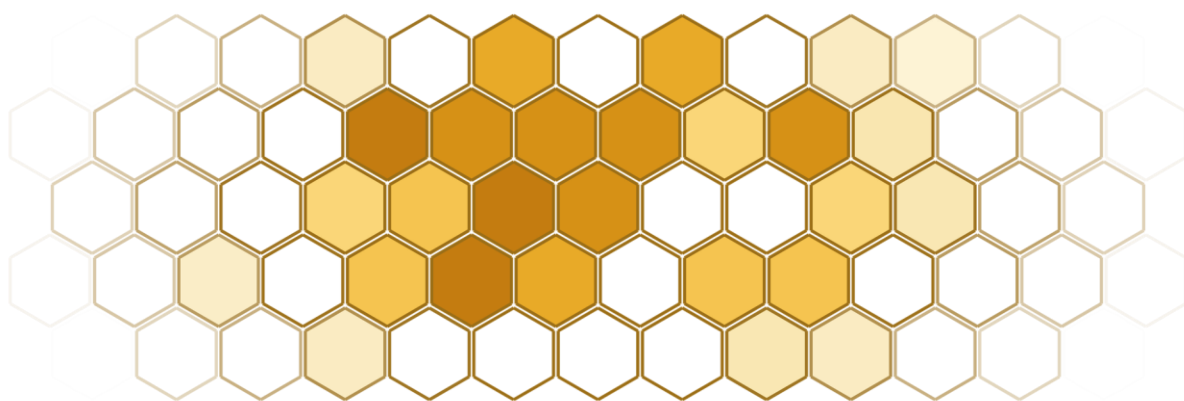


BEEKEEPING IN THE SOUTHEAST

WRITTEN STUDY GUIDE

Certified Beekeeper Level



*A Chapter-by-Chapter Companion for Beekeepers
Preparing for Certification*

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OCTOBER 2026

A Note to the Reader

This document is a result of organizing and researching many online resources, proven topics from Certified Beekeeper courses in South Carolina, and PowerPoints developed and presented by me to beginning beekeeper classes, local groups, and at State conferences.

To assist in the creation of this Certified Beekeeper 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 should always perform due diligence to ascertain the validity of any information contained here.

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Introduction to the Study Guide

Beekeeping rewards curiosity and punishes neglect. A colony of honey bees is a living superorganism that responds to weather, forage, pests, and the beekeeper's decisions, and the difference between a thriving apiary and a string of dead-outs usually comes down to knowledge applied at the right moment. This study guide was written to give beginning beekeepers that foundation in one place, organized so it can be read straight through or used as a reference, and pitched at the level expected of a Certified Beekeeper, the first rung of most beekeeper certification ladders.

The guide is written for the Southeastern United States, and South Carolina in particular. Bloom calendars, nectar flows and dearths, pest pressures such as small hive beetle and the yellow-legged hornet, and the state agencies and regulations that govern beekeeping all differ from region to region, and the examples here reflect conditions in the Southeast. The underlying biology and management principles, however, apply wherever honey bees are kept.

Twelve chapters move from the history of beekeeping and the biology of the honey bee, through safety, site selection, equipment, and the yearly cycle of colony management, to queens and colony increase, forage and pollinator protection, pests and diseases, and the products of the hive. A glossary and an answer key for the chapter review questions follow the final chapter.

No book can replace time spent in the bee yard. The guide is meant to be used alongside hands-on practice with an experienced mentor, membership in a local beekeepers association, and the publications of university extension programs, several of which are listed at the end of each chapter. Science and recommended practice continue to change, especially in the treatment of pests and diseases, so readers should confirm current guidance with their extension office or state apiary officials before acting on any specific recommendation.

How to Use This Study Guide

This guide is organized around the core topics a beginning beekeeper needs to master, in the sequence a new beekeeper will find most useful: the History of Beekeeping; Honey Bee Biology and Behavior; Safety in the Bee Yard; Allergic Reactions and Anaphylaxis; Selecting an Apiary Site; Beekeeping Equipment and Getting Started; Hive Management; Seasonal Management; Queens and Colony Increase; Forage, Nutrition, and Pollinator Protection; Predators, Pests and Diseases of Honey Bee Colonies; and Honey Bee Products.

Every chapter follows the same structure, so you always know where to look:

- **Chapter Objectives** — a short list of what you should be able to do after studying the chapter. Read these first, so you know what to watch for.
- **Lettered sections (A, B, C...)** — the narrative content of the chapter, with tables and figures. The section letters match the references in the companion test bank.
- **Chapter Summary** — a bulleted recap of the key points. Use it to review before an exam or to refresh your memory before a bee-yard task.
- **Review Questions** — about five quick-recall questions on the chapter's essential facts. Answers are in the "Answers to Chapter Review Questions" section at the end of the guide.
- **Test bank practice** — the range of questions in the companion Certified Beekeeper Test Bank that covers the chapter.
- **References for Further Study** — books, extension publications, and websites for going deeper.

A suggested way to study each chapter is: (1) read the objectives; (2) read the lettered sections, noting anything you cannot yet explain in your own words; (3) read the summary and answer the review questions without looking back, then check your answers; (4) explain the chapter's main ideas aloud or in writing, as you might in a practical exam; and (5) take the matching section of the test bank. Revisit any section where you missed a question. Spreading your study over several weeks, and pairing each chapter with time in the bee yard, will fix the material far better than a single cram session.

The glossary defines common beekeeping terms, and the clickable table of contents at the front of the guide takes you directly to any chapter or section.

Note: This guide is paired with a companion test bank and answer key; each test bank question points back to the chapter and section that covers it, and the test bank's section numbers match this guide's chapter numbers. The guide is a study aid, not a replacement for hands-on field training with an experienced mentor or for current official guidance; always check with your instructor, extension office, or state regulators for procedural or regulatory specifics.

Chapter 1: History of Beekeeping

Chapter Objectives

After studying this chapter, you should be able to:

- Describe how hives evolved from honey hunting and fixed-comb hives (pottery, skeps, log gums, bark hives) to the movable-frame hive.
- Explain bee space and identify the contributions of Huber, Prokopovych, Dzierzon, and Langstroth.
- Summarize the honey bee's deep history and its importance to early civilizations.
- Recall the key milestones of honey bees in America, from their arrival in 1622 to the arrival of Varro and Africanized bees.
- Identify historically significant beekeepers and the contribution each is known for.

