Give each:

- Roughly **equal frames of sealed and open brood**
- **Adhering nurse bees** — and consider shaking in extra bees from a third frame, since foragers will fly home
- **Pollen and honey** — a frame of each at minimum
- **Empty drawn comb or foundation** for expansion

Leave the queen in one half.

The queenless half must contain eggs and larvae under about three days old so it can rear an emergency queen — or alternatively be given a ripe queen cell or a mated queen.

17.2.2 What must be verified before walking away

This is the examinable part:

1. **That the queenless half has eggs or very young larvae.** Without them it has no means of making a queen, and you will come back in three weeks to a colony with no brood and laying workers developing.
2. **That both halves have adequate stores** — honey and pollen — and **enough bees to cover their brood.**
3. **That the queenright half has no queen cells left**, if swarming is to be prevented.

And, since you will not know which half has the queen unless you found her:

4. **Which half has the queen** — or a plan to determine it in a few days by checking for eggs.

17.2.3 Southeastern additions

Reduce entrances and add beetle traps, because splits are small and vulnerable to small hive beetle and to robbing (Chapter 15). Size the box to the bees: use a follower board or a nuc box rather than giving a small split a full ten-frame box of undefended comb.

Feed unless there is a strong flow. A split has lost its foraging force and needs to draw comb.

Place in sun rather than deep shade.

17.2.4 The timeline

A beekeeper splits a strong colony in April, leaving the queenless half with frames of eggs and young larvae to rear their own queen.

Day	Event
0	Split made
about 1	Emergency cells started
about 12–16	Queen emerges (depending on the age of the larvae selected)
about 5–6 days later	Mature enough to fly
about 24–30	Mated and laying

So: a split made in early April should show eggs by late April or early May. Mark the calendar. Check at about three weeks, and again a week later before concluding failure.

What can go wrong:

- **The colony selects an older larva** and produces a poor-quality queen — smaller, fewer ovarioles, more likely to be superseded.
- **The virgin fails to return** from a mating flight — birds, weather, or disturbance.
- **Poor mating weather** produces a drone layer.
- **The split is too weak** to keep the cells warm or to defend itself.
- **The beekeeper opens the colony repeatedly** during the mating period, which is a recognized cause of queen loss.
- **Small hive beetle or robbing** overwhelms the small unit.

17.2.5 The alternative, and its cost

A purchased mated queen shortens the broodless interval by two to three weeks and a ripe queen cell by about one week; both give known genetics, at the cost of the purchase price.

Weigh it honestly:

Option	Time to laying queen	Genetics	Cost	Risk
Walk-away (own cells)	about 3–4 weeks	The colony's own, mated locally	Free	Highest — quality and mating both uncontrolled
Ripe queen cell	about 2–3 weeks	Chosen maternal line, mated locally	Low	Cell handling; mating still uncontrolled
Mated queen	about 1 week to laying	Chosen and already mated	Highest	Acceptance

For a beekeeper hoping for a crop, or splitting late, the mated queen usually earns its price. For a beekeeper making increase in early April with time to spare, the walk-away is perfectly sound — provided the eggs are there.

And note the mite benefit runs the other way: the **longer** broodless interval of a walk-away split gives the **better brood break**.

17.3 Variants

Even split. As described above: resources divided roughly equally. Best when both halves have time to build.

Weak-side split (nuc split). Take a smaller unit — two frames of brood, one of stores, adhering bees — leaving the parent colony strong enough to make a crop. This is the standard approach when you want both a crop and increase.

Cut-down split. Remove most of the brood and the queen to a new box, leaving the parent colony with the foraging force, a queen cell and little open brood to feed. The parent colony, with a large field force and no brood to provision, puts everything into the flow. A honey-production manipulation as much as a split.

Shook swarm / artificial swarm. Shake or move bees onto fresh equipment, mimicking a swarm. Discussed in Chapter 18 as swarm control, and in Chapter 15 as an EFB management option.

Split for a brood break. Timed specifically so the queenless half is broodless when you want to apply oxalic acid (Chapter 16).

Splitting to multiple nucs. A very strong colony in April can yield three or four nucs plus the parent. Each needs eggs or a cell, stores, and enough bees.

Making up nucs for sale or for overwintering. A five-frame nuc going into autumn needs to be a **complete, functioning colony**: a laying queen, brood of all stages, stores, and bees covering the comb.

17.4 Nucleus Colonies

17.4.1 What a nuc is for

A nucleus colony — a small but complete functioning colony on drawn frames, with a laying queen, brood of all stages, stores and adhering bees — is one of the most useful things in a beekeeper's yard, and a Journeyman-level operation should keep a few permanently.

Uses:

- **Spare queens.** A nuc is a queen bank you can inspect.
- **Emergency requeening.** A colony goes queenless in August; you have a laying queen ready.
- **Boosting.** A frame of emerging brood from a nuc props up a colony that is behind.
- **Overwintering surplus queens.**
- **Catching returning foragers** when you move a colony within a yard.

- **Swarm capture** and quarantine of unknown swarms.
- **Sale.**

17.4.2 Nuc versus package, for a beginner

	Package	Nucleus colony
Composition	2–3 lb loose bees + caged queen unrelated to them; no comb, no brood	Complete colony on drawn frames: laying queen, all brood stages, stores, bees
Advantage	Cheaper; available earlier; no comb , so less risk of importing disease or beetles	Builds faster, lower failure rate ; already functioning
Drawback	Must draw comb from nothing; needs continuous feed; higher failure rate	More expensive; comes with someone else's comb history; available later

Timing for a Southeastern beginner: a package installed in **March** has the whole spring flow ahead of it; a nuc bought in **May** may miss the main flow but is better positioned for the summer dearth.

17.4.3 Keeping a nuc alive in the Southeast

This is where Southeastern practice diverges sharply from northern practice, and it is examined.

Why small units are especially vulnerable: they have **few adult bees relative to their comb area**, so they cannot patrol and confine small hive beetles. A beetle population a full colony would contain **can overwhelm a nuc within days**, leading to slimed comb and absconding.

Precautions:

- **Keep nucs tightly sized** so the bees cover all the comb. Use **follower boards** or smaller boxes rather than a partly filled full box.
- **Reduce entrances.**
- **Install and maintain beetle traps**; refresh the oil.
- **Avoid pollen patties**, or use only small pieces sized to a few days.
- **Place nucs in sun** rather than deep shade.
- **Inspect frequently** — a nuc can be lost between weekly visits — except during the queen mating window, which is the tension you have to manage.
- **Combine or build up** any nuc that is losing ground rather than hoping it recovers.
- Watch for **fire ants** and **robbing**.

17.5 Timing Against the Season

Period	Split?	Notes
February	Generally too early	Colonies not yet strong; drones not flying, so no mating
March–May	Prime	Swarm control + increase + brood break; drones available; whole season ahead
June	Acceptable	After the main flow; feed and protect from beetles
July–August	Avoid	Dearth: robbing, beetle pressure, no forage, poor mating; splits made now usually fail
September–October	Generally no	Too late to build to wintering strength; better to combine

The drone constraint. A split that must rear and mate its own queen needs **mature drones flying**. In middle Georgia drones are generally on the wing by mid-March; farther south, earlier. A split made in February with no drones available produces a virgin who cannot mate.

The flow constraint. Splitting during the flow costs surplus. Decide what you want from the season: a crop, or increase. You can sometimes get both with a **weak-side split** or a **Demaree**, but not with an even split during the tulip poplar flow.

17.6 Combining: When Not to Divide

The opposite operation, and often the correct one.

17.6.1 The decision

Two colonies in an Alabama apiary each cover four frames in early October. Both have laying queens, adequate stores, low mite counts and no disease. What now?

Combine them over newspaper after removing one queen, or winter them as a paired double nucleus in a divided box with separate entrances, since one larger cluster — or two sharing heat — winters better than two marginal units.

Note the condition the scenario supplies and that you must always verify: **verified absence of disease and mite problems**. Uniting a diseased colony into a sound one spreads the problem.

Feeding each of them up to fill a second brood box is counterproductive, because it increases the volume each small cluster must maintain and creates **undefended space that small hive beetle will exploit**. This is a distractor, and an appealing one.

17.6.2 The general decision rule

First determine why each colony is weak.

- If the weakness is caused by **disease**, particularly American foulbrood, or by an **uncontrolled mite and virus problem**, combining **spreads the problem** and should not be done until the cause is addressed.
- If both are simply **small but healthy**, with sound queens or one sound queen, combining produces one colony with a far better chance of surviving winter than two marginal ones.

17.6.3 The newspaper combine

1. **Remove the poorer queen.** (Or, if you want to keep her, put her in a nuc.)
2. **Place a sheet of newspaper with a few small slits** between the two colonies' boxes.
3. **Set one colony on top of the other.**
4. The bees **chew through over a day or two**, by which time the colony odors have merged and fighting is avoided.
5. **Check about a week later** to confirm the union and consolidate frames — remove the newspaper remnants and reduce to the boxes the combined colony actually needs.

Why it works: nestmate recognition depends on a **learned chemical signature** (Chapter 3). The newspaper delay lets the two colony odors merge before the bees meet. Note: During a nectar flow the bees are less prone to fight and a combine **without** newspaper may be successful.

17.6.4 The paired double nucleus

A useful Southeastern alternative to combining: winter two small colonies as a paired double nucleus in one box divided by a partition, with separate entrances on different sides.

Each keeps its own queen while **sharing heat** through the divider. You go into spring with two queens rather than one, which is worth a good deal in March. Purpose-made divided boxes exist, or a follower board can be sealed in place.

17.7 Supporting a Colony That Is Behind

A colony that swarmed in March is inspected in mid-April with a laying queen but roughly half the population of its neighbors. The beekeeper hopes for a honey crop.

The appropriate action: support its recovery with space, stores and possibly a frame or two of emerging brood from a healthy colony, accepting little or no surplus this season.

The reasoning:

- The colony has **swarmed and successfully requeened itself**. It is **functional but demographically behind**, and what it needs is **time**, not intervention.

- **Boosting with emerging brood** from a healthy donor is the standard remedy — emerging brood, not open brood, because emerging brood adds bees without adding nurse-bee demand.
- **Requeening a newly mated queen accomplishes nothing** and sets the colony back further.
- **Combining it with the strongest colony** discards a functioning colony and its queen.
- **Treating for AFB as a precaution** is neither indicated nor lawful in the sense implied.

Two caveats on boosting:

- The donor must be **free of disease** — moving brood moves whatever the donor carries (§17.8).
- **Do not weaken a productive colony to prop up a marginal one.** Take from a colony that has surplus brood to give.

17.8 Disease Risk in Moving Brood

Moving frames of brood between hives moves whatever the donor colony carries — AFB and EFB, chalkbrood spores, *Nosema*, viruses and *Varroa*. Blind equalization can distribute a disease through an entire apiary in one afternoon.

To do it responsibly:

1. **First determine why the recipient is weak.** Adding brood does not fix a failing queen or a mite problem — and if the recipient is weak because of mites, adding brood gives the mites more to reproduce in.
2. **Take brood only from colonies you have inspected carefully** and believe to be healthy.
3. **Do not weaken a productive donor** below its own requirements.
4. **Avoid moving comb between apiaries**, or from colonies of unknown history.
5. **Clean the hive tool between colonies**, and **work known or suspect colonies last**.

This applies with equal force to making splits: a split from a colony carrying EFB or a heavy mite load is a split that starts in trouble.

17.9 Moving a Split Within the Yard

A split made in the same apiary **loses its foragers**, which fly back to the parent hive's location. Three ways to handle it:

1. **Accept it.** Shake in extra bees from an additional frame to compensate, and expect the split to be nurse-bee heavy for a week.
2. **Move the split more than three miles** for two to three weeks, then bring it back (Chapter 3).

3. **Move the parent colony** a few feet to one side and place the split on the original stand, so the returning foragers boost the split rather than the parent. This is the classic **artificial swarm** manipulation and it is dealt with in Chapter 18.

A related trick: when you must move a colony within a yard, **put a nuc or a swarm trap at the old location** to collect the returning foragers rather than losing them.

Numbers to Memorize

Item	Figure
Split to laying queen (own cells)	about 3–4 weeks
Emergency cell started after split	within about 1 day
Queen emerges after split	about 12–16 days
Prime splitting period, Southeast	March–May
Larvae required for emergency queen	under about 3 days old
Complete brood break	about 3 weeks
Newspaper combine: check union	about 1 week later
Colony move rule	<3 ft or >3 miles

Key Terms

Walk-away split — dividing a colony and leaving the queenless half to rear its own queen.

Weak-side split — taking a small unit and leaving the parent strong enough to make a crop.

Cut-down split — removing most of the brood and the queen, leaving the foraging force on the flow.

Nucleus colony (nuc) — a small but complete colony: laying queen, all brood stages, stores, bees.

Follower board — a solid board reducing the effective volume a small colony must patrol.

Newspaper combine — uniting two colonies separated by newspaper so their odors merge before contact.

Paired double nucleus — two small colonies wintered in one divided box with separate entrances, sharing heat.

Boosting — adding frames of emerging brood from a healthy donor to a colony that is behind.

Equalizing — moving brood between colonies to even up strength; carries real disease risk.

Self-Check

1. **(SA)** Describe how to perform a simple walk-away split for swarm control in April, and state what the beekeeper must verify before walking away.
2. **(MC)** Splitting colonies in the Southeast is most commonly done in which period, and for what combined purposes? A) March through May, to hold down swarming, make increase, replace expected losses, and put in a brood break that helps with mite management B) January through February, ahead of red maple C) June through July, once the main flow is over D) September through October, to make increase before winter
3. **(SA)** A beekeeper splits a strong colony in April, leaving the queenless half with eggs and young larvae. State the approximate date by which the new queen should be laying, and list two things that can go wrong.
4. **(SA)** Explain the difference between a nucleus colony and a package, and give one advantage of each for a beginning Southeastern beekeeper.
5. **(MC)** Two colonies in your Alabama apiary each cover four frames in early October. Both have laying queens, adequate stores, low mite counts and no disease. The most sensible action is: A) Combine them over newspaper after removing one queen, or winter them as a paired double nucleus in a divided box with separate entrances B) Feed each heavy syrup and a pollen substitute until they fill a second brood box C) Winter them apart with reduced entrances and insulated inner covers D) Requeen both from a southern breeder before the end of October
6. **(SA)** Explain how a beekeeper should decide whether to combine two weak colonies in the autumn, and describe how to do it.
7. **(MC)** A colony that swarmed in March is inspected in mid-April with a laying queen but roughly half the population of its neighbors. For a beekeeper hoping for a honey crop, the most appropriate action is: A) Support its recovery with space, stores and possibly a frame or two of emerging brood from a healthy colony, accepting little or no surplus this season B) Treat it for American foulbrood as a precaution C) Combine it with the strongest colony in the yard D) Requeen it immediately
8. **(SA)** Explain why equalizing colonies by moving frames of brood carries disease risk, and describe how to do it responsibly.

Answers

1. Divide the colony's resources between the original hive and a new box: give each roughly equal frames of sealed and open brood, adhering nurse bees, pollen and honey, plus empty drawn comb or foundation for expansion. Leave the queen in one half. The queenless half must contain **eggs and larvae under about three days old** so it can rear an emergency queen, or be given a ripe queen cell or a mated queen. **Before walking away, verify:** that the queenless half has eggs or very young larvae; that both halves have adequate stores and enough bees to cover their brood; and that the queenright half has no queen cells left if swarming is to be prevented. In the Southeast, also reduce entrances and add beetle traps, since splits are small and vulnerable to small hive beetle and robbing, and size the box to the bees.
2. **A.** Splits made in early spring have the whole season to build; splits made during the dearth need feeding and beetle protection and are far more likely to fail. The trade-off is that splitting

during the flow costs surplus honey, which is why some beekeepers split after the main flow or use a Demaree that preserves the foraging force.

3. Emergency cells are started within a day, a queen emerges roughly 12 to 16 days after the split depending on the age of the larvae selected, and she should be **laying roughly 3 to 4 weeks after the split** — so a split made in early April should show eggs by late April or early May.

Things that can go wrong: the colony selecting an older larva and producing a poor-quality queen; the virgin failing to return from a mating flight because of birds, weather or disturbance; poor mating weather producing a drone layer; the split being too weak to keep the cells warm or defend itself; the beekeeper opening the colony repeatedly during the mating period; and small hive beetle or robbing overwhelming the small unit. The alternative of introducing a purchased mated queen or a ripe cell shortens the broodless interval by two to three weeks and gives known genetics, at the cost of the purchase price.

4. A **package** is a screened box of loose bees, typically two to three pounds, with a caged queen unrelated to them and no comb or brood. A **nucleus colony** is a small but complete functioning colony on drawn frames, with a laying queen, brood of all stages, stores and adhering bees. *Advantage of a nuc:* it is already a working colony with brood and drawn comb and builds faster with less risk of failure. *Advantage of a package:* it is cheaper, more widely available early in the season, and carries no comb and therefore less risk of importing disease or pests such as small hive beetle. A Southeastern beginner should also weigh timing: a package installed in March has the whole spring flow ahead of it, whereas a nuc bought in May may miss the main flow but is better positioned for the summer dearth.

5. A. The condition attached to combining is exactly what the scenario supplies: verified absence of disease and mite problems, since uniting a diseased colony into a sound one spreads the problem. Feeding them up to fill a second brood box is counterproductive, since it increases the volume each small cluster must maintain and creates undefended space that small hive beetle will exploit.

6. First determine why each colony is weak. If the weakness is caused by disease — particularly American foulbrood — or by an uncontrolled mite and virus problem, combining spreads the problem and should not be done until the cause is addressed. If both are simply small but healthy, with sound queens or one sound queen, combining produces one colony with a better chance of surviving winter than two marginal ones. **To combine:** remove the poorer queen, place a sheet of newspaper with a few small slits between the two colonies' boxes, and set one on top of the other. The bees chew through over a day or two, by which time the colony odors have merged and fighting is avoided. Check about a week later to confirm the union and consolidate frames. A useful Southeastern alternative is to winter two small colonies as a **paired double nucleus** in one box divided by a partition, with separate entrances, so each keeps its queen while sharing heat.

7. A. A colony that has swarmed and successfully requeened itself is functional but demographically behind, and it needs time rather than intervention. Boost with **emerging** brood from a disease-free donor, and do not weaken a productive colony to prop up a marginal one. Requeening a newly mated queen accomplishes nothing.

8. Moving brood comb moves whatever the donor colony carries — AFB and EFB, chalkbrood spores, *Nosema*, viruses and *Varroa* — so blind equalization can distribute a disease through an entire apiary in one afternoon. To do it responsibly: first determine why the recipient is weak,

since adding brood does not fix a failing queen or a mite problem; take brood only from colonies you have inspected carefully and believe to be healthy; do not weaken a productive donor below its own requirements; and avoid moving comb between apiaries or from colonies of unknown history. Cleaning the hive tool between colonies, and working known or suspect colonies last, are simple habits that limit what equalization can move.

References for Further Study

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Regional and extension - UGA Extension apiculture publications on splitting and increase - Clemson Cooperative Extension apiculture publications - UF/IFAS EDIS EENY-474, *Small Hive Beetle, Aethina tumida Murray* — essential for nuc management in this region

Primary literature - Honey Bee Health Coalition, *Tools for Varroa Management* — on splits as brood breaks.

Chapter 18: Swarming Prevention and Control

Learning Objectives

When you have finished this chapter you should be able to:

- Explain swarming as colony reproduction and describe the mechanism that links congestion to the swarming impulse.
 - State the Southeastern swarm season and the inspection interval, and explain why both differ from the northern calendar.
 - Describe the sequence of a swarm from cell building to nest occupation.
 - List the conditions that predispose a colony to swarm and give the management response to each.
 - Distinguish prevention from control, and explain why cutting cells alone fails.
 - Perform the principal swarm-control manipulations: split, artificial swarm, Demaree, cut-down, checkerboarding.
 - Recognize afterswarms and manage a colony that has already swarmed.
 - Distinguish swarming from supersedure and from absconding, and manage absconding.
 - Build and site a bait hive.
 - Hive a swarm and integrate it safely.
 - Perform and price a structural removal, and state the drawback of a trap-out.
 - Explain the relationship between swarming and *Varroa*, and why swarming is not a mite strategy.
-

18.1 Swarming Is Reproduction

Swarming is how a honey bee colony reproduces. The superorganism divides: the old mated queen leaves with a large proportion of the workers to found a new colony, while the parent nest is inherited by a daughter queen.

This framing matters because it sets the management logic. Swarming is not a malfunction, not a disease, and not a sign of bad beekeeping. It is what a prosperous colony does. **The beekeeper's job is not to suppress a pathology but to redirect a reproductive drive** — usually by doing the dividing themselves, on their own schedule, into their own equipment.

What it costs the beekeeper:

- **The honey crop.** A colony that swarms in April loses roughly half its foragers just as the main flow opens.
- **Time.** The parent colony spends three to four weeks queenless and then broodless before it rebuilds.
- **The bees themselves,** if the swarm is not caught.
- **Public relations,** if the swarm settles in a neighbor's soffit.
- And it **spreads mites and disease** into the feral population and the neighborhood.

18.2 The Mechanism

Queen mandibular pheromone (QMP) is produced by the queen and distributed through the colony by contact and food sharing. Among its functions is **inhibiting queen rearing** (Chapter 3).

The amount each bee receives depends on how many bees are sharing it. A crowded colony distributes the same pheromone output among more bees, so **each bee receives less**, the inhibition weakens, and workers begin building queen cups and provisioning them.

That is the link between congestion and swarming, and it is also the lever the beekeeper pulls: relieving congestion raises the per-bee pheromone share.

A second and equally important driver is **the ratio of nurse bees to brood to feed**. A colony with a large population of young bees and insufficient brood to occupy them has a surplus of nurses, and that surplus is itself a swarming stimulus. It is why **removing brood and bees** (a split) works and why **adding empty supers on top** often does not.

An **aging queen**, producing less pheromone, contributes. So does a **honey- or pollen-bound brood nest**, which restricts laying and therefore reduces the brood available to occupy nurses.

18.3 The Southeastern Swarm Season

In middle Georgia and upstate South Carolina, the primary swarm season typically runs from mid-February or March through May, peaking in April — considerably earlier than in northern states. In Florida it begins earlier still.

Why: the Southeastern spring arrives early. **Red maple pollen in January and February starts brood rearing**, and by the time tulip poplar and blackberry bloom in April, colonies are at maximum congestion.

The consequence, and it is the single most examined regional point in this subject:

A beekeeper following a book written for the upper Midwest will begin swarm inspections a month or more too late, and will find empty boxes and capped cells.

18.3.1 The inspection interval

Begin swarm-season inspections at roughly 7-day intervals starting in late February or early March.

The arithmetic: queen cells are capped about **8 days after the egg is laid**, and a primary swarm issues at or shortly after capping. A **7-day interval** therefore intercepts the sequence; a 10-day or 14-day interval does not reliably.

And the corresponding manipulations — splitting, Demaree, adding drawn comb, supering — **must all be ready before the colony makes its decision**. Equipment built in April is equipment that was needed in March.

18.4 The Sequence

Stage	What happens
Preparation	Colony builds and provisions queen cups, typically along bottom bars and lower comb margins ; drone rearing increases
Cells capped	about day 8 from the egg
Queen slimmed	The old queen is fed less and shaken by workers so she loses weight and can fly
Primary swarm issues	At or shortly after the first cells are capped , with the old mated queen and a large proportion of workers, typically on a warm mid-day
Clustering	The swarm settles nearby — a branch, a fence post — while scouts search
Scouting and decision	Scouts assess cavities and recruit by waggle dance; consensus builds over hours to days
Occupation	The swarm flies to the chosen cavity and begins drawing comb
Afterswarms	Successive virgins may lead smaller casts over following days
Resolution	One virgin remains, mates, and begins laying about 3 weeks after the primary swarm

Two details worth carrying:

- **The old queen's weight loss** is why a swarm's queen resumes laying quickly once hived: she is a proven layer, temporarily slimmed.
- **A newly issued swarm clustered on a branch is typically docile**, because the bees have **engorged on honey** before leaving and have **no nest or brood to defend**. This is why swarm capture is usually straightforward. The exceptions: a swarm of **African-derived** bees may be considerably less tolerant (Chapter 6), and a swarm that has been clustered several days and begun drawing comb is more defensive.

18.5 Predisposing Conditions and Responses

Condition	Management response
Congestion of the brood nest	Add drawn comb or foundation; super ahead of need; open the brood nest by inserting empty drawn frames
Large population of young nurse bees relative to brood to feed	Make a split , or remove frames of brood and bees
Aging queen with declining pheromone output	Requeen

Condition	Management response
Restricted laying space — honey- or pollen-bound nest	Add empty drawn comb; reverse boxes when brood distribution allows; remove filled frames
Poor ventilation	Improve ventilation; consider a slatted rack; upper entrance
Abundant drone population	A contributing signal rather than a cause; note it as an indicator

The general principle: swarming is a reproductive response to **prosperity and crowding**, so the management response is to **relieve the condition**, not merely to remove the cells.

18.6 Prevention Versus Control

Prevention is what you do before cells are started: space, brood-nest management, requeening, splitting on your own schedule.

Control is what you do once cells are present: a manipulation that removes the stimulus and the cells together.

Once queen cells are started, added space seldom reverses the decision. This is the point at which many beekeepers are surprised.

18.6.1 Why supering alone is not enough

Adding supers before a colony needs them — “supering ahead of the bees” — is good practice, but it is not sufficient by itself, and the examination tests this as a true/false item.

The reason: the congestion that sets off the swarming impulse is congestion of the brood nest. A colony can be **backfilled and crowded below** while empty supers stand above it. The bees are not distributing themselves evenly through the stack; they are making a decision about the nest.

Effective swarm control combines room with brood nest management — a split, an artificial swarm, or a Demaree — **and the brood nest still has to be inspected.**

18.6.2 Why cutting cells alone fails

Cutting out all queen cells and doing nothing else is poor swarm control, for three reasons that should be given together:

1. **It leaves the congestion unaddressed**, so cells are rebuilt within days.
2. **A hidden cell is easily missed** — on a comb covered with bees, tucked into a corner, or on the face of a frame you did not pull.
3. **If the colony has already swarmed**, destroying all the cells leaves it **queenless with no means of requeening itself.**

Cell removal has a legitimate place **as part of** a manipulation such as a Demaree or an artificial swarm, where the underlying condition is also addressed. On its own it usually delays rather than prevents swarming, and it creates the risk of an accidental queenless colony.

18.7 The Manipulations

18.7.1 The split

Covered fully in Chapter 17. As swarm control it works because it **removes brood and bees**, relieving both congestion and the nurse-bee surplus.

Cost: it divides the foraging force and generally sacrifices the crop.

18.7.2 The artificial swarm (Pagden method)

The manipulation that most closely mimics what the colony wants to do.

1. Move the **original hive** to a new position a few feet away.
2. Place a **new box on the original stand**, with foundation or drawn comb.
3. Find the **queen** and place her, on one frame of open brood, in the new box on the original stand.
4. **Returning foragers enter the new box**, because they navigate to the original location.

The result: the queen has a large field force and empty comb — exactly a swarm's situation, and the swarming impulse is satisfied. The parent colony, moved aside, has the brood and the queen cells; reduce its cells to one good cell, or give it a mated queen.

A refinement: about a week later, move the parent colony to the other side of the new hive, so that it loses another tranche of foragers to the queenright unit. This further weakens the swarming impulse in the parent and strengthens the production colony.

18.7.3 The Demaree method

The manipulation for a beekeeper who wants a crop rather than increase, and one the examination asks about directly.

The procedure:

1. **The queen is left in the bottom box** on one or two frames of open brood, together with drawn comb or foundation.
2. **A queen excluder is placed above her**, often with a honey super between.
3. **All remaining brood combs, open and sealed alike, are placed in a box above the excluder.**
4. **All queen cells started in the upper box must be destroyed about a week later.**

Why it works: the queen has abundant laying space and few nurse bees immediately around her; the sealed brood emerges above the excluder and the emerging bees join the colony; the colony remains a **single large foraging unit**.

The principal advantage over simply splitting: the colony remains one large foraging unit and can therefore still produce a full honey crop, whereas an even split divides the workforce and generally sacrifices the crop.

The demand it makes: the **follow-up inspection of the upper box**, which is the step most often forgotten. Brood above an excluder with no queen will build emergency cells, and a virgin emerging up there produces a mess.

The Demaree suits a Southeastern beekeeper aiming for a tulip poplar, gallberry or sourwood crop from a strong colony.

18.7.4 The cut-down split

Remove most of the brood and the queen to a new box, leaving the parent colony with the **foraging force**, a queen cell, and little open brood to feed. The parent puts everything into the flow.

A honey-production manipulation as much as swarm control, and best timed immediately before a heavy flow.

18.7.5 Checkerboarding

Alternating frames of drawn comb (or empty comb) with frames of honey above the brood nest in late winter, on the theory that it disrupts the colony's assessment of its stores and delays the swarming decision. Popularized by Walt Wright.

The evidence base is weaker than the advocacy, and you should present it as a technique with practical adherents rather than as established practice. It also requires a substantial stock of drawn comb.

18.7.6 Opening the brood nest

Inserting empty drawn comb **within** the brood nest, rather than adding space above it, directly addresses the relevant congestion. Do this in warm weather and with a strong colony — inserting empty frames into a small brood nest in cool weather splits and chills it.

18.7.7 Requeening

A young queen carries a **much lower swarming impulse**. This is one of the arguments for the Southeastern practice of **late summer or early autumn requeening** (Chapter 14): the young queen goes into the following spring's swarm season with a lower propensity to swarm, in a region where that season opens in late February or March.

18.8 After the Colony Has Swarmed

18.8.1 Recognizing it

- **Population noticeably reduced** relative to neighbors
- **Opened queen cells** with hinged caps, or capped cells and no eggs
- **No eggs**, and the youngest brood progressively older
- **Piping** — tooting from a free virgin, quacking from mature virgins in cells (Chapter 14)
- A **virgin queen** present, or no queen at all

18.8.2 Afterswarms

Afterswarms (casts) are usually smaller than the primary swarm and contain one or more virgin queens, and may issue in succession over several days, reducing the parent colony below viable strength.

Once a primary swarm has issued, the management goal changes. Swarm prevention is now too late. The goal becomes:

- **Reduce the remaining queen cells to a single good cell, or**
- **Remove all cells and introduce a mated queen**

Leaving a full complement of cells invites repeated casts, and a colony that has thrown a primary swarm and two afterswarms in April will not make a crop and may not survive the summer.

This is why hearing piping during a June inspection should change your management: shift from swarm prevention, which is now pointless, to cell reduction.

Note the distractor: afterswarms are **not** larger than the primary swarm, do **not** contain the old mated queen, and do **not** occur only in autumn.

18.9 Absconding

Absconding differs from swarming in that the entire colony abandons the hive, typically leaving brood and stores, usually in response to intolerable conditions rather than as reproduction.

It is an **escape response, not reproduction**. No division occurs; there is no second viable unit.

Southeastern triggers, in roughly descending order of frequency:

- **Heavy small hive beetle infestation and slime-out** — the leading cause in this region
- **Severe wax moth damage**
- **Dearth starvation**
- **Extreme heat** in an unshaded yard
- **Ants**
- **Repeated disturbance**
- Heavy mite and disease load

Finding an empty hive with brood abandoned in the combs should prompt a search for the stress that caused it, not the assumption that a swarm has issued. That is the diagnostic point: a swarm leaves a colony behind; absconding leaves brood behind.

African-derived colonies abscond far more readily than European stock (Chapter 6).

18.10 Bait Hives and Swarm Capture

18.10.1 The bait hive

An effective bait hive should be about 40 liters — roughly a single deep box — with a small entrance near the bottom, placed several feet above ground, shaded, and baited with old comb or lemongrass.

Scouts **discriminate among cavities**, and matching their preferences markedly improves occupancy (Seeley & Morse, 1978). The standard arrangement:

- **Volume about 40 L** — roughly one ten-frame deep
- **Entrance small**, approximately 2 square inches, **near the bottom**
- **Several feet above ground** — 8 to 15 feet is often cited, though this trades off against your ability to retrieve it
- **Shaded**, and facing south if you can
- **Baited** with one frame of old comb and several frames of foundation, plus a **lemongrass oil** lure (which approximates Nasonov pheromone) or a commercial swarm lure

Southeastern timing: place traps by late February to cover the early swarm season.

Check them regularly so that captured swarms are hived before they fill the box with comb.

18.10.2 Hiving a swarm

The standard technique: shake or brush the cluster into a box, or set the box beneath and shake the branch sharply; watch for **bees fanning Nasonov at the entrance**, which tells you the queen is inside and the swarm is going in (Chapter 3). Leave the box until dusk, then close and move it.

For an exposed cluster on an awkward support — a fence, a wall, a hedge — a bee vacuum or a slow patient coaxing with smoke and a frame of open brood works.

18.10.3 Integrating a captured swarm

The most prudent practice with a swarm of unknown origin: hive it on foundation or clean comb, keep it apart while observing for disease, temperament and queen performance, monitor for *Varroa*, then integrate it.

Each element does work:

- **Foundation or clean comb** limits what it brings with it — a swarm hived onto your good drawn comb may contaminate that comb.
- **Isolation** allows observation before it can affect the rest of the yard.
- **Disease observation** — a swarm may carry AFB spores in the honey its bees are carrying.
- **Temperament observation** is a **public safety matter** in areas with African-derived bees, and requeening a captured swarm with known stock is common practice.
- **Mite monitoring** — swarms carry mites, and the swarm's brood break is the ideal moment to treat with oxalic acid.

Do **not** feed it honey from another apiary, combine it into an existing colony on the day of capture, or immediately give it a frame of brood from your best colony.

18.10.4 The public-facing swarm call

A basketball-sized cluster hanging from a low branch in a suburban yard in April; the homeowner is alarmed.

Almost certainly a swarm, usually docile because the bees have engorged on honey and have no nest to defend.

The response has four parts, and the first two are as important as the last two:

1. **Reassure the homeowner.**
2. **Explain what is happening** — this is a colony looking for a new home, they are not aggressive, they will very likely leave within a day or two anyway.
3. **Hive it by standard technique.**
4. **Keep it apart from your apiary** while you watch its health and temperament.

Swarm calls are the most common public interaction a beekeeper has, and **handling them well builds goodwill for beekeeping generally**. Handling them badly — turning up late, leaving a mess, or refusing without explanation — costs the whole local association something.

18.11 Structural Removals

Two approaches, and the examination asks for both plus the drawback of the less invasive one.

18.11.1 The cutout

Open the wall, remove the comb and brood, salvage brood comb into frames, collect the bees and the queen, and seal and repair the cavity after removing all comb and honey.

- **Advantage:** complete. The colony is removed, the comb and honey are removed, and the cavity can be sealed and made unattractive to future swarms.
- **Requirements:** construction skill, tools, insurance, and a plan for repair.

18.11.2 The trap-out

Fit a one-way cone over the entrance so foraging bees leave and cannot return, with a nucleus colony placed adjacent to receive them, gradually depleting the colony.

- **The principal drawback:** it **does not remove the comb, brood, or usually the queen**. Honey and wax are left in the wall, where they can **melt, attract pests and stain the structure**, and the cavity remains **attractive to future swarms** unless it is opened and cleaned.
- It is also **slow** — weeks — and rarely complete.

Many experienced removers will not perform trap-outs on occupied structures for these reasons, and a candidate who says so is showing judgment.

18.11.3 The business

Before agreeing (Chapter 9):

- A **written agreement** covering scope of work
- **Who opens and repairs the structure**
- **Liability and insurance**
- **What happens if the queen or all the bees cannot be recovered** — manage the expectation in advance
- **Whether the beekeeper is equipped for the job**

Structural removals are **construction work as much as beekeeping**, and the most common disputes concern **repair responsibility** and **unrealistic expectations about complete removal**. A beekeeper without insurance and construction competence should refer the job.

In areas with African-derived bees, add **temperament assessment** and **occupant and neighbor safety** during the work.