A. The Evolution of the Hive

Before any form of hive existed, early humans were honey hunters, not beekeepers — raiding wild colonies nesting in hollow trees or rock crevices for their honey and brood, a practice depicted in rock art (such as Spain's Cuevas de la Araña) dated to roughly 8,000 years ago. Keeping bees in a human-made container began only once people learned to provide bees with an attractive artificial cavity and started tending colonies deliberately rather than simply raiding wild ones.

Hive design then evolved independently in different regions, generally driven by whatever materials were locally abundant, but every early design shared one limitation: the comb could not be removed and inspected without cutting it out or destroying it.

- **Egyptian pottery/mud hives** — ancient Egyptian beekeepers stacked horizontal hives of clay or mud, as shown in the earliest known picture of hives, from the sun temple of King Nyuserre (about 2400 BCE, roughly 4,400 years ago). Ptolemaic records (about 250 BCE) describe hives being moved ahead of the Nile flood, and later travelers' accounts describe hives floated on rafts down the river to follow the bloom. Clay pipe hives of this kind remain traditional across the Middle East and North Africa.
- **Mediterranean clay and wicker hives; northern European straw skeps** — Greek and Roman beekeepers used clay hives along with woven wicker, bark, and cork hives (Roman writers such as Varro and Columella describe wicker hives coated with mud or dung). The coiled-straw skep developed later in northwestern Europe and Britain, where it remained the dominant hive for many centuries.
- **Log hives and American “gums”** — upright hollow-log hives were the traditional hive of the forests of northern and eastern Europe. Early American beekeepers, especially in Appalachia and the Southeast, used the same idea, standing hollowed sections of black gum (tupelo) logs on end, which is why log hives here are still called “gums.”
- **African bark hives** — traditional African beekeepers commonly used cylindrical hives fashioned from bark or woven reeds, often hung in trees, a design still used in parts of Africa today.

All of the designs above were fixed-comb hives: the comb could not be removed without cutting it out, which generally meant destroying it (and often killing or driving off the colony) to harvest honey. The movable-frame hive that solved this problem was not the work of a single inventor, and Langstroth — despite his enduring “Father of American Beekeeping” title — was neither the first to build a workable movable-frame hive nor the one who first noticed that bees leave a consistent, propolis-free gap around their comb. Swiss naturalist François Huber built an early hinged-frame “leaf hive” (sometimes called a book

hive) as far back as 1789, and Ukrainian beekeeper Petro Prokopovych is credited with a genuine movable-frame hive in 1814, allowing combs to be inspected and harvested individually. Most significantly, Polish-German apiarist Johann (Jan) Dzierzon built a movable-comb hive in 1838 and, by 1848, had worked out the specific spacing — grooves cut to about 8 mm, the midpoint of the 1/4–3/8 inch range now called bee space — that kept hive walls free of propolis, more than a decade before Langstroth's own work.

Langstroth's real contribution, reached independently in 1851 (historians differ on how much, if anything, he knew of Dzierzon's earlier published work), was to apply that spacing — now called “bee space” — consistently to every side of a frame suspended inside a single top-opening box, so that each frame could be lifted out individually without being glued to its neighbors, the box walls, or the frames above and below it. No earlier design had combined full bee space on all sides with a simple top-opening format. Langstroth patented this design on October 5, 1852, and it was this combination of bee space, movable frames, and practical, stackable construction — not the mere discovery of bee space itself — that made his hive the first commercially practical, widely adopted movable-frame hive and the direct ancestor of the modern wooden hive still used throughout the United States today (see Chapter 6).

B. Honey Bees Through Deep Time and Early Civilization

The honey bee lineage is ancient: the oldest known bee fossil, preserved in amber, dates back about 100 million years, roughly to the Cretaceous period, and fossil evidence places recognizably modern honey bees at tens of millions of years old. Humans, by contrast, have interacted with honey bees for only a tiny fraction of that span — but wherever they have, honey, wax, pollen, and propolis have been valued resources.

Early civilizations used honey as a prized (and often scarce or valuable) sweetener and preservative; wax for candles, sealants, and later for lost-wax metal casting; pollen as a nutritional supplement; and propolis for its antimicrobial properties, including early wound care and embalming. Honey and beeswax appear repeatedly in the religious, economic, and medicinal records of ancient Egypt, Greece, and Rome, underscoring how central the honey bee was to pre-modern life long before refined sugar became widely available.

C. Honey Bees in America

Apis mellifera is not native to the Americas — it was brought over by European colonists. The timeline below captures the major milestones of honey bees' spread and development in the United States:

Year	Event
1622	The Virginia Company ships the first honey bee colonies to the Jamestown colony, introducing <i>A. mellifera</i> to North America.
1640s	Honey bees are being kept in the Massachusetts Bay Colony.
1851	Lorenzo Langstroth applies “bee space” (spacing principles earlier used by Jan Dzierzon from 1838) to every side of a removable frame in a top-opening box, producing the first widely practical movable-frame hive.
1853	Christopher Shelton makes the first successful introduction of honey bees to California, at San Jose.

Year	Event
1857	Johannes Mehring invents the wax foundation sheet, giving bees a template to draw straight comb.
1859–60	After earlier failed attempts, the first Italian honey bees are successfully imported and begin replacing the darker, more defensive “German” bees the colonists had brought over.
1865	Franz von Hruschka invents the centrifugal honey extractor, allowing honey to be spun out of comb without destroying it.
1870s	Commercial foundation mills begin mass-producing wax foundation sheets.
1873	Moses Quinby builds the first bellows smoker (unpatented); T.F. Bingham's improved design, patented in 1878, set the basic pattern still used today.
1904–1919	“Isle of Wight disease” kills most colonies on the Isle of Wight and spreads through Britain. In 1921 it is blamed on a newly described tracheal mite (<i>Acarapis woodi</i>), prompting the U.S. import restrictions of 1922; the true cause is still debated.
1922	The Federal Honey Bee Act restricts honey bee imports into the U.S. to help keep out foreign pests and diseases.
1973	Karl von Frisch receives the Nobel Prize in Physiology or Medicine for decoding the honey bee waggle dance.
1987	Varroa destructor is first detected in the continental United States.
1990	Africanized honey bees establish a permanent, breeding presence in the United States, crossing from Mexico into Texas (an earlier isolated colony had been detected and eradicated in California in 1985).

Russian honey bee stock was also imported to the U.S. (primarily beginning in the late 1990s) specifically for its naturally higher resistance to Varroa mites, part of the broader effort to breed and select bees that need less chemical mite treatment.