18.12 Swarming and *Varroa*

What happens to the mite population when a colony swarms:

The swarm leaves with only the mites **riding on the adult bees**, leaving behind those in sealed brood. The **brood break** while the swarm draws comb further interrupts mite reproduction. So **the swarm begins with a reduced mite load per bee**.

Why swarming is nonetheless not an acceptable *Varroa* management strategy:

1. **The parent colony retains a heavy mite population** — all the mites that were in sealed brood.
2. **The swarm still carries mites and viruses.**
3. **The beekeeper loses the honey crop** and much of the colony's population.
4. **Swarms that escape become feral colonies** that spread mites and disease and create nuisance problems in settled areas.

The legitimate application of the same principle is a deliberate brood break — made by splitting or by caging the queen — **combined with an oxalic acid treatment during the resulting broodless window** (Chapter 16). You get the biology without giving away the bees.

Numbers to Memorize

Item	Figure
SE primary swarm season	mid-Feb/March through May, peaking April
Begin swarm inspections	late February / early March

Item	Figure
Inspection interval	7 days
Queen cells capped	about day 8 from the egg
Primary swarm issues	at or shortly after first cells capped
Swarm leaves with	the old mated queen
Bait hive volume	about 40 liters (one deep box)
Bait hive height	several feet above ground
Bait hives placed by	late February (Southeast)
Parent colony to laying queen after swarm	about 3 weeks

Key Terms

Primary swarm — the first swarm, led by the old mated queen.

Afterswarm / cast — a smaller subsequent swarm led by one or more virgin queens.

Artificial swarm (Pagden) — moving the queen and a frame of brood onto the original stand so returning foragers join her.

Demaree — confining the queen below an excluder with all other brood above, preserving the colony as one foraging unit.

Cut-down split — removing brood and queen, leaving the foraging force on the flow.

Checkerboarding — alternating comb and honey above the brood nest in late winter.

Opening the brood nest — inserting empty drawn comb within the brood nest.

Absconding — abandonment of the nest by the whole colony, leaving brood and stores; an escape response.

Bait hive / swarm trap — a cavity of about 40 L sited and baited to attract scouts.

Cutout / trap-out — the two methods of removing a colony from a structure.

Piping — tooting and quacking from free and confined virgin queens.

Self-Check

1. (MC) In middle Georgia and upstate South Carolina, the primary swarm season typically runs approximately: A) September through November B) Mid-February or March through May, peaking in April, considerably earlier than northern states C) December through January D) June through August

2. (SA) List four conditions that predispose a colony to swarm, and for each state the corresponding management response.

- 3. (MC)** A primary swarm normally issues at approximately what point, and which bee leads it?
 A) Before any queen cells are started B) At or shortly after the first queen cells are capped, roughly day 8 from the egg; the old mated queen leaves with a large proportion of the workers
 C) Only after the colony's honey stores have been consumed D) After the new virgin queen has emerged and mated
- 4. (MC)** Cutting out all queen cells and doing nothing else is poor swarm control because: A) It leaves the congestion unaddressed so cells are rebuilt within days, a hidden cell is easily missed, and if the colony has swarmed it may be left queenless B) Queen cells cannot be located reliably on a comb covered with bees C) The practice is prohibited under most state apiary statutes D) Removing cells deprives the colony of stored royal jelly
- 5. (SA)** Describe the Demaree method of swarm control and state its principal advantage over simply splitting the colony.
- 6. (TF)** Supering ahead of the bees is the single most reliable means of swarm prevention, and a colony given ample super space in good time will not need its brood nest examined for queen cells.
- 7. (MC)** Afterswarms differ from the primary swarm in that they: A) Occur only in autumn B) Contain no queen at all C) Are larger and contain the old mated queen D) Are usually smaller and contain one or more virgin queens, and may issue in succession over several days, reducing the parent colony below viable strength
- 8. (MC)** Absconding in a Southeastern apiary is most commonly triggered by: A) Intolerable conditions such as heavy small hive beetle infestation and slime-out, wax moth damage, dearth starvation, extreme heat, ants or repeated disturbance B) The presence of a young and vigorous queen C) Cold weather in midwinter D) An excess of stored honey packed into the brood nest
- 9. (SA)** You are called to remove a colony from the wall of an occupied house. Describe the two main removal approaches and state the principal drawback of the less invasive one.
- 10. (SA)** Explain what happens to the *Varroa* population in a colony that swarms, and why swarming is nonetheless not an acceptable *Varroa* management strategy.
- 11. (MC)** An effective bait hive should have approximately: A) About 5 gallons with a large top entrance at ground level B) At least 100 liters with several entrances C) About 40 liters, roughly a single deep box, with a small entrance near the bottom, several feet above ground, shaded, and baited with old comb or lemongrass D) No particular characteristics

Answers

- 1. B.** Red maple pollen in January and February starts brood rearing, and by the time tulip poplar and blackberry bloom in April colonies are at maximum congestion. A beekeeper following a northern book begins swarm inspections a month or more too late.
- 2.** *Congestion of the brood nest* — add drawn comb or foundation, super ahead of need, and open the brood nest. *A large population of young nurse bees relative to brood to feed* — make a split, or remove frames of brood and bees. *An aging queen with declining pheromone output* — requeen. *Restricted laying space because the brood nest is honey- or pollen-bound* — add empty drawn comb, reverse boxes when brood distribution allows, or remove filled frames. Poor ventilation and an abundant drone population are contributing signals. The general principle is

that swarming is a reproductive response to prosperity and crowding, so the response is to relieve the condition rather than merely to remove the cells.

3. B. Because capping occurs about eight days after the egg is laid, a 7-day inspection interval during swarm season is the standard way to intercept the sequence. Note also that the old queen is fed less and shaken by workers in the days before departure so that she loses weight and can fly — which is why a swarm's queen resumes laying quickly once hived.

4. A. Cell removal treats the symptom. It has a legitimate place as part of a manipulation such as a Demaree or an artificial swarm, where the underlying condition is also addressed.

5. The queen is left in the bottom box on one or two frames of open brood together with drawn comb or foundation; a queen excluder is placed above her, often with a honey super between; and all remaining brood combs, open and sealed alike, are placed in a box above the excluder. **All queen cells started in the upper box must be destroyed about a week later.** The advantage over splitting is that **the colony remains a single large foraging unit and can therefore still produce a full honey crop**, whereas an even split divides the workforce and generally sacrifices the crop. The Demaree suits a Southeastern beekeeper wanting a tulip poplar or gallberry crop from a strong colony, but it demands the follow-up inspection of the upper box — the step most often forgotten.

6. False. Supering ahead is good practice but not sufficient by itself. The congestion that sets off the swarming impulse is congestion of the **brood nest**, and a colony can be backfilled and crowded below while empty supers stand above it. Once queen cells are started, added space seldom reverses the decision. Effective swarm control combines room with brood nest management — a split, an artificial swarm or a Demaree — and the brood nest still has to be inspected.

7. D. Once a primary swarm has issued, the management goal changes: reduce the remaining cells to a single good cell, or remove all cells and introduce a mated queen. A colony that throws a primary swarm and two afterswarms in April will not make a crop and may not survive the summer.

8. A. Absconding means the whole colony leaves, usually abandoning brood and stores, and it is an escape response rather than reproduction. Small hive beetle is the leading Southeastern cause. Finding an empty hive full of abandoned brood should send the beekeeper looking for the stressor rather than assuming a swarm.

9. A **cutout** involves opening the wall, removing the comb and brood, salvaging brood comb into frames, collecting the bees and the queen, and sealing and repairing the cavity after removing all comb and honey. A **trap-out** involves fitting a one-way cone over the entrance so foraging bees leave and cannot return, with a nucleus colony placed adjacent to receive them, gradually depleting the colony. **The principal drawback of the trap-out is that it does not remove the comb, brood or usually the queen**, so honey and wax are left in the wall where they can melt, attract pests and stain the structure, and the cavity remains attractive to future swarms unless it is opened and cleaned. A complete answer also notes the business considerations: a written agreement about who repairs the structure, liability insurance, and honest disclosure that a trap-out is slower and leaves material behind. Many experienced removers will not perform trap-outs on occupied structures for these reasons.

10. The swarm leaves with only the mites riding on the adult bees, leaving behind those in sealed brood, and the brood break while the swarm draws comb further interrupts mite reproduction — so the swarm begins with a reduced mite load per bee. It is **not** an acceptable management strategy because the **parent colony retains a heavy mite population**; the swarm still carries mites and viruses; the beekeeper loses the honey crop and much of the colony's population; and swarms that escape become feral colonies that spread mites and disease and create nuisance problems in settled areas. The legitimate application of the same principle is a **deliberate brood break**, achieved by making a split or caging the queen, combined with an oxalic acid treatment during the resulting broodless window.

11. C. Place traps by late February in the Southeast to cover the early swarm season, and check them regularly so captured swarms are hived before they fill the box with comb.

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Chapter 19: Environmental Evolutionary Adaptiveness

Learning Objectives

When you have finished this chapter you should be able to:

- Explain the superorganism concept and why selection acts on the colony rather than the individual bee.
 - Explain haplodiploidy, polyandry and patriline, and the adaptive value of genetic diversity within a colony.
 - Explain why a queen's merit must be judged from her colony and why open-mated daughters of a selected queen regress toward the local mean.
 - Describe the dance language and the other communication systems as adaptations to specific ecological problems.
 - Explain nest site selection and collective decision-making.
 - Explain defensive behavior as an adaptation, list the non-genetic factors that raise it, and use that knowledge in the field.
 - Explain drifting, robbing and absconding in adaptive terms.
 - Describe the traits available for selection — hygienic behavior, VSH, grooming, mite-biting — and how each is measured.
 - Argue both sides of local adaptation, and both sides of treatment-free beekeeping, and state what a responsible treatment-free practice requires.
 - Describe the beekeeper's own safety practice: protective equipment, smoker safety, heat stress, and sting response.
-

19.1 The Colony as a Unit of Selection

A honey bee colony is more usefully understood as **one organism than as a collection of organisms**. The term of art is **superorganism**, and it is not merely a metaphor.

Consider what the individual worker cannot do: she cannot reproduce, she cannot thermoregulate, she cannot survive more than a few days alone, and she cannot perform most of her own life-support functions independently. The colony can do all of these. **The colony reproduces** (by swarming), **the colony thermoregulates** (Chapter 3), **the colony makes decisions** (§19.5), **the colony has an immune system** in the social sense — hygienic behavior, grooming, propolis envelope, undertaking.

The individual bee is, in this framing, closer to a **cell** than to an organism, and the worker's sterility is no more paradoxical than the sterility of a liver cell.

Selection therefore acts on the colony. This has three practical consequences for a beekeeper:

1. **A queen's genetic merit cannot be assessed from her own appearance or laying behavior; it must be judged from the colony she heads** (§19.3).

2. **Selection criteria are colony-level observations** — temperament, brood pattern, hygienic behavior, productivity, wintering — made over time, not snapshot judgments about an individual bee.
3. **Colony-level traits can be adaptive even when they cost individual bees their lives.** A worker who stings a mammal dies; the colony survives.

19.2 Haplodiploidy and Polyandry

19.2.1 Haplodiploidy

Males are haploid, from unfertilized eggs; females are diploid, from fertilized eggs.

The queen controls the sex of each egg by controlling sperm release as the egg passes down the oviduct, assessing cell width with her forelegs beforehand.

Consequences, all examinable:

- **A drone has no father** — but he has a grandfather.
- **A queen with an exhausted spermatheca becomes a drone layer**, laying normally but producing only unfertilized eggs.
- **Old, damaged or enlarged comb accumulates drone brood**, because the queen reads cell width.
- **All drones from one queen are NOT genetically identical.** Each unfertilized egg is a product of meiosis **with recombination**, so each drone carries a **different random half** of the queen's genome. Drones from one queen are related to one another by **one half, not by one**. This matters for anyone thinking about drone saturation for mating control: using one drone mother does **not** give genetically uniform drones.
- **Complementary sex determination.** Sex is determined by a locus (*csd*) at which heterozygotes are female and homozygotes are diploid **drones**, which nurse bees remove shortly after hatching. Inbreeding raises the frequency of homozygotes and produces the characteristic “**shot brood**” or “**pepperbox**” pattern: scattered empty cells in an otherwise solid and healthy pattern — half of the fertilized eggs from any drone sharing a *csd* allele with the queen, so commonly a quarter or less of the cells overall, depending on how many of her mates match, with no ropiness, no odor, no scale and negligible mite counts. The remedy is to introduce unrelated genetics.

19.2.2 Polyandry and patrines

A queen mates with a dozen to twenty or more drones and stores their sperm for life. This is **extreme polyandry**, unusual among insects, and it is an **adaptation** rather than an accident.

The result: the workers in a colony are a mixture of full sisters within each patriline and half sisters across patrines. Within a patriline (one father) sisters share, unusually, about 75 percent of their genes, because their haploid father contributed identical genes to all of them. Across patrines they share about 25 percent.

The adaptive value of that diversity is measurable. Genetically diverse colonies:

- **Regulate brood nest temperature more precisely**, because workers from different patriline have slightly different temperature thresholds for fanning and heating, giving the colony a graded rather than an all-or-nothing response
- **Resist disease better**
- **Forage more effectively**, with a broader range of task thresholds
- **Are more productive** overall (Mattila & Seeley, *Science*, 2007)

For the beekeeper, the practical consequence is that a colony's observable traits reflect a blend of many fathers, so a single daughter queen from an excellent mother will not reliably reproduce the mother colony's performance.

19.3 The Limits of Selection Under Open Mating

19.3.1 Why you judge the colony, not the queen

Workers are diploid and derive half their genes from the drones the queen mated with. A queen must therefore be judged by her colony's performance, not by inspecting the queen herself. Her size, color and laying behavior tell you something about her own condition; they tell you very little about her genetic merit as a breeder.

This is also why **instrumental insemination and isolated mating yards exist**, and why the traits that matter — **temperament, brood pattern, hygienic behavior, productivity and wintering** — are all **colony-level observations made over time**.

19.3.2 Why resistance dilutes

A beekeeper buys a queen of a well-regarded mite-resistant stock and is pleased with the colony. The following year she raises daughters from that queen and lets them open-mate locally. Why is the resistance likely to diminish?

Mite resistance is a quantitative trait influenced by many genes, and the colony's traits are **expressed by its workers**, whose **fathers are the drones the daughter queen mated with**. Open mating in a local drone population means the daughters mate with **unselected feral and neighborhood drones**, so **half the genetic contribution to each worker comes from outside the selected line**, and the trait is **diluted toward the local average with each generation**.

The practical options:

1. **Buy replacement queens from the selected source on a schedule.**
2. **Participate in a program with controlled or instrumentally inseminated matings.**
3. **Saturate the local area with drone-producing colonies from the selected stock, which shifts but does not determine paternity.**

19.3.3 Hybrid vigor and F1 queens

A purchased hybrid queen may perform very well, but her open-mated daughters segregate and may be variable and sometimes more defensive.

This is the genetics behind the common complaint that a wonderful purchased queen produced disappointing daughters. F1 hybrids express heterosis; F2 and backcross generations segregate.

The argument that follows is either to **buy replacement queens from the producer**, or to **select deliberately over several generations** if you wish to develop your own line — which is a multi-year project requiring records, a plan, and enough colonies to make selection meaningful.

19.3.4 Selecting breeder colonies

The most useful criteria are: colonies combining gentleness, production, low mite growth, good brood pattern, disease resistance and overwintering, judged over at least a full season.

Selecting from a single snapshot rewards luck rather than genetics, since colony performance in a given week depends heavily on position in the yard, forage, disturbance history and queen age.

Keeping written colony records across a season is what turns opinion into selection, and it is the habit that most separates a working beekeeper from a hobbyist. It is also the only reliable way to distinguish a genuine stock difference from an accident of circumstance.

Wrong criteria that appear as distractors: any colony that happens to have queen cells; the most defensive colonies (on the theory that defensiveness indicates vigor); and whichever colony is largest on the day you decide to graft.

19.3.5 Feral colonies

Feral honey bee colonies in the Southeast contribute drones to local matings, act as reservoirs of *Varroa* and disease, and may contribute African-derived genetics to open-mated queens in some areas.

They are neither a resource to be romanticized nor a menace to be eliminated, but they are a **real factor in open mating and in area-wide mite and disease dynamics.**

The practical implications: **requeening from a known source is the only way to control the maternal line**; captured feral swarms should be observed and usually requeened; and **you cannot control what drones your queens meet.**

The romantic claim — that feral colonies always carry superior genetics because they have survived without treatment, and should therefore be propagated in preference to purchased stock — is worth examining rather than dismissing. Some feral populations genuinely do show resistance (§19.9). But most feral colonies in a settled landscape are **recent escaped swarms** from managed colonies, not long-surviving lineages, and a captured swarm tells you nothing about its ancestry.

19.4 Traits Available for Selection

Trait	What it is	How it is measured
Hygienic behavior	Detecting, uncapping and removing diseased,	Freeze-killed brood assay (about 100 cells,

Trait	What it is	How it is measured
	dead or parasitized sealed brood	liquid nitrogen or freeze-and-return; score at 24 h; at least 95% removal = hygienic); or pin-kill test
Varroa Sensitive Hygiene (VSH)	Detecting sealed cells containing reproducing <i>Varroa</i> and removing the contents, interrupting mite reproduction	Assessment of the proportion of non-reproducing foundresses in sealed brood
Grooming / mite-biting	Removing mites from the bodies of adult bees	Proportion of fallen mites showing damage to legs or body
Reduced mite population growth	The net colony-level outcome	Paired mite counts over a season
Gentleness	Defensive response	Observation over a season, under varied conditions
Overwintering	Survival and spring build-up	Records
Productivity	Surplus	Records, ideally with a hive scale

VSH is distinct from general hygienic behavior and from grooming, and the three are selected separately. A beekeeper buying resistant stock should **know which trait the supplier selects for**, and should **continue monitoring rather than assuming the stock has solved the problem.**

Hygienic behavior gives real resistance to AFB, chalkbrood and, to a degree, Varroa — though not immunity. It reduces incidence and severity rather than eliminating disease, so it complements rather than replaces inspection and good management. A distractor sometimes claims hygienic colonies pull sound brood along with the sick at a net cost; they do not, and the trait is one of the few genetic tools available to an ordinary beekeeper.

19.5 Communication as Adaptation

19.5.1 The dance language

The waggle dance conveys direction by the angle of the waggle run relative to straight up on the comb, corresponding to the angle from the sun; and distance by the duration of the waggle.

Straight up on the comb represents the direction of the sun. A run angled 30 degrees to the right of vertical means the source lies 30 degrees to the right of the sun's azimuth.

Longer waggle runs mean greater distance. The **enthusiasm** of the dance — its vigor and the number of circuits — conveys **quality**. **Odor carried on the dancer** helps recruits identify the flower once they arrive.

The adaptive problem it solves is specific: **a colony forages over several square miles from a fixed nest, and resources are patchy, ephemeral and unpredictable.** A colony that can direct recruits to a good patch exploits it before competitors do.

19.5.2 The round dance, and what it does not encode

Bees use a round dance for sources very close to the hive, generally under about 50 to 100 meters.

The round dance conveys NO directional information at all. The reversals at the end of each circle alternate irregularly and encode nothing. A commonly examined false statement claims direction is conveyed by the side on which the dancer reverses.

And that absence is itself the adaptation. Within a short radius of the hive, recruits can search in all directions and find the source, so direction need not be communicated.

Directional coding appears with the waggle run as sources become more distant, with an intermediate transitional form between the two.

19.5.3 The other signals

- **Nasonov pheromone** — “come here.” Orientation at the entrance, at a settling swarm, at a water source, after a move. Recognizing the raised-abdomen fanning posture tells you a swarm is going into the box you just put it in (Chapter 3).
- **Alarm pheromone** — isopentyl acetate (banana) and other compounds from the Koschevnikov gland and sting-sheath glands; 2-heptanone from the mandibular glands has at most a weak alarm role. Recruits defenders and **marks a target**. Crushing a bee marks you; a sting marks the spot.
- **Queen mandibular pheromone** — inhibits queen rearing and worker ovary development; diluted by crowding; the mechanism linking congestion to swarming (Chapter 18).
- **Brood pheromone** — signals larval presence and quantity; influences foraging effort and pollen collection; suppresses worker ovary development, which is why repeated frames of open brood suppress laying workers.
- **Piping, tremble dance, stop signal, shaking signal** — a rich repertoire of shorter-range signals regulating nectar receiving, foraging effort and swarming.

19.5.4 Nest site selection

Seeley’s work on swarm decision-making is one of the most satisfying pieces of biology in the subject, and it is worth knowing both for its own sake and because it explains bait hives.

A clustered swarm sends out **scouts**, which locate candidate cavities, assess them, and return to **advertise them by waggle dance on the surface of the cluster**. Scouts dance more vigorously and for longer for better sites. Other scouts are recruited to inspect, and if they agree, they dance too. Scouts advertising poorer sites **cease dancing** over time. The process converges on a **quorum** at the best available site, and the swarm then lifts off and flies to it.

Scouts discriminate on: cavity **volume** (around 40 liters is preferred), **entrance size** (small, approximately 2 square inches), **entrance position** (near the bottom), **height above ground, exposure and shelter**, and **prior occupancy** (old comb is attractive).

That is why bait hives work, and why their specification is what it is (Chapter 18).

19.6 Defensive Behavior

19.6.1 As an adaptation

A honey bee colony is a large, immobile, concentrated store of protein and carbohydrate in a world full of things that want to eat it. **Defensive behavior is the adaptation to that problem**, and it is graded: guards challenge intruders, alarm pheromone recruits, and the response scales with the perceived threat.

The sting is a modified ovipositor, barbed in workers so that it tears loose in elastic mammalian skin, killing the bee — a cost the individual pays and the colony recovers. Against another insect's exoskeleton the barbs do not catch, and a worker can sting repeatedly.

Selection for defensiveness varies with the environment. **African-derived stock evolved under intense predation pressure** — honey badgers, ants, primates, birds — in a climate where absconding and rapid rebuilding were viable alternatives to standing and fighting for a large honey store. Hence the differences described in Chapter 6.

19.6.2 The non-genetic factors

A colony that has become noticeably more defensive over several weeks, with no change in weather or management, most likely reflects a queen change through supersedure or swarming introducing different genetics, or queenlessness, or nightly predator harassment such as by a skunk.

But for a single bad day, genetics is usually not the explanation. **Factors other than genetics that increase the defensive response of an otherwise gentle colony:**

- **Nectar dearth**
- **Queenlessness**
- **Cool, cloudy, windy or threatening weather; approaching storms**
- **Late afternoon or evening inspection**, when most foragers are home
- **Rough handling**, jarring, dropping equipment
- **Excessive or hot smoke** — or too little smoke
- **Recent robbing or predator disturbance**
- **Strong odors**: gasoline, alcohol, sweat, and banana-scented products that mimic alarm pheromone
- **Crushing bees**, which releases alarm pheromone
- **Dark, fuzzy clothing** (which resembles a bear)

A beekeeper who can list these can usually choose a better time and method rather than concluding a colony is bad-tempered. In the Southeast the practical consequence is to **work colonies in mid-morning to early afternoon on a clear warm day during a flow**, and to be far more careful during the summer dearth.

19.6.3 Guard behavior and colony odor

Guard bees distinguish nestmates from intruders primarily by colony odor — a learned chemical signature carried on the cuticle and strongly influenced by the comb and by the colony’s forage. Not by sight, not by wingbeat sound, not by size.

Because the signature is **learned and partly environmental**, colonies fed alike and kept on shared comb accept one another more readily — which is why **newspaper combines work** and why **drifting increases when hives look and smell alike**.

A returning forager loaded with nectar is also challenged less, which is why **drift and robbing behave differently during a flow than during a dearth**.

19.6.4 Drifting and robbing

Drifting — bees returning to the wrong hive — is increased by long straight rows of identical hives facing one direction. It is adaptive from the drifting bee’s point of view (she gets accepted, particularly if loaded) and costly from the beekeeper’s: it **moves mites and pathogens between colonies** and makes end-of-row hives artificially strong (Chapters 7, 16).

Robbing is foraging on a defenseless colony, and it accelerates through **positive feedback** — the more robbers succeed, the more are recruited. It is an adaptation to a world in which other colonies fail and their stores become available.

Distinguishing robbing from orientation flights is a core field skill:

	Orientation flights	Robbing
Flight	Young bees facing the hive , hovering in slowly widening arcs	Fast, weaving, searching along the hive body
Where they go	In and out of the entrance	Probing cracks, corners and seams
Fighting	None	Wrestling pairs on the landing board and ground
Dead bees	None	Present
Wax flecks	None	Wax flecks and torn cappings from chewing into stored honey
Time	Typically early afternoon on a warm day	Any time; worst in dearth
Whose bees	All from that same hive	Robbers attempting entry and being challenged

Robbing calls for immediate action; orientation calls for none.

The immediate response to robbing: reduce the target colony’s entrance to a very small opening or fit a robbing screen, clear spilled syrup and exposed comb, and

close or move it if it persists. Speed matters because of the positive feedback. **Opening the colony to inspect makes it worse.**

Prevention is far better: keep entrances reduced during dearth, avoid open feeding, do not leave wet supers or burr comb in the yard, and equalize colony strength so no colony is a defenseless target. In the Southeast, the **July and August dearth is the predictable high-risk window.**

19.6.5 Bearding, absconding and the rest

Bearding is thermoregulation (Chapter 3) — normal, and not a swarm signal.

Absconding is an escape response to intolerable conditions (Chapter 18) — an adaptation that is much more strongly expressed in tropically adapted stock, where a colony can rebuild quickly elsewhere, and much less so in temperate stock that has invested in winter stores.

Undertaking — removing dead bees and debris — is a social immune behavior. A scattering of dead bees on the ground in front of a hive in late winter is normal cleanout; **a large pile of freshly dead bees at the entrance in the middle of a flow warrants investigation,** most commonly pesticide exposure.

19.7 Local Adaptation

19.7.1 The case for local stock

1. **Locally raised bees have survived local conditions** — the summer dearth, high humidity, small hive beetle pressure, and the regional disease and mite environment. Whatever survived here was tested here.
2. **Their queens have mated with local drones**, which are subject to the same selection.
3. **Practical advantages:** earlier availability, **shorter shipping with less thermal stress on queens** (Chapter 14), and knowledge of the producer's management practices.

19.7.2 The case against exclusive reliance

A small local gene pool can narrow genetic diversity and can perpetuate poor traits if selection is not deliberate. “Local” is not the same as “good”; a local population that nobody has selected is a local population carrying whatever happens to be there, including defensiveness, poor wintering and susceptibility.

And **locally available stock may lack specific selected traits** — VSH, say — that a specialist breeding program offers.

19.7.3 The balanced practice

Raise local queens from the best-performing colonies while periodically introducing outside genetics from a reputable selected source. This is what most extension programs recommend, and it is the answer an examiner is looking for: neither romantic localism nor perpetual dependence on a catalogue.

19.8 Stock Characteristics

Stock	Characteristics
Italian (<i>A. m. ligustica</i>)	Light, prolific , good comb builders, gentle — but rear brood late into autumn and consume stores freely. The historical mainstay of American beekeeping; suits the long Southeastern season.
Carniolan (<i>A. m. carnica</i>)	Dark, rapid spring build-up , frugal , gentle, winters well on a small cluster — and correspondingly more swarm-prone . Builds explosively on the early red maple and poplar flow, which in the Southeast demands close swarm management.
Caucasian (<i>A. m. caucasica</i>)	Dark, gentle, long tongues, heavy propolizers .
Russian	Imported by USDA from the Primorsky region for its long history of coexistence with <i>Varroa</i> ; carries resistance. Distinctive management requirements — variable build-up, tendency to maintain queen cells.
Buckfast	Composite line developed by Brother Adam; selected for productivity, gentleness and tracheal mite resistance.
VSH lines	Selected specifically for Varroa Sensitive Hygiene.
Minnesota Hygienic	Selected for general hygienic behavior.

Stock choice is a set of trade-offs matched to a region and a management style, not a ranking. A distractor pattern to recognize: descriptions that reverse the Italian/Carniolan characteristics, or that claim Russian stock has no history of mite exposure.

19.9 Treatment-Free Beekeeping

The examination asks for **both arguments** and for what a **responsible** treatment-free practice requires. Give all three parts.

19.9.1 The argument for

- **Treating every colony prevents natural selection for resistance.** If you rescue every susceptible colony, you preserve susceptibility in the population.
- **Chemical residues accumulate in wax** (Chapters 11, 13), with documented sublethal effects.

- **Some populations of bees have been shown to persist with *Varroa* — the Arnot Forest population studied by Seeley, the Gotland population, and others — under conditions of low colony density.**

19.9.2 The argument against

- **In a densely stocked managed landscape, colonies that collapse from mites are robbed by neighbors, so an untreated failing colony becomes a mite and virus source for every beekeeper within flight range** (Chapter 16). The costs are externalized onto other people.
- **Most beekeepers attempting it lose the majority of their colonies without achieving selection**, because they **continue to replace losses with purchased commercial stock** — which means no selection has occurred at all; the population has simply been cycled.
- The surviving populations that are cited **survived under low colony density and with substantial losses**, conditions that do not describe most managed apiaries.

19.9.3 What a responsible treatment-free practice requires

1. **Rigorous monitoring** — you cannot claim a selection program without data.
2. **Willingness to identify and remove collapsing colonies before they become reservoirs**, rather than letting them die in place. This is the crux.
3. **Honest accounting of losses**, including over multiple years.
4. **Transparency with neighboring beekeepers.**
5. **Propagating from survivors** rather than replacing losses with bought stock.

The examinable point: the philosophical position and its execution are **separable**, and **the obligation not to impose mite pressure on neighbors applies regardless of the beekeeper's philosophy.**

19.10 The Beekeeper in the Apiary: Safety

The colony's defensive adaptations are what the beekeeper actually has to work with. The rest of this chapter is the human side of that.

19.10.1 Protective equipment — and why more is not always better

At minimum, a veil. A sting to the eye can cause serious injury, and there is no argument for working without face and eye protection.

Beyond that, a jacket or full suit, and gloves, are **matters of judgment.**

Why more is not always better:

- **Heavy clothing prevents evaporative cooling** and creates a real heat illness risk in the Southeastern summer (§19.10.3).
- **Gloves reduce dexterity**, which leads to clumsy handling, **crushed bees and released alarm pheromone**, making the colony more defensive. The beekeeper in heavy gauntlets is often the reason the colony is angry.
- **Over-reliance on equipment encourages rough handling.**

The primary determinants of how a colony responds are gentle stock, suitable weather, correct smoker use and calm technique — not the thickness of the suit.

The balancing consideration, which must be stated: **experience is not a reason to work without a veil**, particularly with unfamiliar colonies, in public settings, or anywhere **African-derived bees may be present**, where full protection is appropriate (Chapter 6).

19.10.2 Smoker safety

- **Use dry, natural fuel** free of treated or painted materials and of anything producing toxic smoke. Pine straw, pine needles, burlap (untreated), wood shavings, dried leaves.
- **Manage the smoker so it produces cool white smoke rather than flame or hot smoke.** Hot smoke drives bees off the combs, taints honey and can provoke rather than calm a colony.
- **Never set a lit smoker on dry grass or pine straw**, or in a vehicle.
- **Transport it in a metal container** or an ammunition box with the lid closed, which also extinguishes it.
- **Ensure it is fully out** before leaving the apiary or storing it. **A smoldering smoker is a serious wildfire risk in the dry pine landscapes of the Southeast**, and apiary fires started by carelessly handled smokers are a recurring and entirely preventable problem.
- **Keep water or a fire extinguisher available.**
- Be aware that **a hot smoker will burn the beekeeper** as readily as anything else.
- In some seasons and counties, **open burning restrictions apply** — check with the state forestry commission.

19.10.3 Heat stress

Heat stress is a serious occupational hazard for beekeepers in the southeastern US because protective clothing prevents evaporative cooling.

And the usual warning signs are unreliable in exactly the wrong direction, which is examined as a true/false item:

- **Thirst lags dehydration.** By the time you feel thirsty you are already behind.
- **Cessation of sweating is a late and ominous sign of heat stroke**, not a reassurance that earlier sweating provided cover. A beekeeper who has stopped sweating in Southeastern heat is in serious trouble.
- **Humidity is the aggravating factor:** sweat that cannot evaporate does not cool.

The signs to act on: cramps, headache, nausea, weakness, dizziness, and **any confusion** — confusion is an emergency.

The controls: work early; pre-hydrate and keep drinking; take shade breaks; use ventilated clothing; do not work alone in extreme heat; and be willing to stop. The hive will still be there tomorrow.

19.10.4 Stings: reactions and response

Covered in Chapter 3; summarized here because it belongs to apiary safety practice.

Removal: speed matters more than method. The detached sting continues to pump venom, and controlled measurement found that **elapsed time governed the dose delivered while the method of removal did not significantly affect it** (Visscher, Vetter & Camazine, *Lancet*, 1996). Scrape it out with a hive tool or fingernail if that is quickest; do not hesitate while looking for something to scrape with.

Local versus systemic:

- **A local reaction** brings pain, redness and swelling **at and continuous with the sting site.**
- **A systemic allergic reaction** brings signs **away from that site** — generalized hives, facial or throat swelling, breathing difficulty, dizziness, collapse.

The distinguishing question is always: are the symptoms away from the sting?

First aid for a systemic reaction:

1. **Administer epinephrine immediately** by intramuscular injection into the **outer thigh**, using an auto-injector if available and prescribed.
2. **Call emergency medical services at once.**
3. **Keep the person lying down with legs elevated** unless breathing difficulty makes sitting necessary. **Do not have them stand or walk.**
4. **Be prepared to give a second dose** if there is no improvement within roughly five to fifteen minutes and a second injector is available.
5. **Ensure transport to hospital for observation** even if symptoms improve, because reactions can recur hours later.
6. **Remove the sting promptly** by any means.
7. **Antihistamines are an adjunct and are not a substitute for epinephrine.**

Planning, which is the part that is actually examinable as judgment: a beekeeper hosting visitors, teaching a class or mentoring should **ask in advance about sting allergies**, know where the nearest emergency services are, **ensure a phone has signal at the apiary**, and never work alone with a known allergic person present without a plan.

Mass envenomation — hundreds of stings — is a **toxic**, not allergic, phenomenon and is dangerous to anyone (Chapter 6). Hospital evaluation is required regardless of how the person feels.

Numbers to Memorize

Item	Figure
Relatedness, full sisters (same patriline)	about 75%
Relatedness, half sisters (different patriline)	about 25%
Drones from one queen, relatedness	about 50% (not identical)
Round dance range	under about 50–100 m

Item	Figure
Waggle dance	angle from vertical = angle from sun; duration = distance
Preferred nest cavity volume	about 40 L
Hygienic threshold	at least 95% removal at 24 h
Inbreeding brood pattern	up to about 25% of cells empty
Epinephrine second dose	after about 5–15 min if no improvement

Key Terms

Superorganism — the colony as the functional organism and unit of selection.

Haplodiploidy — males haploid from unfertilized eggs, females diploid from fertilized eggs.

Complementary sex determination (*csd*) — the locus at which homozygosity produces diploid drones.

Patriline — the subfamily of workers fathered by one drone.

Polyandry — mating with many males.

Heterosis / hybrid vigor — enhanced performance of F1 hybrids, not maintained in later generations.

VSH — Varroa Sensitive Hygiene: removal of sealed cells containing reproducing mites.

Freeze-killed brood assay — the standard test for hygienic behavior.

Quorum — the threshold of scout agreement at which a swarm commits to a nest site.

Colony odor — the learned cuticular signature by which guards recognize nestmates.

Undertaking — removal of dead bees from the nest.

Self-Check

1. (MC) Because a queen mates with many drones, the workers in a single colony are: A) All clones of the queen B) All unrelated to one another C) All identical twins D) A mixture of full sisters within each patriline and half sisters across patrilines, giving diversity that improves thermoregulation, resistance and performance

2. (SA) A beekeeper buys a queen of a well-regarded mite-resistant stock, is pleased with the colony, and the following year raises daughters and lets them open-mate locally. Explain why the resistance is likely to diminish, and give the practical options.

3. (TF) All drones produced by a single queen are genetically identical to one another because they develop from unfertilized eggs.