D. Historically Significant American Beekeepers

- **Lorenzo Langstroth (1810–1895)** — a Congregationalist minister often called the “Father of American Beekeeping”; building on earlier European movable-frame hives and spacing concepts (notably Jan Dzierzon's), his 1851 application of bee space to every side of a removable frame, patented in 1852, produced the first fully practical, widely adopted movable-frame hive.
- **Amos Root (1839–1923)** — founded the A.I. Root Company, a major early manufacturer of beekeeping equipment, and published *Gleanings in Bee Culture*, one of the longest-running U.S. beekeeping journals.
- **Moses Quinby (1810–1875)** — a New York commercial beekeeper who built the first bellows smoker (1873) and wrote *Mysteries of Bee-keeping Explained* (1853); often called the “Father of Commercial Beekeeping” in America.

- **Dr. C.C. Miller (1831–1920)** — a physician-turned-beekeeper and influential writer whose *Fifty Years Among the Bees* remains a classic of American beekeeping literature.
- **Harry H. Laidlaw Jr. (1907–2003)** — developed practical instrumental insemination techniques for honey bee queens, enabling controlled breeding programs still used today; often called the “Father of Honey Bee Genetics.”
- **Stephen Taber III (1924–2008)** — born in Columbia, South Carolina; a USDA bee researcher at the Baton Rouge, Louisiana, and Tucson, Arizona, bee laboratories who pioneered instrumental insemination work and wrote *Breeding Super Bees* (1987).
- **C.L. Farrar** — a USDA apiculturist based at the University of Wisconsin in Madison from the 1930s onward whose research showed that large, populous colonies produce far more honey per bee than small ones, which made colony population management (and pollen supplements to build it) a core principle of modern beekeeping.

One non-American name also appears regularly on certification exams: **Brother Adam** (Karl Kehrle, 1898–1996), a Benedictine monk at Buckfast Abbey in England. After Isle of Wight disease devastated British colonies in the early 1900s, he spent roughly 70 years crossing surviving stock with bees collected across Europe, North Africa, and the Middle East, producing the gentle, productive Buckfast bee, still sold in the U.S. today.

Chapter Summary

- Early humans were honey hunters; the first hives were fixed-comb vessels of clay, straw, wicker, bark, or hollow logs (“gums”), which had to be destroyed to harvest honey.
- Huber (1789), Prokopovych (1814), and Dzierzon (1838–48) developed movable combs and spacing before Langstroth, whose 1851 insight, patented in 1852, applied bee space to every side of a removable frame in a top-opening box.
- Bees have existed for about 100 million years, and honey, wax, pollen, and propolis were valued throughout ancient Egypt, Greece, and Rome.
- Honey bees are not native to the Americas; they arrived in Virginia in 1622, and key later milestones include wax foundation (1857), Italian bees (1859–60), the extractor (1865), the bellows smoker (1873), the Honey Bee Act (1922), Varroa (1987), and Africanized bees in Texas (1990).
- Langstroth, Root, Quinby, Miller, Laidlaw, Taber, and Farrar shaped American beekeeping, and Brother Adam developed the Buckfast bee in England.

Review Questions

1. In what year did honey bees first arrive in North America, and in which colony?
2. Who patented the movable-frame hive in 1852?
3. Who invented the centrifugal honey extractor, and in what year?
4. What foundational shortcoming did all fixed-comb hives share?
5. Which beekeeper developed practical instrumental insemination of queens and is called the “Father of Honey Bee Genetics”?

Test bank practice: this chapter is covered by Questions 1–27 (Section 1) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

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- Cornell University Library, "A Buzz about Bees: Four Hundred Years of Bees and Beekeeping" (online exhibit): exhibits.library.cornell.edu/beekeeping
- Langstroth, L.L. *Langstroth on the Hive and the Honey-Bee* (1853), free at gutenberg.org/ebooks/24583; Quinby, M. *Mysteries of Bee-keeping Explained* (1853), free at gutenberg.org/ebooks/25185
- Eva Crane Trust, free papers on the history of traditional hives: evacranetrust.org

Chapter 2: Honey Bee Biology and Behavior

Chapter Objectives

After studying this chapter, you should be able to:

- Identify *Apis mellifera*, its closest relatives, and the major geographic races kept by beekeepers.
- Name the main external and internal body parts of the honey bee and the functions of its glands.
- Distinguish the queen, worker, and drone and recall their development times (“Bee Math”).
- Explain bee space, colony needs, temperature regulation, and division of labor.
- Describe the roles of the major pheromones and how the waggle dance communicates direction and distance.
- Explain swarming, supersedure, and laying workers, and tell honey bees apart from native bees and wasps.

A. Origins of the Western Honey Bee

The honey bee kept throughout North America is *Apis mellifera* (the “western” or “European” honey bee), a member of the insect order Hymenoptera along with ants and wasps. Its closest relative is *Apis cerana*, the eastern honey bee of Asia (one of a small group of Asian cavity-nesting honey bees that together are *A. mellifera*'s nearest kin) — a species whose original mite parasite, *Varroa*, later jumped to *A. mellifera* with devastating consequences (covered in Chapter 11). *A. mellifera*'s native range stretched from western Asia and the Middle East across Europe to the southern tip of Africa, and humans have since carried colonies to every continent except Antarctica.

Several geographic races of *A. mellifera* are commonly referenced by beekeepers: German bees (*A. m. mellifera*, northern Europe), Italian bees (*A. m. ligustica*, the Mediterranean), Carniolan bees (*A. m. carnica*, eastern Europe), Caucasian bees (*A. m. caucasica*, the Caucasus region), and African bees (*A. m. scutellata*, southern/eastern Africa). Most commercially available queens in the U.S. today are Italian or Carniolan hybrids selected for gentleness and productivity.

Honey bees are economically indispensable: they pollinate a large share of U.S. food and fiber crops, and their value to U.S. agriculture is commonly estimated at \$15–20 billion per year (the USDA puts the value of crops pollinated by honey bees at about \$15 billion, covering more than 130 fruits, nuts, and vegetables). Honey, beeswax, and mead were among the most valuable products to early human civilizations, which is why honey bee husbandry (and honey hunting before it) has a written history stretching back thousands of years.

B. Honey Bee Anatomy and Development

Like all insects, a honey bee's body is divided into head, thorax, and abdomen, and it has six legs, four wings, and three simple eyes (ocelli) in addition to two large compound eyes. Compound eyes sense color, contrast, and movement; ocelli sense light intensity, helping with flight stability and judging light levels (for example, when to stop foraging at dusk). Bees can see ultraviolet light, a wavelength invisible to humans, which helps them locate nectar guides on flowers.