4. (TF) Because workers derive all of their genes from the queen that laid them, a queen's genetic merit can be assessed directly from her own appearance and laying behavior.
5. (MC) Varroa Sensitive Hygiene (VSH) refers to: A) The ability of workers to detect sealed cells containing reproducing *Varroa* mites and remove the contents, interrupting mite reproduction B) A resistance in the queen herself C) The tendency to groom mites from adult bees D) The tendency to abscond once mite levels rise
6. (TF) Bees use a round dance for sources under about 50–100 m, and the round dance conveys direction by the side on which the dancer reverses at the end of each circle.
7. (SA) List four factors, other than genetics, that increase the defensive response of an otherwise gentle colony on a given day.
8. (SA) Distinguish orientation flights from robbing at a hive entrance, giving at least three observable differences.
9. (SA) Give two practical arguments for keeping locally adapted stock in the Southeast and one practical argument against relying exclusively on it.
10. (SA) Explain the argument for and the argument against a treatment-free approach to *Varroa*, and state what a responsible treatment-free practice requires.
11. (SA) Explain what personal protective equipment is appropriate for beekeeping and why more is not always better.
12. (TF) Heat stress is a serious hazard for Southeastern beekeepers, and its early stages are reliably signalled by thirst and heavy sweating, so a beekeeper still sweating freely is not yet at risk.
13. (SA) List the safety practices a beekeeper should observe when using a smoker.

Answers

1. **D.** Multiple mating is an adaptation, not an accident: genetically diverse colonies regulate brood nest temperature more precisely, resist disease better and are more productive. The practical consequence is that a colony's traits reflect a blend of many fathers, so a single daughter queen will not reliably reproduce her mother colony's performance.
2. Mite resistance is a **quantitative trait influenced by many genes**, and the colony's traits are expressed by its **workers**, whose fathers are the drones the daughter queen mated with. Open mating in a local drone population means the daughters mate with unselected feral and neighborhood drones, so **half the genetic contribution to each worker comes from outside the selected line**, and the trait is diluted toward the local average with each generation. The practical options are to buy replacement queens from the selected source on a schedule, to participate in a program with controlled or instrumentally inseminated matings, or to saturate the local area with drone-producing colonies from the selected stock — which shifts but does not determine paternity.
3. **False.** Drones are haploid and carry only the queen's genes, but each unfertilized egg is the product of meiosis **with recombination**, so each drone carries a different random half of her genome. Drones from one queen are related by one half, not by one. This matters for anyone

considering drone saturation for mating control: one drone mother does not give genetically uniform drones.

4. False. Workers are diploid and derive half their genes from the drones the queen mated with, which is why a queen must be judged by her colony's performance rather than by inspecting the queen herself. It is also why open mating limits how much of a breeder's selection carries through, and why instrumental insemination and isolated mating yards exist. The traits that matter — temperament, brood pattern, hygienic behavior, productivity and wintering — are all colony-level observations made over time.

5. A. VSH is distinct from grooming behavior, which removes mites from adult bees, and from general hygienic behavior toward dead brood. All three contribute to resistance and are selected separately, so a beekeeper buying resistant stock should know which trait the supplier selects for — and should continue monitoring rather than assuming the stock has solved the problem.

6. False in the second half. The distance figure is right; the direction claim is not. **The round dance carries no directional information at all** — the reversals alternate irregularly and encode nothing. That is precisely the point: within a short radius of the hive, recruits can search in all directions and find the source, so direction need not be communicated. Directional coding appears with the waggle run as sources become more distant, with a transitional form between the two.

7. Any four of: nectar dearth; queenlessness; cool, cloudy, windy or threatening weather, or approaching storms; late afternoon or evening inspection when most foragers are home; rough handling, jarring or dropping equipment; excessive or hot smoke, or too little smoke; recent robbing or predator disturbance; and strong odors such as gasoline, alcohol or banana-scented products that mimic alarm pheromone. The practical consequence is to work colonies in mid-morning to early afternoon on a clear warm day during a flow, and to be far more careful during the summer dearth.

8. Orientation flights: young bees **facing the hive** and hovering in slowly widening arcs in front of the entrance, typically in the early afternoon on a warm day, with **no fighting** and no bees investigating cracks or seams; all are leaving and returning to that same hive. **Robbing:** bees flying in a **fast, weaving, searching** pattern along the hive body, **probing cracks and corners** rather than using the entrance; **fighting and wrestling pairs** on the landing board and ground; **dead bees**; and often **wax flecks and torn cappings** from bees chewing into stored honey. A further check is that robbers are attempting to enter and being challenged. Robbing calls for immediate action — reduce the entrance or fit a robbing screen, clear spilled syrup and exposed comb, and close or move the colony if it persists; orientation calls for none.

9. For: locally raised bees have survived local conditions, including the summer dearth, high humidity, small hive beetle pressure and the regional disease and mite environment, and their queens have mated with local drones subject to the same selection; and buying locally means earlier availability, shorter shipping with less thermal stress on queens, and knowledge of the producer's management. **Against exclusive reliance:** a small local gene pool can narrow genetic diversity and can perpetuate poor traits if selection is not deliberate, and locally available stock may lack specific selected traits such as VSH that a specialist breeding program offers. The balanced practice most extension programs recommend is to raise local queens from the best-performing colonies while periodically introducing outside genetics from a reputable selected source.

10. For: treating every colony prevents natural selection for resistance; chemical residues accumulate in wax; and some populations have been shown to persist with *Varroa* under conditions of low colony density. **Against:** in a densely stocked managed landscape, colonies that collapse from mites are robbed by neighbors, so an untreated failing colony becomes a mite and virus source for every beekeeper within flight range; and most beekeepers attempting it lose the majority of their colonies **without achieving selection**, because they continue to replace losses with purchased commercial stock. **A responsible treatment-free practice requires:** rigorous monitoring; willingness to identify and remove collapsing colonies before they become reservoirs rather than letting them die in place; honest accounting of losses; transparency with neighboring beekeepers; and propagating from survivors rather than buying replacements. The examinable point is that the philosophical position and its execution are separable, and the obligation not to impose mite pressure on neighbors applies regardless of philosophy.

11. At minimum a **veil**, to protect the face and eyes, since a sting to the eye can cause serious injury. Beyond that, a jacket or full suit and gloves are matters of judgment. **More is not always better** because heavy clothing prevents evaporative cooling and creates a real heat illness risk in the Southeastern summer; because gloves reduce dexterity, leading to clumsy handling, crushed bees and released alarm pheromone that makes the colony more defensive; and because over-reliance on equipment encourages rough handling. The primary determinants of how a colony responds are gentle stock, suitable weather, correct smoker use and calm technique, not the thickness of the suit. **The balancing consideration** is that experience is not a reason to work without a veil, particularly with unfamiliar colonies, in public settings, or anywhere African-derived bees may be present, where full protection is appropriate.

12. False. The warning signs described are unreliable in exactly the wrong direction. Thirst lags dehydration, so a beekeeper is already behind by the time they feel it, and the **cessation of sweating is a late and ominous sign of heat stroke** rather than a reassurance. Humidity is the aggravating factor, since sweat that cannot evaporate does not cool. The signs to act on are cramps, headache, nausea, weakness and any confusion; the controls are working early, pre-hydrating, taking shade breaks and not working alone in extreme heat.

13. Use dry, natural fuel free of treated or painted materials and of anything producing toxic smoke; light and manage the smoker so it produces **cool white smoke** rather than flame or hot smoke; never set a lit smoker on dry grass, pine straw or in a vehicle; transport it in a metal container or ammunition box with the lid closed to extinguish it; **ensure it is fully out** before leaving the apiary or storing it, since a smoldering smoker is a serious wildfire risk in the dry pine landscapes of the Southeast; keep water or a fire extinguisher available; and be aware that a hot smoker will burn the beekeeper as readily as anything else. In some seasons and counties open burning restrictions apply.

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Chapter 20: The Bee Year — Putting It All Together

Learning Objectives

When you have finished this chapter you should be able to:

- Describe the shape of the Southeastern nectar-flow year and name the major flows and the major dearth.
 - Name the principal Southeastern honey plants with their botanical names, regions, bloom periods and honey characteristics.
 - Explain why a Southeastern beekeeper cannot follow a general beekeeping calendar, with concrete examples.
 - Learn and record a local bloom calendar.
 - Work a month-by-month management calendar for the region.
 - Manage the July–August dearth.
 - Prepare colonies for winter in the Southeast and explain how that differs from northern practice.
 - Recognize and respond to the characteristic problems of each season.
 - Mentor a new beekeeper through a first Southeastern year.
 - State the habits of mind that distinguish a competent beekeeper from one who has merely read about beekeeping.
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20.1 The Shape of the Year

The Southeastern nectar-flow year has a distinctive shape, and holding it in your head explains most of the region's management calendar.

Period	Character
January–March	Early build-up. Red maple, willow, henbit, dandelion, elm, fruit bloom. Pollen first, then some nectar. Colonies expand steeply.
April–May	The main surplus flow. Tulip poplar, blackberry and dewberry, clover, black locust, holly, privet; gallberry in the coastal plain May into June; tupelo in the Apalachicola basin late April–May. Peak population and peak swarming.
Late June–July	Sourwood in the mountains. Vitex, cotton, soybean in places.
July–August	The dearth. Severe. Robbing, starvation, beetle pressure, mite build-up.

Period	Character
September–October	Autumn flow on goldenrod and aster. Nutritionally critical; commercially minor.
November–January	Mild winter. Little or no true broodless period.

The two features that most distinguish this calendar from northern practice:

1. **How early the spring begins** — build-up from January, swarm season from late February or March.
2. **The severity of the midsummer dearth**, which drives robbing, small hive beetle pressure, starvation and the need for feeding **at a time when northern colonies are still storing surplus.**

20.2 Southeastern Honey Plants

20.2.1 The major flows

Plant	Botanical name	Region	Bloom	Honey
Red maple	<i>Acer rubrum</i>	Throughout	Jan (FL, S. GA) – Feb	Pollen ; the build-up trigger
Willow	<i>Salix</i> spp.	Throughout, wet ground	Late winter	Pollen and some nectar
Henbit / purple dead nettle	<i>Lamium</i> spp.	Throughout, disturbed ground	Late winter–spring	Early pollen and nectar
Fruit bloom	<i>Prunus</i> , <i>Pyrus</i> , <i>Malus</i>	Throughout	Feb–March	Build-up
Blackberry / dewberry	<i>Rubus</i> spp.	Throughout	Spring , with poplar	Light, reliable; one of the most dependable regional sources
Tulip poplar	<i>Liriodendron tulipifera</i>	Piedmont, mountains, upper coastal plain	April–May	Heavy, dark reddish amber , distinctive, strong
Black locust	<i>Robinia pseudoacacia</i>	Piedmont, mountains	April–May	Light, delicate; erratic
Chinese privet	<i>Ligustrum sinense</i>	Throughout, bottomland	April–May	Substantial flow; strong

Plant	Botanical name	Region	Bloom	Honey
Clover (crimson, white)	<i>Trifolium incarnatum</i> , <i>T. repens</i>	Throughout	Spring: crimson about April, white into early summer	flavor; invasive Light table honey; mowing matters
Holly Gallberry	<i>Ilex</i> spp. <i>Ilex glabra</i>	Throughout Coastal plain and flatwoods of GA, FL, SC	Spring May into June	— Light amber with body, slow to granulate; historically one of the most important commercial sources in the Southeast
Tupelo (Ogeechee)	<i>Nyssa ogeche</i>	River swamps of the Apalachicola basin , FL panhandle and S. GA	Late April—early May	Light, delicate; resists granulation due to high fructose; substantial premium
Saw palmetto	<i>Serenoa repens</i>	FL and coastal Southeast, flatwoods and scrub	Spring	Light
Chinese tallow	<i>Triadica sebifera</i>	Gulf coastal plain	May—June	Substantial flow; aggressive invasive
Sourwood	<i>Oxydendrum arboreum</i>	Appalachians and foothills: N. GA, W. NC, upstate SC, E. TN	Late June—July	Premium light varietal , distinctive spicy flavor; high price
Vitex / chastetree	<i>Vitex agnus-castus</i>	Throughout, planted	Early summer	Covers part of the dearth; often planted

Plant	Botanical name	Region	Bloom	Honey deliberately as bee forage
Cotton	<i>Gossypium hirsutum</i>	Deep South	Summer	Light; floral AND extrafloral nectaries
Soybean	<i>Glycine max</i>	Throughout row-crop areas	Summer	Variable — some years and sites, not others
Goldenrod	<i>Solidago</i> spp.	Throughout	Sept–Oct	Strong odor and flavor, granulates readily; usually left on
Aster	<i>Symphyotrichum</i> spp.	Throughout	Sept–Oct	With goldenrod; the pollen matters most

20.2.2 The piedmont bloom sequence

The typical order through the season:

Red maple and willow › fruit bloom and henbit › blackberry and tulip poplar › clover and privet › sourwood › summer dearth › goldenrod (blooms overlap, so the order is approximate)

Know the sequence rather than fixed dates. Bloom timing shifts by one to several weeks with latitude, elevation and season. The practical skill is to **track the sequence locally**, correlate it with colony weight and incoming pollen, and use it to schedule supering, splitting, harvesting and dearth feeding.

20.2.3 Plants with a complication

Chinese privet is an **introduced invasive**, not a native, and it forms dense thickets that displace native understory across large parts of the region. **The honest position holds both facts at once:** a beekeeper may take a real crop from an invasive that is already in the landscape while still supporting its control and never planting or spreading it. The same tension arises with **Chinese tallow**, which is an excellent Gulf coast honey plant and a serious ecological liability. **A master beekeeper should be able to explain both aspects without pretending the conflict away.**

Pines yield no nectar and only low-value pollen, so pine stands are poor forage — **though the gallberry understory beneath them can be excellent.** This distinction matters for apiary siting in a region dominated by pine plantations: **look at the understory, not the**

canopy. Managed pine flatwoods with an open, burned understory support gallberry and other excellent sources; dense unburned plantation with a closed canopy supports very little.

Corn is a **wind-pollinated crop yielding pollen but no nectar, gathered heavily by bees**, which gives exposure to systemic insecticides and planting dust. This is a practically important point: a crop that is not considered “bee-attractive” because it has no nectar may nonetheless be a **major pollen source**, and may therefore be treated without pollinator precautions while bees are working it.

Cotton secretes nectar from **floral and extrafloral nectaries**, so **bees work cotton fields even outside bloom**. This is the examinable point: an applicator who believes bees are not present because the crop is not flowering may be badly mistaken. Cotton can yield a light honey crop, and cotton production areas require careful communication about spray programs.

Soybean secretion **varies with variety, weather, soil moisture and management**, so it yields a surplus some years and sites and little in others. The general lesson: **a plant’s presence does not guarantee a flow**. Nectar secretion depends on the interaction of genotype and environment, which is why a beekeeper’s own weight records are far more reliable than a plant list.

Buckeye (*Aesculus* spp.) and **summer (swamp) titi** (*Cyrilla racemiflora*) are associated with brood disorders (Chapter 15); the concern with them is brood loss, not the honey crop. Do not confuse summer titi with **spring titi or buckwheat tree** (*Cliftonia monophylla*), a valuable early-spring nectar and pollen source along the Gulf coast.

Bitterweed / sneezeweed (*Helenium* spp.) imparts a bitter off-flavor (Chapter 10).

20.2.4 Extrafloral nectaries

An extrafloral nectary is a nectar-secreting structure located outside the flower — on leaves, petioles, stipules or bracts — whose ecological role is generally to **attract ants and other arthropods that defend the plant** against herbivores.

Cotton is the best-known Southeastern example; several *Vicia* species, some *Prunus*, passionflower, elderberry and various others also have them.

Why they matter to a beekeeper: bees will work them, so **a crop can be attractive to bees outside its bloom period**, which affects both the potential for a honey crop and — far more importantly — **the assumption that a non-flowering crop is safe to spray**. This is botanical knowledge with a direct safety application, and it is worth raising with a grower planning an application to a non-flowering crop near an apiary.

20.2.5 Granulation, and why it matters here

Granulation is driven chiefly by the ratio of glucose to fructose and by the glucose-to-water ratio, since glucose is the sugar that crystallizes. Honeys high in glucose granulate quickly; honeys high in fructose stay liquid. **Nucleation particles** (pollen, fine wax) and **storage temperature** also matter, with crystallization fastest near **57 °F**.

Southeastern examples: tupelo is the classic honey that resists granulation, because of its high fructose content — and that property is the basis of its premium. **Clover** and **cotton** granulate relatively quickly; **goldenrod** granulates readily.

Practical consequences: fast-granulating honeys must be extracted promptly and are good candidates for **creamed honey**; slow-granulating honeys command a premium as liquid product.

20.2.6 Learning your own bloom calendar

A beekeeper new to a Southeastern county should:

1. **Obtain the state extension service's regional nectar flow calendar** and the **local beekeeping association's records** as a starting framework.
2. **Observe directly.** Record the **first, peak and last bloom dates** of the major plants within about two miles of the apiary, every year.
3. **Record incoming pollen colors** and match them to plants.
4. **Keep hive weight records**, or heft consistently, and note when colonies gain and lose.
5. **Photograph and identify** unfamiliar plants.
6. **Correlate the sequence with weather** rather than with fixed dates, since bloom shifts by weeks between years.
7. **Talk to established local beekeepers**, who often know the local sequence in fine detail.

The most valuable output is not the list of flows but the identification of the dearth periods, since those drive feeding, robbing precautions, mite treatment windows and split timing.

20.2.7 Verifying a flow

A beekeeper wants to know whether their colonies are actually gaining weight during the claimed spring flow. Two practical methods:

1. **Place a hive scale under a representative colony** and record weight continuously or daily. The onset, rate and end of the flow appear directly as changes in the weight curve — daily gains during a flow, losses during dearth. Electronic hive scales with logging are increasingly affordable.
2. **Weigh a representative hive with a luggage or crane scale at intervals**, or **heft hives consistently** and record the impression, comparing across the season.

Supporting evidence: **incoming pollen colors**, the presence of **fresh white wax** (a reliable sign of a flow), and the **rate at which supers fill**.

Doing this across several seasons is how a beekeeper builds an accurate local flow calendar, which is far more useful than a generic regional one because bloom timing varies by elevation, latitude, land use and year.

20.3 The Management Calendar

20.3.1 January–February: the trigger

What happens: **Red maple blooms**, with willow, henbit and dandelion, supplying the **first substantial pollen** and stimulating the queen to expand brood rearing. This is the classic

Southeastern build-up trigger, as early as January in Florida and south Georgia and in February farther north.

What to do:

- **Heft hives** and feed if light. Late winter is a peak starvation period, because brood rearing has resumed and consumption has risen sharply while forage has not yet arrived.
- **First inspection** on a warm day: confirm the queen is laying, check stores, assess population.
- **Take a mite count.**
- **Reverse brood boxes** — conditionally (§20.3.2).
- **Plan swarm season:** build and paint equipment now, because in March you will need it.
- **Place bait hives by late February.**
- **Consider a protein patty** if pollen is short, sized to a few days (Chapter 5).

Watch for: isolation starvation — a small cluster on empty comb with honey two frames away. Move frames of capped honey next to the cluster if the weather allows a brief manipulation, or **set fondant or dry sugar directly above it**. Thin syrup in cold weather adds moisture the colony must evaporate and may not be taken at all. And then ask **why** the cluster was too small to bridge to its stores (Chapter 16).

20.3.2 Reversing brood boxes

The purpose: to **relieve congestion after the cluster has moved into the top box**, by setting the emptied lower box above so bees expand upward — **without dividing brood in the cold**.

The manipulation is conditional, not calendrical. If brood spans both boxes, reversing splits the brood nest and risks chilling it. In the Southeast, where late cold snaps follow warm spells, the caution matters.

Check the actual distribution of brood before reversing, and consider simply **adding space above** instead.

20.3.3 March–May: build, swarm, super, harvest

What happens: the main event. Tulip poplar and blackberry in April and May, gallberry on the coastal plain into June, tupelo in the Apalachicola basin late April and early May. **Peak population, peak congestion, peak swarming.**

What to do:

- **Begin 7-day swarm inspections in late February or early March** and continue through May (Chapter 18).
- **Add space ahead of need** — drawn comb where you have it.
- **Make splits** (Chapter 17), or perform swarm-control manipulations — artificial swarm, Demaree — if you want a crop.
- **Super ahead of the bees**, and remember that supering alone is not swarm control.
- **Do not treat with anything not labeled for use with supers on** (Chapters 13, 16).

- **Open the brood nest** with empty drawn comb in warm weather.
- **Watch for honey-bound brood nests**, particularly during gallberry on the coastal plain (Chapter 5).
- **Requeen** where needed; drones are flying by mid-March in middle Georgia.
- For **varietal production**, clear the supers of earlier honey before the target bloom (Chapter 8).

Watch for: swarm cells on bottom bars; a colony that has already swarmed (piping, opened cells, no eggs); European foulbrood during rapid expansion; chilled brood if you inspect on a cool day.

20.3.4 Late May–June: harvest and reset

- **Remove and extract honey supers promptly** at the end of the main flow. In the Southeast this is not optional: undefended comb is what small hive beetle exploits, and standing honey takes up moisture and ferments (Chapter 8).
- **Extract within a day or two** and hold supers beetle-tight.
- **Return wet supers** to the colonies they came from, late in the day, then store them dry (Chapters 7, 8).
- **Monitor mites and treat if needed**, now that supers are off.
- **Consider a deliberate brood break** (Chapter 16).
- **Reduce entrances** ahead of the dearth.
- **Sourwood producers:** clean supers on before late June.

20.3.5 July–August: the dearth

This is the season that defines Southeastern beekeeping, and the examination returns to it repeatedly.

What a piedmont beekeeper should do in preparation:

1. **Remove and extract honey supers promptly** at the end of the main flow, so undefended super space is not left on colonies.
2. **Reduce entrances** to a defensible size.
3. **Ensure every colony has adequate stores**, and be prepared to **feed sugar syrup**, checking colony weight regularly.
4. **Complete a *Varroa* assessment** and, if thresholds are exceeded, **plan treatment timed to protect the bees that will rear the autumn population**.
5. **Deploy or refresh small hive beetle traps**, and **avoid leaving oversized pollen patties**.
6. **Avoid open feeding** and any spillage that could start robbing.
7. **Provide shade, ventilation and a reliable water source**.

The unifying idea: the Southeastern midsummer is the season of scarcity, and the risks it brings — robbing, starvation, beetle takeover and mite build-up — are all managed by anticipation rather than reaction.

The characteristic problems of the dearth:

Robbing. Erratic flight around several hives, fighting on landing boards, **wax flecks littering the ground** in front of one colony (Chapter 19). **Act immediately:** cut the target colony's entrance to a very small opening or fit a robbing screen; clear exposed comb and spilled syrup from the yard; if it persists, close the colony with ventilation or move it. **Do not open the colony to inspect** — that makes it worse.

Small hive beetle. Colonies that cannot patrol their comb get overwhelmed. Slime-out is an **end point** — find what weakened the colony first (Chapter 15).

Starvation. Heft regularly, feed with internal feeders.

Mite build-up. The **critical late-summer count** falls in this window.

Absconding. Usually beetle-driven.

Heat. Shade, ventilation, water — for the bees and for you (Chapter 19).

20.3.6 The critical mite decision

The most critical time of year to have *Varroa* under control is late summer into early autumn, because the bees reared then are the long-lived winter population, and mites feeding on their pupae leave them short-lived and virus-damaged.

A colony can look populous and productive in August and die in January. Measurement, not observation, drives the decision, and **treatment must be completed before the autumn bees are reared** (Chapter 16).

The constraint the Southeast imposes: in early August, daytime highs of 94–95 °F exceed the label temperature limits of some products — formic acid most importantly (Formic Pro's upper limit is about 85 °F) — and honey supers may still be on, which rules out the thymol, amitraz and other supers-off products. The defensible course:

Check which registered products are permitted with supers in place under **current labels**, and evaluate their **temperature restrictions** and the colony's **brood status**. Several current products can be used with supers on and in hot weather — the extended-release oxalic acid strip (which spans brood cycles), hop beta acids (labeled to about 100 °F), sucrose octanoate and the L-glutamic acid strip — while oxalic dribble or vapor alone is weak in a colony full of sealed brood. **If no labeled option suits the colony, remove and extract the supers so that a suitable treatment can be applied without delay** — rather than allowing the mite population to compound through the period when winter bees are being reared.

Pulling supers remains a sound choice, and often the simplest one; what has changed is that it is no longer the *only* lawful choice when supers are on.

The examinable judgment: colony survival outranks the remaining honey crop, and the label governs the choice rather than the beekeeper's estimate of what would probably be safe.

20.3.7 September–October: preparing for winter

What happens: goldenrod and aster bloom. Their importance in the Southeast is **nutritional rather than commercial:** they provide the late nectar and, more to the point,

the pollen that lets colonies rear the healthy autumn bees that overwinter — even where that honey is left on the hive. **A poor autumn bloom is a signal to consider protein supplementation.**

Goldenrod honey has a strong odor while curing, which beekeepers notice at the hive, and it **granulates readily**; it is **usually left on the colonies** because it comes late when it is needed as winter stores, and its strong flavor limits the table market.

What to do — at least five actions:

1. **Confirm each colony is queenright with a good brood pattern**, and **requeen those that are failing**. Late summer and early autumn requeening is **recommended** in this region (Chapter 14).
2. **Complete *Varroa* monitoring and any needed treatment early enough to protect the bees being reared for winter** — and **verify efficacy with a post-treatment count**.
3. **Assess and build stores**, feeding 2:1 syrup **while temperatures still allow the bees to ripen and cap it**.
4. **Consolidate weak colonies** rather than trying to winter units too small to survive, uniting them over newspaper **after confirming they are free of disease** (Chapter 17).
5. **Reduce entrances** and fit **mouse guards** where rodents are a problem.
6. **Remove queen excluders** so the cluster can move upward freely.
7. **Ensure hives are level or tipped slightly forward for drainage**, with sound covers and adequate ventilation to prevent condensation.
8. **Remove and store surplus supers properly** to protect them from wax moth and beetles (Chapter 7).

The Southeastern emphasis differs from the North: insulation and wrapping are usually unnecessary, while **mite control, beetle management and moisture control matter as much or more.**

When to stop feeding syrup. A colony being fed 2:1 in October that **stops taking it** has usually hit the temperature limit: **below roughly the mid-50s °F, bees will not take and ripen liquid feed**. Cold syrup left standing ferments. **Complete liquid feeding early enough, then rely on fondant or dry sugar** for winter emergencies.

20.3.8 How much honey to leave

A beekeeper in upstate South Carolina asks how much honey to leave for winter.

Why a single number is inadequate: the winter requirement depends on the **length and severity of the local winter, colony size and configuration, hive type and exposure, and how early reliable forage returns in spring.**

Southeastern colonies generally need **considerably less** than colonies in the upper Midwest — but they also **break cluster and rear brood during warm spells**, which consumes stores faster than a continuously clustered colony does.

A reasonable approach:

1. **Determine a local target** from experience and regional extension guidance — commonly on the order of **40 to 60 pounds in the piedmont**, and **less in the coastal plain**.
2. **Heft or weigh hives through the winter.**
3. **Be prepared to feed**, using **fondant or dry sugar** rather than syrup once temperatures are too low for the bees to take and ripen liquid feed.

The examinable point is the method rather than the number: monitor weight, know when your first reliable spring forage arrives, and keep a margin for a late spring.

Hefting — lifting the back of the hive slightly from the stand — is a fast, non-invasive way to **gauge the weight of stored honey, and so whether the colony needs feeding, without opening the hive and breaking the cluster up.** It works well once you have calibrated your own sense of what a well-provisioned colony feels like. A **hive scale** gives the same information continuously and more precisely.

20.3.9 November–January: leave them alone

- **Heft** periodically and provide **emergency feed** — fondant or dry sugar above the cluster — if light.
- **Provide a small upper vent, or an absorbent or insulated inner cover.** **Condensation dripping from the inner cover onto a winter cluster is more damaging than cold air itself:** bees generate water vapor as they metabolize honey, that vapor condenses on the coldest surface — typically the inner cover directly above the cluster — and drips back down, and **wet bees chill and die.** The humid Southeastern winter makes moisture management **more** relevant, not less.
- **Condensing-hive management:** Altering the lid or providing overhead insulation moves the coolest surface to the hive's side walls, reducing or eliminating overhead condensation. Water forming on the side walls runs down without dripping on the cluster and can serve as a winter water source.
- **Keep an ear on the weather** and expect brood rearing to restart very early.
- **Repair, paint and build equipment.**
- **Protect drawn comb** (Chapter 7).
- **Render wax, clean up, do the accounts, and plan the coming season.**
- **Order queens and packages.**

Note the regional fact: in most of the Southeast, colonies rear at least some brood through much of the winter and rarely experience a long, completely broodless period, which complicates the use of treatments that only reach mites on adult bees. Northern beekeepers rely on a midwinter broodless window for a single highly effective oxalic acid application. Here, the window is short, unpredictable or absent, so you must **verify broodlessness before relying on such a treatment**, create a brood break deliberately, use repeated applications, or select treatments that penetrate cappings or persist over weeks. **This is one of the most consequential regional differences in mite management.**

20.4 Why a General Calendar Fails Here

Explain why a Southeastern beekeeper often cannot simply follow the seasonal management calendar printed in a general beekeeping book.

General texts are usually written for a northern temperate calendar. Three concrete differences:

1. **The spring build-up and swarm season begin one to two months earlier**, so a beekeeper following a northern calendar starts swarm inspections **after colonies have already swarmed**.
2. **The Southeast has a severe midsummer dearth in July and August**, requiring feeding and robbing precautions **at a time when northern colonies are still making surplus**.
3. **Southeastern colonies rarely experience a long broodless winter period**, so **mite treatments that rely on a broodless window must be planned differently**.

A fourth: **small hive beetle is a year-round major pest in the Southeast and a minor one in much of the North**, which changes how splits, nucs, supers, feeding and honey handling are all managed.

The professional habit this tests is checking regional extension sources, the state beekeeping association, and local bloom records rather than transplanting a calendar from elsewhere.

20.5 Mentoring a First Southeastern Year

Outline the six or seven checkpoints you would put on a new beekeeper's calendar and what happens at each.

February. First inspection on a warm day. Check stores and heft; confirm the queen is laying; begin feeding if light; plan for swarm season; **take a mite count**.

March. Begin **7-day swarm inspections**. Add space. Make splits or perform swarm-control manipulations. **Add supers ahead of the flow**.

April–May. Main flow. Keep supers ahead of the bees. Continue swarm watch. **Do not treat with anything not labeled for use with supers on**.

Late May or June. **Remove and extract honey promptly**, then **monitor and treat for mites**. **Reduce entrances** ahead of the dearth.

July–August. Dearth management: feed if light; guard against **robbing and small hive beetle**; take the **critical late-summer mite count** and treat if the threshold is exceeded.

September–October. **Verify the treatment worked**. Requeen failing colonies. Build winter stores with 2:1 syrup while it is warm enough. Combine weak colonies. Remove excluders. Reduce entrances.

November–January. Leave colonies alone apart from hefting and emergency feeding. Repair and store equipment. Protect drawn comb. Plan the coming season.

The mentoring value lies in tying each checkpoint to a reason, so the new beekeeper learns to **read the season** rather than following dates mechanically.

20.5.1 The over-enthusiastic beginner

A first-year beekeeper in South Carolina inspects their single hive every two days because they enjoy it, including on cool damp mornings.

Advise reducing inspections to roughly every seven to ten days during the active season, and less often outside it, **choosing warm, calm, sunny conditions in the middle of the day**.

Explain the reasons rather than issuing a rule. Frequent opening:

- **Chills brood** in cool weather
- **Disrupts** the colony's temperature and humidity regulation
- **Breaks propolis and burr comb seals** the bees must repair
- **Sets back comb building and brood rearing**
- **Risks injuring or killing the queen**
- **Makes the colony more defensive**

Then redirect the enthusiasm, because enthusiasm is an asset in a new beekeeper and should not be suppressed. Suggest they:

- **Observe entrance activity**
- **Watch incoming pollen** and match colors to plants
- **Heft the hive**
- **Keep written records**
- **Have a specific question in mind before each inspection**, so it has a purpose

The manner of the advice matters as much as the content.

20.6 Putting It Together: Two Worked Scenarios

20.6.1 Sourwood in the north Georgia mountains

Describe your management plan for the season.

1. **Build colonies to strength through the early spring** on red maple and the April poplar and blackberry flow, **managing swarming with splits or a Demaree so the foraging force stays intact**. (An even split during the flow costs surplus; a Demaree, weak-side or cut-down split need not.)
2. **Complete any needed mite treatment before the sourwood supers go on**, since many products require supers off. Plan this in spring — it is the constraint most often overlooked.
3. **Remove and extract all earlier honey before sourwood bloom begins in roughly late June**, leaving each colony with **clean, empty drawn supers**, so the sourwood is not blended with poplar or clover honey.
4. **Put those clean supers on immediately before or at the start of the sourwood bloom**.

5. **Monitor the bloom** and **remove and extract the supers promptly when sourwood finishes**, before the bees add honey from later sources.
6. **Keep the crop segregated** through extraction, settling and bottling, and **handle it gently** to preserve its light color and delicate flavor.

The single most important step is clearing the supers of other honey before the target bloom begins, since anything already in the comb will be extracted along with the sourwood.

20.6.2 The March swarm signal

On 20 March in middle Georgia you open a strong two-story colony and find bees on nearly every frame, a laying queen, and nine capped queen cells along the bottom bars.

This is classic swarm preparation driven by congestion in the early Southeastern build-up. Numerous cells on the bottom bars of a congested, populous, queenright colony in March is the standard swarm signal in this region.

Sound responses include a split, an artificial swarm or a Demaree manipulation, along with added space — rather than simply cutting the cells. Cutting cells alone leaves the underlying congestion untouched and the colony will rebuild cells within days.

And one further check the examiner expects: verify whether the colony **has already swarmed**, by confirming that **eggs are present** and that the queen seen is the original one. Capped cells and a laying queen are consistent with imminent swarming; capped cells and no eggs mean it has gone.

20.7 The Habits That Distinguish a Competent Beekeeper

This is the final synthesis item on the examination, and it is assessed on whether you can name the habits and express them clearly enough to teach them.

A competent Southeastern beekeeper:

Observes and measures rather than assuming. They **count mites** instead of judging by appearance. They **weigh or heft hives** instead of guessing at stores. They **keep written colony records** so that impressions become evidence.

Works from the local calendar rather than a book written for another region. They know when their own flows and dearths occur and adjust swarm control, feeding, harvesting and treatment accordingly.

Diagnoses before acting. They distinguish a **sign** such as spotty brood from its several possible causes, and they **exclude the serious possibilities before settling on the convenient one.**

Reads labels as binding. They keep records of what they applied and **verify that it worked.**

Plans ahead of the bees rather than reacting. Most Southeastern problems — swarming, robbing, beetle takeover, mite damage — are **far cheaper to prevent than to fix.**

Knows the limits of their own knowledge. They consult their state extension service, inspector and local association, and they **give advice honestly, including saying when they are not sure.**

Those six habits are the answer to the last question on the examination, and they are also, more or less, the definition of the Journeyman rank.

Numbers to Memorize

Item	Figure
Build-up trigger	red maple , Jan–Feb
Main flow	April–May (poplar, blackberry)
Gallberry	coastal plain, May–June
Tupelo	Apalachicola basin, late April–early May
Sourwood	mountains, late June–July
Dearth	July–August
Autumn flow	goldenrod and aster, Sept–Oct
Winter stores, SE piedmont	about 40–60 lb; less in coastal plain
Syrup cut-off temperature	about mid-50s °F
Swarm inspections begin	late Feb / early March
Inspection interval, active season	7 days (swarm season); 7–10 otherwise
Critical mite window	late summer into early autumn

Key Terms

Dearth — a period with no significant nectar available; in the Southeast, July and August.

Honey-bound / pollen-bound — brood nest filled with nectar or beebread, restricting the queen.