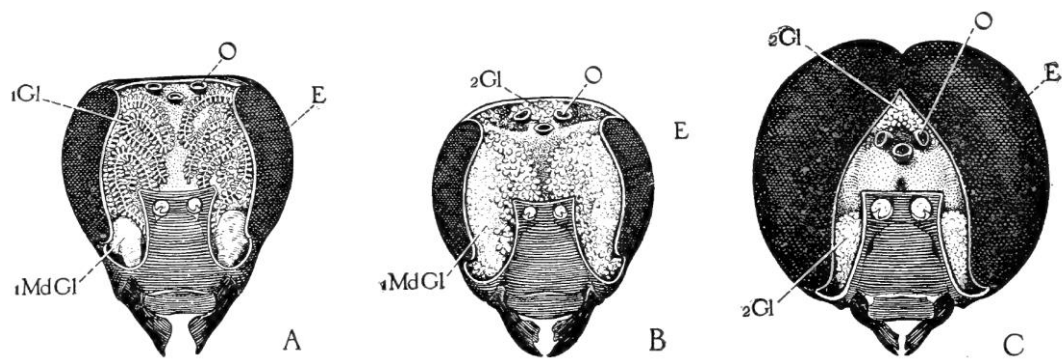


Figure 2.1. Front views of the heads of the worker (A), queen (B), and drone (C), with the face plate and mouthparts removed to show the glands beneath. The drone's compound eyes (E) are far larger and meet at the top of the head, crowding the three ocelli (O) down onto the face. R.E. Snodgrass, *The Anatomy of the Honey Bee* (USDA Bureau of Entomology Technical Series No. 18, 1910), Fig. 10. Public domain.

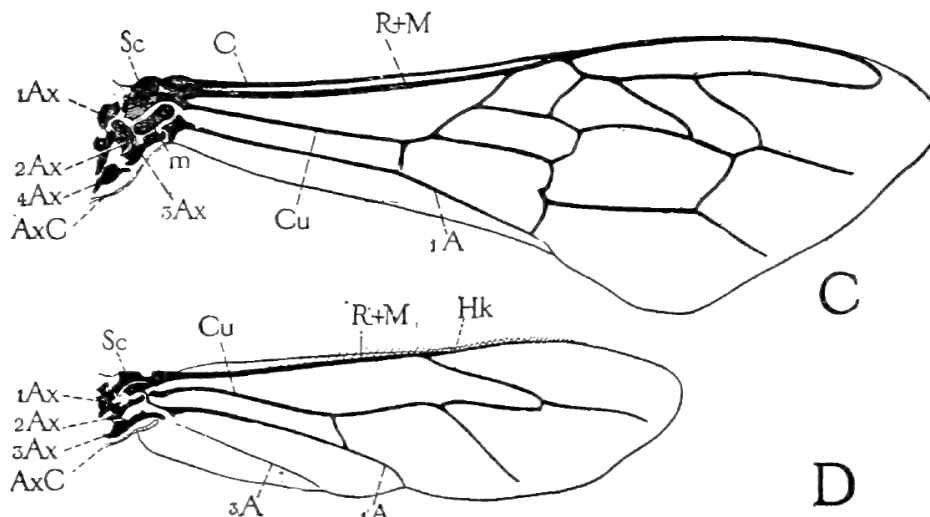


Figure 2.2. Front wing (C) and hind wing (D) of the honey bee. The row of tiny hooks (Hk, the hamuli) on the front edge of the hind wing catches a fold on the front wing, so the two wings on each side beat together as one. R.E. Snodgrass, *The Anatomy of the Honey Bee* (USDA Bureau of Entomology Technical Series No. 18, 1910), Fig. 25. Public domain.

Bees have complex, dual-purpose mouthparts: hardened mandibles for chewing solids (wax, pollen, wood, propolis) and a straw-like proboscis for drawing up liquids (water, nectar, honey). The hind legs of workers carry a flattened, concave structure called the corbicula (pollen basket) used to carry pollen or resin back to the hive. Specialized branched body hairs (setae) help bees sense touch and vibration and also let them collect pollen efficiently, giving them their characteristic “fuzzy” look.

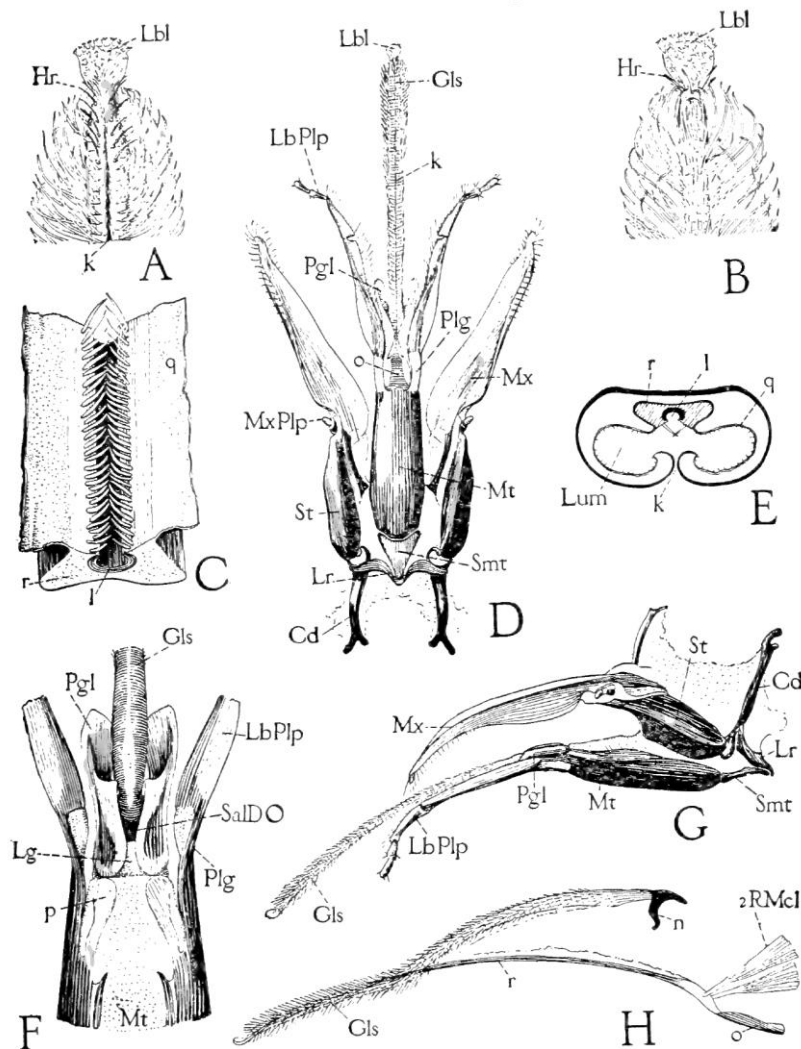


Figure 2.3. Mouthparts of the worker. D shows the proboscis spread flat: the long central tongue (glossa, Gls) ending in a hairy, spoon-like tip (labellum, Lbl; enlarged in A and B), flanked by the labial palps (LbPlp) and the maxillae (Mx). G and H show the same parts from the side. The chewing mandibles are not shown. R.E. Snodgrass, The Anatomy of the Honey Bee (USDA Bureau of Entomology Technical Series No. 18, 1910), Fig. 15. Public domain.