Hefting — lifting the back of the hive to gauge stores without opening it.

Reversing — exchanging brood boxes so the cluster can expand upward; conditional on brood distribution.

Varietal honey — honey predominantly from one plant source; requires clean supers and prompt removal.

Extrafloral nectary — a nectar-secreting structure outside the flower; cotton is the Southeastern example.

Winter bees — the long-lived autumn-reared cohort whose quality determines survival.

Broodless window — the period with no sealed brood; short, unpredictable or absent in much of the Southeast.

Self-Check

- 1. (SA)** Describe the shape of the typical Southeastern nectar-flow year, naming the major periods of surplus and the major dearth.
- 2. (MC)** In most of the Southeast, what event in January or February signals the beginning of the colony's build-up? A) The tulip poplar flow B) Goldenrod bloom C) The first hard freeze D) The bloom of red maple, with willow, henbit and dandelion, supplying the first substantial pollen
- 3. (MC)** Sourwood honey is associated with which part of the Southeast, and when does it bloom? A) The river swamp country of the Florida panhandle, blooming mid-April to early May B) The piedmont of central Georgia, blooming late April and early May C) The Appalachian mountains and foothills of north Georgia, western North Carolina, upstate South Carolina and east Tennessee, blooming in late June and July D) The lower coastal plain, blooming mid-May to early June
- 4. (SA)** Explain what a beekeeper in the Georgia or Alabama piedmont should do in preparation for the July and August dearth, listing at least four actions.
- 5. (TF)** In most of the Southeast, colonies rear at least some brood through much of the winter and rarely experience a long, completely broodless period, which complicates the use of treatments that only reach mites on adult bees.
- 6. (MC)** Goldenrod and aster are important in the Southeastern autumn chiefly because they: A) Provide the last nectar, which winter bees convert directly into fat body reserves B) Provide the late nectar and, more to the point, the pollen that lets colonies rear the healthy autumn bees that overwinter C) Provide abundant late pollen but very little nectar D) Provide the darkest surplus of the Southeastern year
- 7. (SA)** Describe what a beekeeper should do in September and October in the Southeast to prepare colonies for winter, listing at least five actions.
- 8. (SA)** Explain why a Southeastern beekeeper often cannot simply follow the seasonal management calendar printed in a general beekeeping book, giving three concrete examples.
- 9. (MC)** Cotton is relevant to beekeepers in the Deep South because it: A) Secretes nectar from floral nectaries alone during a brief bloom B) Draws bees mainly for pollen C) Yields a heavy surplus of light table honey D) Secretes nectar from floral **and extrafloral** nectaries, so bees work cotton fields even outside bloom, which matters for pesticide exposure
- 10. (SA)** A beekeeper in upstate South Carolina asks how much honey to leave for winter. Explain why a single number is inadequate and give a reasonable approach.
- 11. (SA)** Final synthesis: describe the habits of mind and practice that most distinguish a competent Southeastern beekeeper from one who has merely read about beekeeping.

Answers

1. An early spring build-up on red maple, willow, henbit and fruit bloom from January through March; the main surplus flow in April and May on tulip poplar, blackberry and dewberry, clover, black locust, holly and privet, with **gallberry** in the coastal plain in May and June and **tupelo** in the Apalachicola basin in late April and May, and Chinese tallow on the Gulf coastal plain in May and June; **sourwood** in the mountains of north Georgia, western North Carolina, upstate South Carolina and east Tennessee in late June and July; then a **pronounced dearth through July and August**; a modest autumn flow on goldenrod, aster; and a mild winter with little or no true broodless period. The two features that most distinguish this from northern practice are how early the spring begins and the severity of the midsummer dearth, which drives robbing, beetle pressure, starvation and feeding at a time when northern colonies are still storing surplus.

2. D.

3. C. Sourwood is a premium light varietal commanding a high price, and producing it requires clean supers put on specifically for the sourwood bloom after earlier honey has been removed, so that the crop is not contaminated with poplar or clover honey. It is a mountain crop; a beekeeper in the coastal plain will not produce it.

4. Any four (and preferably more) of: remove and extract honey supers promptly at the end of the main flow, so undefended super space is not left on colonies; reduce entrances to a defensible size; ensure every colony has adequate stores and be prepared to feed sugar syrup, checking colony weight regularly; complete a *Varroa* assessment and, if thresholds are exceeded, plan treatment timed to protect the bees that will rear the autumn population; deploy or refresh small hive beetle traps and avoid leaving oversized pollen patties; avoid open feeding and any spillage that could start robbing; and provide shade, ventilation and a reliable water source. The unifying idea is that the Southeastern midsummer is the season of scarcity, and its risks — robbing, starvation, beetle takeover and mite build-up — are all managed by anticipation rather than reaction.

5. True. Northern beekeepers can rely on a reliable midwinter broodless window for a single highly effective oxalic acid application. Here beekeepers must verify broodlessness before relying on such a treatment, create a brood break deliberately, use repeated applications, or select treatments that penetrate cappings or persist over weeks.

6. B. The autumn flow's value in most of the region is nutritional rather than commercial. Because these plants supply the pollen that produces the winter bee cohort, a poor autumn bloom is a signal to consider protein supplementation.

7. Confirm each colony is queenright with a good brood pattern and requeen those failing; complete *Varroa* monitoring and any needed treatment early enough to protect the bees being reared for winter, and verify efficacy; assess and build stores, feeding 2:1 syrup while temperatures still allow the bees to ripen and cap it; consolidate weak colonies rather than wintering units too small to survive, uniting over newspaper after confirming freedom from disease; reduce entrances and fit mouse guards where rodents are a problem; remove queen excluders so the cluster can move upward freely; ensure hives are level or tipped slightly forward for drainage, with sound covers and adequate ventilation to prevent condensation; and remove and store surplus supers properly to protect them from wax moth and beetles. The Southeastern

emphasis differs from the North in that insulation and wrapping are usually unnecessary, while mite control, beetle management and moisture control matter as much or more.

8. General texts are usually written for a northern temperate calendar. (a) The spring build-up and swarm season begin **one to two months earlier**, so a beekeeper following a northern calendar starts swarm inspections after colonies have already swarmed. (b) The Southeast has a **severe midsummer dearth in July and August** requiring feeding and robbing precautions at a time when northern colonies are still making surplus. (c) Southeastern colonies **rarely experience a long broodless winter period**, so mite treatments that rely on a broodless window must be planned differently. A fourth: **small hive beetle** is a year-round major pest here and a minor one in much of the North. The professional habit is checking regional extension sources, the state association and local bloom records rather than transplanting a calendar from elsewhere.

9. D. The extrafloral nectaries are the examinable point: because they secrete outside the bloom period, an applicator who believes bees are not present because the crop is not flowering may be mistaken.

10. The winter requirement depends on the length and severity of the local winter, colony size and configuration, hive type and exposure, and how early reliable forage returns in spring. Southeastern colonies generally need considerably less than colonies in the upper Midwest, but they also break cluster and rear brood during warm spells, which consumes stores faster than a continuously clustered colony. A reasonable approach is to determine a local target from experience and regional extension guidance — commonly on the order of **40 to 60 pounds in the piedmont and less in the coastal plain** — then to heft or weigh hives through the winter and be prepared to feed, using fondant or dry sugar rather than syrup once temperatures are too low for the bees to take and ripen liquid feed. The examinable point is the method rather than the number.

11. A competent beekeeper **observes and measures rather than assuming**: they count mites instead of judging by appearance, weigh or heft hives instead of guessing at stores, and keep written colony records so that impressions become evidence. They **work from the local calendar** rather than a book written for another region, knowing when their own flows and dearths occur and adjusting swarm control, feeding, harvesting and treatment accordingly. They **diagnose before acting**, distinguishing a sign such as spotty brood from its several possible causes and excluding the serious possibilities before settling on the convenient one. They **read labels as binding**, keep records of what they applied, and verify that it worked. They **plan ahead of the bees rather than reacting**, since most Southeastern problems — swarming, robbing, beetle takeover and mite damage — are far cheaper to prevent than to fix. And they **know the limits of their own knowledge**, consult their state extension service, inspector and local association, and give advice honestly, including saying when they are not sure.

References for Further Study

Standard texts - Graham, J. (ed.) *The Hive and the Honey Bee*. Dadant, 2015. - Sammataro, D. & Avitabile, A. *The Beekeeper's Handbook*, 5th ed. Cornell Univ. Press, 2021. - Caron, D. M. & Connor, L. J. *Honey Bee Biology and Beekeeping*, rev. ed. Wicwas Press. - Lovell, H. B. *Honey*

Plants Manual. A. I. Root. Dated but useful. - Ayers, G. S. & Harman, J. R. “Bee forage of North America and the potential for planting for bees,” in Graham (ed.), *The Hive and the Honey Bee*.

Regional and extension — the essential sources for this chapter - **University of Georgia** Honey Bee Program and Extension apiculture publications, including regional nectar flow calendars: bees.caes.uga.edu - **UF/IFAS EDIS** ENY-134, *Keeping Bees in Florida*; ENY-156, *Florida Beekeeping Management Calendar*; and the Florida bee botany publications - **Clemson Cooperative Extension** apiculture publications - **NC State Extension** apiculture — particularly on sourwood - **Auburn, Mississippi State** and **University of Tennessee** Extension apiculture programs - **LSU AgCenter** — Gulf coast plants including Chinese tallow - Your **local beekeeping association’s** bloom records, which are often better than anything published

Monitoring and current guidance - Honey Bee Health Coalition, *Tools for Varroa Management*: honeybeehealthcoalition.org - Project Apis m.: projectapism.org - Bee Informed Partnership (former operator of the national loss survey, now run by Auburn University with Oregon State University and the Apiary Inspectors of America): beeinformed.org

Primary literature - Meikle, W. G. & Holst, N. “Application of continuous monitoring of honeybee colonies.” *Apidologie* 46:10–22 (2015). - Dainat, B. et al. “Predictive markers of honey bee colony collapse.” *PLoS ONE* 7:e32151 (2012).

Appendix A: Glossary

Abandoning — Abandonment of the nest by the entire colony, leaving brood and stores; an escape response to intolerable conditions, not reproduction.

Action threshold — The measured pest level at which intervention is required to prevent damage.

Adulteration — Addition of something that should not be present, or substitution of an inferior substance; feeding syrup while harvest supers are on creates this problem.

Afterswarm (cast) — A smaller swarm following the primary swarm, led by one or more virgin queens.

Age polyethism — The age-related progression of worker tasks: cleaning, nursing, wax and food handling, guarding, foraging.

Alarm pheromone — Isopentyl acetate (banana-scented) and other compounds from the Koschevnikov gland and sting-sheath glands; recruits defenders and marks a target. (2-heptanone, from the mandibular glands, has at most a weak alarm role.)

Artificial swarm (Pagden) — Swarm control in which the queen and a frame of brood are placed on the original stand so returning foragers join her.

Balling — Workers clustering tightly around and killing an introduced or foreign queen.

Bearding — Normal thermoregulatory clustering outside the hive in hot weather; not a swarm signal.

Beebread — Pollen stored in cells with honey and glandular secretions, preserved by lactic acid fermentation that lowers pH.

Bee space — The gap of approximately 1/4 to 3/8 inch that bees maintain as a passageway; smaller gaps are propolized, larger filled with comb.

Black jar class — A honey show class judged on flavor alone, the container being opaque.

Brood break — A period with no sealed brood, halting Varroa reproduction; requires roughly three weeks to be complete.

Burr comb / brace comb — Comb built in excess space between boxes, or bridging frames.

Chain of custody — The documented handling of a sample that makes it usable for regulatory enforcement.

Checkerboarding — Alternating drawn comb and honey above the brood nest in late winter as a swarm-delay technique.

Cloake board — A divider allowing a colony to be made functionally queenless for grafting and queenright for finishing cells.

Colony Collapse Disorder (CCD) — The specific 2007–2010 syndrome: rapid loss of adults, few dead bees present, queen and brood remaining, stores unrobbed.

Complementary sex determination (csd) — The locus at which homozygosity produces diploid drones, removed by nurse bees; the cause of the inbreeding “shot brood” pattern.

Corbicula — The pollen basket on the outer surface of the worker’s hind tibia.

Cottage food law — State rule permitting certain low-risk foods produced in a home kitchen to be sold directly to consumers.

Covert / overt infection — A virus present without visible signs / at levels causing visible disease.

Cut-down split — Removing most brood and the queen, leaving the foraging force on the flow.

Cutout — Removing a colony from a structure by opening it and taking out comb, brood and bees.

Dearth — A period with no significant nectar available; in the Southeast, July and August.

Demaree — Swarm control confining the queen below an excluder with all other brood above, preserving the colony as a single foraging unit.

Drifting — Bees returning to the wrong hive; increased by uniform rows facing one direction; spreads mites and disease.

Drone congregation area (DCA) — An aerial site, typically 30–100 feet up, where drones gather and mating occurs.

Dyce process — Heating honey to kill yeasts, then seeding it with finely granulated honey and holding near 57 °F to produce creamed honey.

Eclosion — Emergence of the adult bee from the cell. Eggs *hatch*; adults *emerge*.

Eusocial — Cooperative brood care, overlapping generations, and reproductive division of labor (plus, in the highly eusocial, a morphologically distinct worker caste).

Extrafloral nectary — A nectar-secreting structure outside the flower; cotton is the Southeastern example, and it means bees work the crop outside bloom.

FABIS — Fast Africanized Bee Identification System, a rapid morphometric screen.

Fat body — Abdominal tissue central to nutrient storage, detoxification, immunity and winter bee longevity; the tissue Varroa feed on while riding adult bees (mites reproducing on pupae feed mainly on hemolymph).

FIFRA — Federal Insecticide, Fungicide, and Rodenticide Act; makes pesticide label directions legally binding.

Follower board — A solid board replacing frames to reduce the volume a small colony must patrol.

Foundress — The adult female Varroa mite that enters a cell and reproduces.

Freeze-killed brood assay — The standard test for hygienic behavior; about 100 cells, scored at 24 hours, with at least 95% removal indicating a hygienic colony.

Frame strength — The number of frames covered with bees; the standard measure in pollination contracts.

Frosting — White patches in creamed honey where it has pulled from the glass; a cosmetic fault.

Guttation — Droplets exuded at leaf margins, which can carry systemic insecticide residues.

Halteres — The reduced hind wings of flies, used as balancing organs; the giveaway that a “bee” is a fly.

Hamuli — The row of hooks coupling hind wing to forewing in Hymenoptera.

Haplodiploidy — Sex determination in which males are haploid from unfertilized eggs and females diploid from fertilized eggs.

Hefting — Lifting the back of a hive to gauge stored honey without opening it.

HMF (hydroxymethylfurfural) — A sugar degradation product formed by heat and storage; toxic to bees and used as a honey quality index.

Honey-bound / pollen-bound — A brood nest filled with nectar or beebread, restricting the queen’s laying.

Honeydew — The sugary excretion of sap-feeding insects; darker, mineral-rich, less digestible, and a poorer winter store where confinement is long.

Hygienic behavior — Detection, uncapping and removal of diseased, dead or parasitized sealed brood.

INCI — International Nomenclature of Cosmetic Ingredients, required on cosmetic labels.

Isolation starvation — Death of a cluster that consumed the stores around it and could not cross cold comb to the remainder.

K-wing — The disjointed wing posture suggestive, but not diagnostic, of tracheal mites.

Laying workers — Workers with activated ovaries laying unfertilized eggs; recognized by multiple off-center eggs and drone brood in worker cells, with no queen present.

Lipophilic — Fat-soluble; the property by which beeswax and propolis concentrate pesticide residues.

Misbranding — Labeling that is false or misleading, or that omits required information.

Mite bomb — A collapsing colony whose stores are robbed out, distributing its mites to every hive within flight range.

Mode of action — The biochemical mechanism by which an acaricide kills; the unit of meaningful rotation.

Morphometrics — Multivariate measurement of body structures used to assign population ancestry.

Nasonov pheromone — Orientation signal released from the dorsal abdominal gland with the abdomen raised and fanning.

Newspaper combine — Uniting two colonies separated by newspaper so their odors merge before the bees meet.

Notifiable disease — A condition that must by law be reported to the regulatory authority; American foulbrood in many states.

Nucleus colony (nuc) — A small but complete functioning colony: laying queen, brood of all stages, stores and adhering bees.

Open feeding — Communal feeding away from the hives; discouraged for uneven distribution, disease spread and robbing.

Osmophilic yeast — Sugar-tolerant yeast responsible for honey fermentation.

Paired counts — Pre- and post-treatment mite counts; the only way to verify a treatment's efficacy.

Parasitic mite syndrome (PMS) — A descriptive label for the mixed brood and adult symptoms of heavy Varroa infestation and its viruses.

Patriline — The subfamily of workers fathered by one drone.

Pfund grader — The instrument used to classify honey color.

Phoretic (dispersal) phase — The period a Varroa mite spends on an adult bee rather than in a sealed cell.

Plumose hair — Branched body hair; the defining character of bees.

Pollenizer / pollinator — The plant that supplies the pollen / the animal that moves it.

Poricidal anther — An anther releasing pollen only through a terminal pore; requires buzz pollination.

Preoviposition period — The interval between a queen's final mating flight and the start of laying.

Propolis — Plant resin gathered by bees and worked with wax and enzymes; seals, smooths, entombs and provides antimicrobial protection.

Proventriculus — The valve between crop and midgut that filters particles from crop contents, making nectar transport possible.

Queen mandibular pheromone (QMP) — Inhibits queen rearing and worker ovary development; diluted by crowding, which is the link between congestion and swarming.

Queenright — Having a laying queen present.

REI / PHI — Restricted-entry interval / pre-harvest interval on a pesticide label.

Ripe cell — A queen cell one to two days from emergence, ready to move.

Robbing screen — An entrance device displacing the opening so residents learn the route and robbers do not.

Ropiness test — Drawing a stick slowly from a diseased cell to see whether the remains form a strand of an inch or more; presumptive for American foulbrood.

Scale — The dried remains of a dead larva; hard and adherent in AFB, easily removed in EFB and sacbrood.

Scopa — A brush of pollen-carrying hairs; on the underside of the abdomen in Megachilidae.

Scorching — Charring scraped interior wood surfaces to destroy pathogen spores.