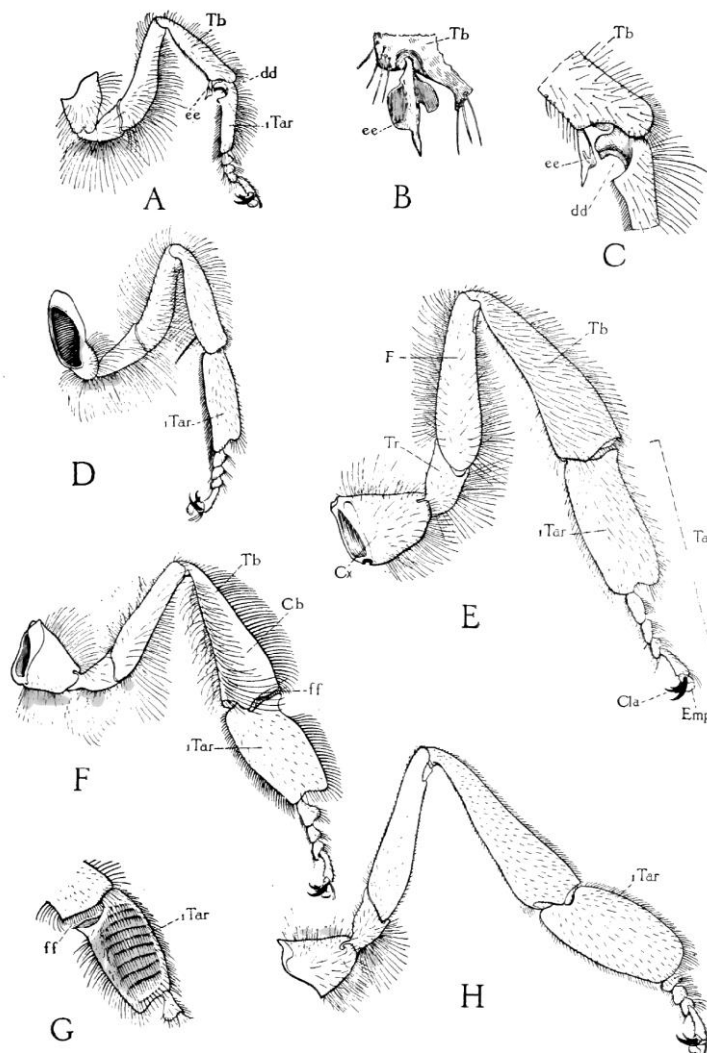


Figure 2.4. Legs of the honey bee. *F* is the worker's hind leg, with the pollen basket (corbicula, *Cb*) on the outer face of the tibia (*Tb*); *G* shows the rows of pollen-gathering hairs on the inner face of the first tarsal segment. *A–C* show the antenna cleaner (notch *dd*) on the worker's front leg, and *D* is her middle leg. *E* and *H* are the hind legs of the queen and drone, which have no pollen basket. R.E. Snodgrass, *The Anatomy of the Honey Bee* (USDA Bureau of Entomology Technical Series No. 18, 1910), Fig. 29. Public domain.

Honey bees undergo complete metamorphosis — egg, larva, pupa, adult — developing into one of three distinct adult forms depending on the egg's fertilization and the food fed to the larva:

- **Workers** — develop from a fertilized egg, fed royal jelly briefly then a mix of nectar/pollen; females that perform nearly all colony labor; possess a barbed stinger.
- **Queens** — develop from the same fertilized eggs as workers but are fed royal jelly exclusively throughout larval development; the sole reproductive female; possess an unbarbed (reusable) stinger.
- **Drones** — develop from unfertilized eggs (drones are haploid); the colony's males, whose only role is mating; they have no stinger.

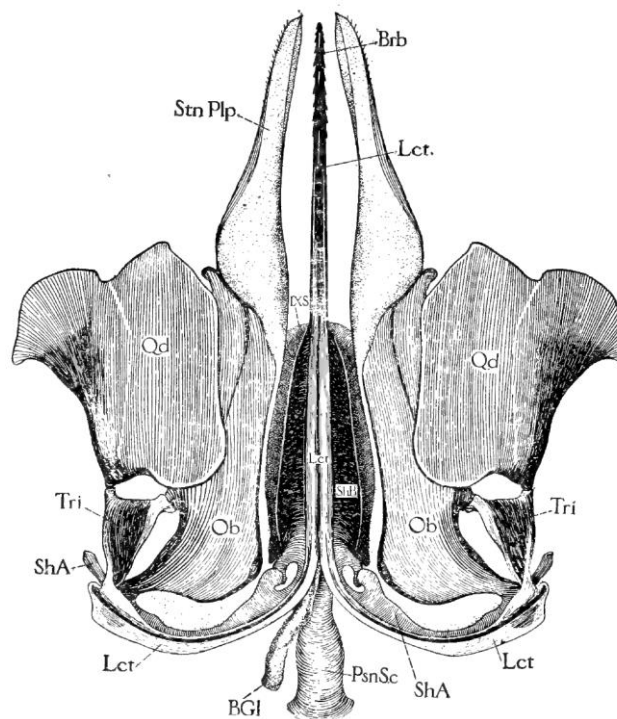


Figure 2.5. Underside view of the worker's sting, flattened out. The two lancets (*Lct*) slide along the central shaft, and the barbs (*Brb*) near the tip anchor the sting in skin, which is why a worker cannot pull it free. R.E. Snodgrass, *The Anatomy of the Honey Bee* (USDA Bureau of Entomology Technical Series No. 18, 1910), Fig. 37. Public domain.

“Bee Math” refers to memorizing these development timelines, which are frequently tested:

Form	Egg hatches	Cell capped	Adult emerges
Worker	Day 3	Day 9	Day 21
Drone	Day 3	Day 10	Day 24
Queen	Day 3	Day 8	Day 16

Study tip: Queens develop fastest (16 days), workers next (21 days), drones slowest (24 days). A simple mnemonic is “16, 21, 24 — queens, workers, drones, in order.”

Internal systems and glands

Inside the body, a honey bee breathes through a network of air tubes (tracheae) that open to the outside through small holes called spiracles along the thorax and abdomen; there are no lungs, and oxygen reaches the tissues directly through these tubes. Its circulatory system is “open”: a tube-like heart along the top of the abdomen pumps blood-like hemolymph forward, and it then bathes the organs freely. Food passes from the mouth to the honey stomach (crop), where foragers carry nectar and water, and then through a valve (the proventriculus) into the midgut, where digestion and absorption take place. Malpighian tubules remove waste, much as kidneys do, and the hindgut stores waste until the bee can fly out to void it, which is why bees take cleansing flights after long confinement. Fat bodies in the abdomen store protein and fat reserves and are especially well developed in long-lived winter bees.

Gland	Location and main function
Hypopharyngeal (brood-food) glands	Head; in young nurse bees, secrete the protein-rich component of brood food and royal jelly; in foragers, produce enzymes (such as invertase) that help convert nectar to honey.
Mandibular glands	Head, at the base of the mandibles; in workers, help make brood food and produce an alarm compound; in the queen, produce queen mandibular pheromone (QMP).
Wax glands	Four pairs on the underside of the worker's abdomen; most active at roughly 12–18 days of age, secreting wax flakes used to build comb.
Nasonov (scent) gland	Near the tip of the worker's abdomen; releases an orienting, lemony scent that guides nestmates to the entrance, a swarm cluster, water, or food.
Sting and venom glands	Tip of the worker's abdomen; produce venom, and the sting area releases alarm pheromone (isoamyl acetate).
Salivary glands	Head and thorax; secrete saliva used to moisten food and work wax and propolis.

C. Honey Bee Behaviors and Colony Structure

A honey bee colony functions as a superorganism: thousands of individuals coordinating through division of labor, sensory perception, and a sophisticated chemical (pheromone) communication system to behave collectively as one unit. The colony must find shelter, collect food, grow, and reproduce, and it is the beekeeper's task to understand this structure well enough to support it.

Colony needs and the nest

Colonies need cavity space, food (nectar/honey, pollen/bee bread, and water), and defensible boundaries. Bees maintain a consistent “bee space” between combs and hive parts: a minimum of about 3/16 inch (4.8 mm) and a maximum of about 3/8 inch (9.5 mm). Many extension sources give the range as 1/4–3/8 inch (6.4–9.5 mm), averaging about 5/16 inch (8 mm). Gaps smaller than bee space get sealed with propolis (plant resin); gaps larger than bee space get filled with burr or bridge comb. This spacing principle — worked out by European beekeepers including Jan Dzierzon in the 1830s–40s and applied by Lorenzo Langstroth to a fully removable frame in 1851 — made practical movable-frame hives possible (see Chapter 1).

Foragers collect four resources for the colony: nectar (converted to honey, the carbohydrate/energy source), pollen (the protein, fat, and vitamin source, stored as fermented “bee bread”), water (for cooling and diluting food), and tree resins (converted into propolis, used to seal and disinfect the hive).

Temperature regulation

The brood nest is held at a remarkably stable 92–95°F regardless of outside conditions. When it is cold, bees cluster together and vibrate their flight muscles to generate metabolic heat. When it is hot, bees fan their wings at the entrance and evaporate water carried into the hive to cool it, much like a swamp cooler.

Division of labor and pheromones

Worker bees progress through an age-based sequence of tasks (temporal polyethism): young workers clean cells, then feed brood as nurse bees (roughly days 3–12 of adult life; about 5 days old is the starting age most often taught, and the brood-food, or hypopharyngeal, glands are fully developed by about day 6–7), then take on hive tasks such as comb-building, food processing, and guarding, before finally transitioning to foraging at around 20 days old. Drones exist solely to mate; queens lay eggs and, through pheromones, regulate the colony.

Pheromones knit this system together. Queen Mandibular Pheromone (“QMP,” the queen sign) suppresses ovary development in workers, inhibits the rearing of new queens, signals that a healthy, mated queen is present, attracts drones during mating flights, and helps hold a swarm together; it also modulates the age-based progression of worker tasks. Nasonov pheromone, released by workers, aggregates bees and helps them orient (e.g., guiding a swarm to cluster, or foragers to the entrance, food, or water). Alarm pheromone (chiefly isoamyl acetate, also called isopentyl acetate, from the sting gland — the same compound that gives bananas their smell) recruits nestmates to defend the colony and marks the target. Brood pheromone, released by larvae, stimulates nurse bees' brood-food glands, suppresses worker ovary development, and influences when young bees begin foraging and how much pollen foragers collect.

The waggle dance

Successful foragers communicate the direction and distance of a resource to nestmates through the waggle dance, performed on the vertical face of the comb in darkness. The angle of the waggle run relative to straight-up (vertical) encodes the angle to the resource relative to the sun's position outside; the length/duration (vigor) of the waggle run encodes the distance to the resource. Nearby bees follow the dance closely, sensing it through vibration, touch, and scent (including hive-related odors carried on the dancer).

Swarming: the colony's reproductive event

Colonies reproduce at the colony level through swarming: in spring, as resources become plentiful and the colony becomes congested, workers build queen cups along the edges/bottom of the comb and the queen lays eggs in them. Workers cap the resulting swarm cells and the old queen, along with roughly half to two-thirds of the workforce, departs to found a new colony, clustering nearby while scout bees search for a permanent cavity. Left behind, a virgin queen emerges from a swarm cell, eliminates rival queens, takes one or more mating flights (mating in the air, never inside the hive, typically with about 12–20 drones), and begins laying in the parent colony.

This differs from supersedure, in which workers replace a failing or lost queen; supersedure cells are typically built in the middle of the brood comb rather than along the edges. If a colony becomes queenless and broodless for an extended period, some workers may develop functioning ovaries and begin laying — but because these “laying workers” were never mated, they can only produce unfertilized (drone) eggs, leaving the colony without a path to raising a new queen.