Screened bottom board — A mite-fall monitoring device with some ventilation benefit; **not** a Varroa control.

Shook swarm — Shaking all adults onto new foundation and destroying the old comb; an option for European foulbrood, not for American foulbrood.

Shot brood / pepperbox — The regular scattered empty cells of inbreeding, from removal of diploid drones.

Slatted rack — A slatted frame beneath the brood nest giving clustering space and buffering drafts.

Slime-out — The fermented, frothy destruction of comb by small hive beetle larvae.

Slungum — The dark residue of cocoons, propolis and debris left after rendering beeswax.

Superorganism — The colony understood as the functional organism and the unit of selection.

Supersedure — Replacement of a failing queen by her own colony, without swarming.

Synergy — One compound increasing the toxicity of another; SBI fungicides with insecticides and in-hive miticides.

Test frame — A frame of eggs and young larvae given to a colony to confirm queenlessness.

Travel stain — Darkening of comb surfaces from bees walking on them; downgrades comb honey.

Trophallaxis — Mouth-to-mouth food transfer; the route by which queen pheromone is distributed.

Trap-out — Removing a colony from a structure with a one-way cone; does not remove comb, brood or usually the queen.

Ultrafiltration — Pressure filtration removing pollen from honey; treated differently under labeling guidance from ordinary straining.

Use inconsistent with the labeling — The statutory phrase for an unlawful pesticide application.

Varroa Sensitive Hygiene (VSH) — Detection and removal of sealed cells containing *reproducing* Varroa, interrupting mite reproduction.

Veterinary Feed Directive (VFD) — The written authorization from a licensed veterinarian required to feed medicated feed to bees since 2017. Other forms of medically important antimicrobials require a veterinary prescription.

Vitellogenin — A storage protein central to winter bee longevity and immune function.

Walk-away split — Dividing a colony and leaving the queenless half to rear its own queen.

Water activity — The availability of water to microorganisms; honey's is too low for most growth.

Winter bees — The long-lived autumn-reared cohort with large fat bodies, whose quality determines colony survival.

Appendix B: Numbers to Memorize — Master Table

Development and biology

Item	Figure
Development, egg to emergence	Queen 16 d , worker 21 d , drone 24 d
Egg stage	3 days, all castes
Queen cell capped	about day 8 from the egg
Worker / drone brood capped	about day 9 / about day 10
Larval instars	5 (four larval molts, then the molt to pupa)
Brood nest temperature	93–96 °F (34–35 °C), about 95 °F
Peak laying rate	1,500–2,000 eggs/day
Summer worker lifespan	4–6 weeks
Winter bee lifespan	several months
Wax gland activity	about 12–18 days of adult age
Wax glands	4 pairs, ventral sterna 4–7
Drone sexual maturity	12–16 days after emergence
Antennal segments	12 (queen, worker), 13 (drone)
Ocelli	3
Normal foraging range	1–2 miles; up to 4–5+
Colony move rule	less than 3 ft, or more than 3 miles
Peak colony population (SE spring)	40,000–60,000+
Midwinter population	10,000–20,000
Honey per pound of wax	about 6–8 lb commonly cited; often more

Queens

Item	Figure
Virgin maturation before mating flights	about 5–6 days
Drone congregation area altitude	about 30–100 ft
Matings per queen	a dozen to 20+ drones

Item	Figure
Emergence to laying	about 10–14 days (up to 3 weeks in poor weather)
Grafting larval age	under 24 hours
Graft › capped cell	about 4–5 days
Graft › move ripe cells	about day 10
Graft › emergence	about 11–12 days
Graft › laying queen	about 3–4 weeks
Split › laying queen (own cells)	about 3–4 weeks
Queen productive life	1–2 years in a production colony
Requeening: temperament change	about 6 weeks (two brood cycles)
Queen marking, 2026	White (1/6 white, 2/7 yellow, 3/8 red, 4/9 green, 5/0 blue)

Varroa and disease

Item	Figure
Alcohol wash sample	about 300 bees (1/2 cup) from a brood frame
Infestation rate	mites ÷ bees × 100
<i>Varroa</i> action thresholds (HBHC 9th ed., 2026)	1% dormant and spring build-up; 2% peak and late summer–autumn
Drone brood capped longer than worker	about 2–3 days
Drone brood mite preference	roughly 8–10×
Complete brood break	about 3 weeks
Most critical control timing	late summer into early autumn
AFB spore viability	decades (35+ years)
AFB infective dose, young larva	about 10 spores
Spores from one diseased larva	about 1 billion or more
AFB ropiness	strand of 1 inch or more
Foulbrood comb sample	at least 2 × 2 in, no honey, wrapped in paper
Nosema sample	30–60 older bees; 1 mL water per bee; 400×
Nosema significance threshold	about 1 million spores per bee
Freeze-killed brood assay	about 100 cells; score at 24 h; at least 95% = hygienic
Comb rotation	about 20% per year; nothing over about 5 years
Freezing comb	0 °F for 24–48 h (does not kill AFB spores)

Equipment and apiary

Item	Figure
Bee space	1/4 – 3/8 in
10-frame deep, full of honey	about 80–90 lb
10-frame medium, full of honey	about 50–60 lb
Deep / medium / shallow depth	9 5/8 / 6 5/8 / 5 11/16 in
Mouse guard opening	about 3/8 in
Bait hive volume	about 40 liters (one deep box)
Nine-frame spacing	drawn comb only

Honey

Item	Figure
Harvest rule	at least 80% capped
US Grade A and B maximum moisture	18.6% (at least 81.4% soluble solids)
US Grade C and Codex general maximum moisture	20%
Fermentation generally prevented below	about 17–17.5%
Honey show disqualification	above 18.6%
Honey pH	about 3.5–4.5
Maximum warming for bottling	about 100–110 °F
Fastest crystallization temperature	about 57 °F
Creamed honey	5–10% seed, held about 57 °F for 1–2 weeks
Extract supers within (Southeast)	1–2 days
Freeze comb honey	0 °F, 24–48 h
Infant honey advisory	under 12 months
Beeswax melting point	144–149 °F (62–65 °C)
Royal jelly harvest	about 72 h after grafting
Pollen drying temperature	under about 110 °F

The Southeastern year

Item	Figure
Build-up trigger	red maple , Jan–Feb
Swarm season	mid-Feb/March – May, peaking April
Swarm inspections begin	late February / early March
Swarm inspection interval	7 days
Main flow	April–May (tulip poplar, blackberry)
Gallberry	coastal plain, May–June
Tupelo	Apalachicola basin, late April–early May

Item	Figure
Sourwood	mountains, late June–July
Dearth	July–August
Autumn flow	goldenrod and aster, Sept–Oct
Winter stores, SE piedmont	about 40–60 lb; less in coastal plain
Syrup cut-off temperature	about mid-50s °F
Prime splitting period	March–May

Dates

Year	Event
1622	Honey bees introduced to Virginia
1851–52	Langstroth: bee space; movable-frame hive patented
1857	Mehring: comb foundation
1865	Hruschka: centrifugal extractor
1889	Doolittle: <i>Scientific Queen-Rearing</i>
1922	Honey Bee Act
1956 / 1957	African bees imported to Brazil / swarms escape
1984	Tracheal mite detected in US
1987	Varroa detected in US
1990	Africanized bees reach Texas
1996 / 1998	Small hive beetle: SC specimen / identified in Florida
2001–2003	Africanized population established in Florida
2006–07	Colony Collapse Disorder named
2017	Veterinary oversight of hive antibiotics
2018	US fumagillin supply interrupted (Fumagilin-B later back on the market)
2023	Yellow-legged hornet confirmed in Georgia
2024–25	Record colony losses (55.6% annual); amitraz-resistance mutation in all mites screened
2025	<i>Tropilaelaps</i> intercepted at sea on a US-bound ship; first RNAi varroacide (vadescana) registered

Appendix C: References for Further Study

The core shelf

If you buy five books, buy these.

1. **Graham, J. (ed.)** *The Hive and the Honey Bee*. Dadant, 2015. The standard American reference; comprehensive, multi-authored, and the book most examination material is written against.
2. **Winston, M. L.** *The Biology of the Honey Bee*. Harvard University Press, 1987. The best single account of the biology.
3. **Sammataro, D. & Avitabile, A.** *The Beekeeper's Handbook*, 5th ed. Cornell University Press, 2021. The best practical manual.
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Standards, law and guidance

- USDA AMS, *United States Standards for Grades of Extracted Honey* (1985).
- Codex Alimentarius, *Standard for Honey* CXS 12-1981.
- US FDA, *Guidance for Industry: Proper Labeling of Honey and Honey Products* (2018); 21 CFR part 101.
- FIFRA, 7 U.S.C. §136 et seq.; US EPA pesticide labeling and pollinator protection guidance.
- Honey Bee Act of 1922, 7 U.S.C. §§281–286; USDA APHIS importation regulations.
- FDA Guidance for Industry 213 and the Veterinary Feed Directive rule (2017).
- Your state’s apiary act, cottage food statute and municipal code.

Regional extension — the indispensable sources

- **University of Georgia** Honey Bee Program and Extension apiculture: bees.caes.uga.edu
- **UF/IFAS EDIS** apiculture series — especially ENY-2052 (live bee removals), ENY-114 (African honey bee), ENY-134 (keeping bees in Florida), ENY-156 (management calendar), EENY-474 (small hive beetle)
- **Clemson Cooperative Extension** apiculture
- **NC State Extension** apiculture
- **Auburn University, Mississippi State** and **University of Tennessee** Extension apiculture
- **LSU AgCenter** apiculture

Organizations and current information

- Honey Bee Health Coalition: honeybeehealthcoalition.org

- Bee Informed Partnership (former operator of the national loss survey, now run by Auburn University with Oregon State University and the Apiary Inspectors of America): beeinformed.org
- Project Apis m.: projectapism.org
- Apiary Inspectors of America: apiaryinspectors.org
- Eastern Apicultural Society: easternapiculture.org
- American Beekeeping Federation: abfnet.org
- Georgia Department of Agriculture — including the Yellow-Legged Hornet program: agr.georgia.gov
- Your state and local beekeeping associations

Periodicals

- *American Bee Journal*
 - *Bee Culture*
 - *Journal of Apicultural Research*
 - *Apidologie*
-

Appendix D: Examination Coverage Map

Every one of the 365 questions on the Intermediate (Journeyman) mock examination is listed below with the chapter or chapters of this guide that cover it. Where two chapters are given, the first is the principal treatment and the second gives supporting material.

By examination section

Exam section	Questions	Principal chapters
1. Honey Bee Biology & Anatomy	1–26	3 (Anatomy and Physiology)
2. Colony Behavior & Communication	27–46	19 (Environmental Evolutionary Adaptiveness), 3, 14, 18
3. Queen Biology, Mating & Rearing	47–68	14 (Queen Rearing), 17
4. Swarming, Supersedure & Absconding	69–83	18 (Swarming Prevention and Control), 17
5. Genetics, Stock Selection & AHB	84–99	19, 6 (Africanized Bees)
6. Equipment, Apiary Setup & Siting	100–113	7 (Equipment and Apiary Siting)
7. The Southeastern Beekeeping Year	114–141	20 (The Bee Year), 5, 16, 17

Exam section	Questions	Principal chapters
8. Nutrition, Feeding & Pollination	142–161	5 (Honey Bee Nutrition), 12 (Pollination)
9. Southeastern Bee Botany & Honey Plants	162–181	20 , 15, 8
10. Brood Diseases — Bacterial & Fungal	182–203	15 (Pests and Diseases)
11. Viruses, Nosema & Adult Bee Disorders	204–217	15 , 13, 16
12. Varroa & Tracheal Mites	218–241	16 (<i>Varroa destructor</i>), 7
13. Small Hive Beetle, Wax Moth, Predators	242–261	15 , 7, 8, 17
14. IPM & Treatment Selection	262–277	16 , 13, 15
15. Pesticides & Environmental Hazards	278–290	13 (Pesticides)
16. Honey Production, Extraction & Food Safety	291–312	8 (Honey Production and Extraction), 9
17. Hive Products	313–324	11 (Hive Products Beyond Honey)
18. Laws, Regulation, Inspection & Organizations	325–336	9 (Honey Labels and Regulation), 1, 13, 15
19. Safety, Stings, Public Relations & History	337–348	19 , 1 (History), 3, 10
20. Applied Scenarios & Case Studies	349–365	All — principally 14, 15, 16, 17, 18, 20

Question by question

Read each entry as *question number* › *chapter(s)*.

Q / Ch	Q / Ch	Q / Ch	Q / Ch	Q / Ch
1 3	74 18	147 12, 4	220 16	293 8
2 3	75 18	148 12	221 16	294 8
3 3, 19	76 18	149 12	222 16	295 8
4 3, 14	77 18	150 5, 3	223 16	296 8
5 3	78 18, 9	151 5	224 16	297 8
6 3, 11	79 18	152 5, 4	225 16	298 8
7 3	80 18	153 5	226 16	299 9
8 3, 8	81 18, 16	154 5	227 16	300 9
9 3, 19	82 18, 6	155 20, 5	228 16	301 8, 9
10 3, 19	83 17, 18	156 5, 9	229 16	302 9

Q / Ch	Q / Ch	Q / Ch	Q / Ch	Q / Ch
11 3, 19	84 19	157 12, 13	230 16	303 9, 10
12 3	85 19	158 12	231 16	304 9, 10
13 3	86 19	159 5, 8	232 16	305 8
14 3	87 6	160 12	233 16	306 8
15 3	88 6	161 5	234 16	307 8
16 3	89 6	162 20	235 16	308 8
17 5, 3	90 6, 9	163 20, 2	236 16, 2	309 9
18 3, 16	91 19, 15	164 15, 20	237 16	310 9, 10
19 3	92 19, 16	165 20	238 7, 16	311 8
20 3	93 19	166 20	239 16	312 8
21 3	94 19	167 20	240 16	313 11
22 3, 14	95 19	168 20	241 16	314 11
23 3	96 19, 1	169 15, 20	242 15, 2	315 11
24 3, 7	97 6, 14	170 8, 20	243 15	316 11
25 3, 20	98 19	171 20	244 15	317 11
26 3, 8	99 19	172 20	245 15	318 11
27 19	100 7	173 10, 20	246 8, 15	319 11
28 19	101 7	174 20	247 15	320 11
29 19	102 7	175 20	248 15	321 11
30 19, 20	103 7	176 20	249 17, 15	322 11
31 19, 6	104 7, 16	177 20	250 15, 2	323 11
32 19	105 7	178 20	251 7, 15	324 11
33 19, 3	106 7	179 20	252 15	325 9
34 7, 16	107 7, 15	180 20, 13	253 15	326 9
35 3	108 7	181 20	254 15	327 1, 9
36 15, 19	109 7	182 15, 2	255 7, 15	328 15, 9
37 14	110 7	183 15	256 15	329 9
38 11	111 7	184 15	257 15	330 9
39 5	112 8, 7	185 15	258 7, 15	331 9
40 14	113 7	186 15, 2	259 15	332 9, 10
41 14	114 20	187 15	260 7, 15	333 13, 9
42 18	115 20	188 15	261 15	334 9
43 3	116 20	189 15	262 16	335 18, 9
44 19, 13	117 20	190 15, 2	263 16	336 9
45 3, 19	118 20	191 15	264 13, 16	337 3, 19
46 14, 18	119 20	192 15, 2	265 16	338 19, 3
47 14	120 8, 20	193 15	266 16	339 3, 19
48 14	121 20	194 15	267 16, 13	340 19
49 14	122 20	195 15, 11	268 16	341 19
50 14	123 5, 20	196 15	269 16	342 9
51 14	124 5, 15	197 15	270 16	343 1
52 14	125 16, 13	198 15	271 13, 16	344 1

Q / Ch	Q / Ch	Q / Ch	Q / Ch	Q / Ch
53 14	126 16, 20	199 15, 7	272 16	345 1, 4
54 14	127 20, 5	200 15	273 15, 16	346 10, 4
55 14	128 20	201 15	274 16	347 19
56 14	129 20	202 15	275 15, 9	348 6, 3
57 14	130 20	203 15, 19	276 16	349 18, 20
58 14	131 20	204 15	277 10, 16	350 16, 15
59 1, 14	132 20	205 15	278 13	351 14
60 14, 17	133 20	206 15	279 13	352 15
61 17, 14	134 17, 20	207 15, 2	280 13	353 16
62 14	135 5, 18	208 15	281 13	354 14, 17
63 14	136 12	209 15	282 13	355 19, 20
64 17, 14	137 8, 15	210 15	283 13	356 16, 5
65 14	138 20	211 15	284 13	357 18, 6
66 7, 14	139 17, 20	212 13, 15	285 13	358 9, 5
67 14	140 20	213 15	286 13	359 15
68 14	141 7, 20	214 15	287 13	360 8, 20
69 18	142 5	215 16, 5	288 13	361 17
70 18	143 5	216 15	289 13	362 20, 10
71 18	144 5	217 15	290 13	363 13, 12
72 17, 18	145 5, 15	218 16, 2	291 8	364 20
73 18	146 5	219 16	292 8	365 20

Coverage note

All twenty sections of the examination and all 365 questions are covered. **Chapter 2 (Nomenclature)** is cited only where an item turns directly on a scientific name, but it underpins the whole guide: the binomials in Chapters 15, 16 and 20 assume it. The three chapters added beyond the original outline — **Chapter 7 (Equipment and Apiary Siting)**, **Chapter 8 (Honey Production and Extraction)** and **Chapter 11 (Hive Products Beyond Honey)** — carry examination sections 6, 16 and 17 respectively, together with substantial parts of sections 13 and 18, which would otherwise have gone unstudied.

Three areas of the examination are deliberately distributed across several chapters rather than concentrated in one:

- **Colony behavior and communication** (section 2) is split between Chapter 3, where the sensory and glandular mechanisms belong, and Chapter 19, where the behavior is treated as adaptation, with the queen-related items in Chapter 14 and the swarming items in Chapter 18.
- **Beekeeper safety** (part of section 19) sits at the end of Chapter 19, following directly from the treatment of defensive behavior as an evolved trait.
- **The applied scenarios** (section 20) draw on the whole guide by design, which is what makes them the most useful items to work last.