D. Honey Bees, Other Bees, and Wasps

The honey bee is only one of roughly 20,000 bee species worldwide and about 4,000 species native to the United States, from bumble bees and carpenter bees to tiny sweat bees and mason bees. Most native bees are solitary, nest in the ground or in hollow stems, and are important pollinators in their own right; a

beekeeper who understands them can explain to neighbors that “bee decline” stories usually concern native and wild bees as much as managed honey bees.

Wasps, hornets, and yellowjackets are not bees, though the public routinely confuses them. Bees are fuzzy, feed their young pollen and nectar, and carry pollen on their bodies or hind legs. Wasps are generally smooth and shiny with a narrow “waist,” and are predators or scavengers that feed their young on insects or meat. Yellowjackets, which nest in the ground or in wall voids and swarm picnic food in late summer, cause many of the stings blamed on honey bees.

Feature	Honey bee worker	Yellowjacket / hornet / paper wasp
Body	Fuzzy, branched hairs; golden-brown with darker bands	Mostly hairless and shiny; bold yellow-and-black or brown markings
Diet of young	Pollen and nectar (honey, bee bread)	Insects and meat; adults also take sugars
Nest	Wax comb in a cavity (tree hollow or hive)	Paper nests, often underground or hanging
Sting	Barbed; usually left in the skin with the venom sac, and the worker dies	Smooth; can sting repeatedly and leaves no stinger
Temperament away from the nest	Rarely stings while foraging	Yellowjackets can be aggressive scavengers, especially in fall

Chapter Summary

- The western honey bee, *Apis mellifera*, is native to Europe, Africa, and the Middle East; its closest relatives are the Asian cavity-nesting honey bees such as *Apis cerana*, the original host of *Varroa*.
- Bees have a head, thorax, and abdomen, compound eyes and three ocelli, pollen baskets on the workers’ hind legs, and glands that produce brood food, wax, pheromones, and venom.
- Queens develop in 16 days, workers in 21, and drones in 24; queens and workers come from fertilized eggs, drones from unfertilized eggs.
- The brood nest is held at about 92–95°F; workers progress through age-based tasks and begin foraging at around three weeks of age.
- Queen mandibular pheromone, Nasonov, alarm, and brood pheromones coordinate the colony, and the waggle dance encodes direction by its angle and distance by the length of the waggle run.
- Colonies reproduce by swarming; superseding replaces a failing queen; laying workers produce only drones.
- About 4,000 bee species are native to the U.S.; wasps and yellowjackets are hairless predators that can sting repeatedly.

Review Questions

1. How many days does a worker bee take to develop from egg to adult, and how many does a queen take?
2. At what temperature range do bees hold the brood nest?
3. Which pheromone, produced by the queen, suppresses worker ovary development and signals her presence?

4. In the waggle dance, what does the angle of the waggle run relative to vertical communicate?
5. Which gland do workers expose and fan to guide nestmates to the hive entrance?

Test bank practice: this chapter is covered by Questions 28–60 (Section 2) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

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- Clemson Apiculture & Pollinator Program: clemson.edu/extension/pollinators/apiculture/index.html; NC State Extension Apiculture: pollinators.ces.ncsu.edu/apiculture
- Snodgrass, R.E. The Anatomy of the Honey Bee. USDA Bureau of Entomology Technical Series No. 18, 1910 (public domain; source of Figures 2.1–2.5). Free scan: archive.org/details/anatomyofhoneybe18snod

Chapter 3: Safety in the Bee Yard

Chapter Objectives

After studying this chapter, you should be able to:

- Recognize the warning signs a colony gives before it stings and the conditions that provoke defensiveness.
- Position yourself and move safely around hives, and respond correctly when bees become agitated.
- Explain how smoke calms bees and how to light, use, and extinguish a smoker safely.
- Choose appropriate protective clothing.
- Assemble a basic bee-yard first aid kit and remove a stinger correctly, and tell a honey bee sting from a wasp sting.

A. Recognizing Defensive Behavior

A calm, confident, and unhurried beekeeper is itself a safety practice: sudden movements, loud noise, and anxious handling all tend to agitate a colony, while slow, deliberate movement tends to keep it calm. Bees give escalating warning signs before they sting, and a beekeeper who recognizes these early can close the hive and step back before anyone is hurt: increased buzzing pitch and volume, bees bumping or “head-butting” the veil or hands as a warning, bees flying at the face in short aggressive darts, and the release of alarm pheromone (which smells like bananas because its main component, isoamyl acetate, is the same compound found in banana flavoring), which recruits nearby bees to join the defense.

Triggers that commonly provoke defensiveness include: opening the hive on a cool, cloudy, or rainy day (fewer foragers are out, so more defenders are home); working bees too quickly or roughly; crushing or rolling bees between frames or boxes; strong perfumes, scented lotions, or the smell of bananas; dark or rough-textured clothing (which can visually and texturally resemble a natural predator such as a bear); and vibration or jarring the hive. Pets and livestock should be kept well away from an apiary, since animals that disturb or are stung by bees can provoke a broader defensive response that also endangers the people nearby.

B. Safe Positioning and Movement Around the Hive

Basic positioning habits reduce sting risk substantially. A beekeeper should approach and stand to the side or rear of the hive entrance, never directly in front of it, since the entrance is the flight path foragers and guard bees actively patrol. Before opening a hive, pause and observe the entrance, landing board, and general bee behavior for a moment to gauge the colony's mood. Movements inside the hive should be slow and deliberate: lifting frames straight up without jarring or bumping adjacent frames, and avoiding any shaking or sudden vibration of the hive body, which can trigger a defensive alarm response throughout the colony.

If bees do become agitated and begin bumping or stinging, the correct response is to move away calmly rather than to run or swat. Running triggers a chase-and-sting response in defending bees (which can follow a person a considerable distance), and swatting crushes bees, releasing more alarm pheromone and escalating the response. A beekeeper should also never use an open flame near the hive or dry grass/leaf litter, since smoker embers and sparks pose a real fire risk in a bee yard, particularly during dry conditions.

C. The Smoker as a Safety Tool

Smoke is the single most effective, low-stress tool for keeping a colony calm during inspection: it masks alarm pheromone (so one stinging bee's warning signal does not spread panic through the colony) and triggers bees to instinctively gorge on honey in anticipation of possibly having to flee a fire, which makes them both calmer and physically less able to curl their abdomens to sting effectively. A few light puffs at the entrance before opening the hive, followed by a few more across the top once the cover is removed, is usually sufficient — oversmoking agitates bees rather than calming them and can taint honey with a smoky off-flavor.

Smokers should always be lit, carried, and extinguished carefully: use only safe fuels (pine straw, burlap, raw cotton, or wood shavings — never materials such as used motor oil, tar paper, or treated wood that release toxic fumes), keep the smoker upright and away from dry grass while lit, and fully extinguish the fuel (by plugging the spout or dousing it) before storing the smoker, since smoldering fuel can reignite later and start a fire.

D. Protective Clothing and Equipment

At an absolute minimum, a beekeeper should wear a veil to protect the face and eyes, since facial stings are both the most painful and the most dangerous (stings near the eyes or airway carry real medical risk). Light-colored, smooth clothing is preferred over dark or rough-textured fabric, both because dark colors and rough texture can trigger defensive responses and because stings are easier to see and remove from smooth, light fabric. A full bee suit (or a jacket with an attached veil) and gloves add substantial additional protection, particularly for new beekeepers still learning to read colony behavior, though many experienced beekeepers work bare-handed or with thin gloves once comfortable. Pant legs should be tucked into boots or secured with bands, and sleeve cuffs should be snug, to keep bees from crawling up underneath clothing — one of the more common causes of unexpected stings.

E. First Aid in the Bee Yard

Every beekeeper should keep a small first aid kit on hand in the bee yard, stocked at minimum with: a hive tool or fingernail for removing an embedded stinger (remove it as fast as possible; research shows that speed of removal matters more than method, because the detached venom sac keeps pumping venom into the skin, so scrape or pluck it out immediately rather than hunting for the “right” tool), an antihistamine (oral or topical) to reduce local swelling and itching, a cold pack or ice to reduce swelling and pain, and — critically, for any beekeeper or helper with a known bee-sting allergy — an epinephrine auto-injector (Epi-Pen), kept accessible and not expired (see Chapter 4 for full guidance on allergic reactions and anaphylaxis). A charged cell phone should also always be within reach in case emergency services need to be called.

Practical, field-tested safety habits worth building into every bee-yard visit include: never working bees alone when possible, or at minimum telling someone else when and where you will be working; keeping an escape route in mind at all times; closing up and leaving calmly, without running, if a colony becomes unusually defensive; and avoiding alcohol or situations that slow reaction time before working bees.

Knowing what stung someone matters. A honey bee worker almost always leaves her barbed stinger and venom sac behind, while yellowjackets, hornets, and paper wasps have smooth stingers, can sting repeatedly, and leave nothing in the skin. That difference is useful for first aid (only a honey bee sting needs

a stinger scraped out) and for an allergist, because venom allergy is often specific to bee venom or to wasp (vespid) venom (see Chapter 2, Section D, and Chapter 4).

Chapter Summary

- Rising buzz, head-butting, darting flights, and the banana-like smell of alarm pheromone warn that a colony is becoming defensive.
- Cool, cloudy weather, rough handling, crushed bees, scents, dark rough clothing, and vibration all increase defensiveness.
- Stand to the side or rear of the entrance, move slowly, and walk away calmly rather than running or swatting.
- Smoke masks alarm pheromone and causes bees to gorge on honey; use cool smoke, safe fuels, and extinguish the smoker fully.
- A veil is the minimum protection; light, smooth clothing and secured cuffs reduce stings.
- Remove stingers immediately by any method, keep antihistamines, cold packs, and (for anyone allergic) an epinephrine auto-injector, and carry a phone.

Review Questions

1. Where should a beekeeper stand when working a hive?
2. Name two effects of smoke on a honey bee colony.
3. What is the minimum protective equipment every beekeeper should wear?
4. According to research, what matters most when removing a stinger: the method or the speed?
5. Which insect usually leaves its stinger in the skin: a honey bee or a yellowjacket?

Test bank practice: this chapter is covered by Questions 61–86 (Section 3) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

- Sanford, M.T. & Bonney, R.E. *Storey's Guide to Keeping Honey Bees*, 2nd ed. Storey Publishing, 2018. Protective gear, smoker use, and working bees safely.
- Storch, H. *At the Hive Entrance: Observation Handbook*. European Apicultural Editions, 1985. Reading colony mood from outside the hive.
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Chapter 4: Allergic Reactions and Anaphylaxis

Chapter Objectives

After studying this chapter, you should be able to:

- Distinguish a normal local reaction, a large local reaction, and a systemic (allergic) reaction, and state how common each is.
- Recognize the signs of anaphylaxis in the skin, respiratory, cardiovascular, and gastrointestinal systems.
- Explain recurrence risk after a systemic reaction and put sting mortality in context.
- Respond appropriately to each type of reaction, including when to use epinephrine and call 911.

A. Types of Sting Reactions

Nearly everyone experiences some reaction to a honey bee sting, and understanding the three general categories helps a beekeeper respond appropriately rather than over- or under-reacting:

Reaction type	Typical presentation	Approximate incidence
Localized (normal) reaction	Pain, redness, and swelling confined to the sting site, usually resolving within a few hours to a day	Nearly universal — expected with any sting
Large local reaction	Swelling that extends well beyond the sting site (e.g., an entire hand or forearm), sometimes peaking a day or two after the sting and lasting several days	About 2.4%–26.4% of stung individuals, depending on the study population
Systemic (allergic) reaction / anaphylaxis	Symptoms occurring away from the sting site — skin, respiratory, cardiovascular, and/or gastrointestinal symptoms — representing a true allergic, immune-mediated response	About 0.5%–3.3% of stung adults; about 0.15%–0.8% of stung children

A large local reaction, while alarming in appearance, is not the same as a true allergy and does not by itself mean a person will react systemically to a future sting — though a person who has had one should still be monitored and may be advised by a physician to carry antihistamines or, in some cases, an epinephrine auto-injector as a precaution. A true systemic/anaphylactic reaction is a medical emergency, by contrast, because it can progress rapidly and involve the airway and cardiovascular system.

B. Recognizing Anaphylaxis by Body System

Anaphylaxis is defined by symptoms occurring in body systems away from the sting site itself, often within minutes of the sting, and typically involving two or more of the following systems (though trouble breathing or a sudden drop in blood pressure after a sting should be treated as anaphylaxis even on its own):

- **Skin** — hives (urticaria) spreading beyond the sting site, widespread itching, flushing, or swelling of the lips, tongue, throat, or face (angioedema).

- **Respiratory** — throat tightness or a sensation of the throat closing, hoarseness, wheezing, shortness of breath, or persistent coughing.
- **Cardiovascular** — dizziness, a rapid or weak pulse, a sudden drop in blood pressure, paleness, or fainting/loss of consciousness.
- **Gastrointestinal** — nausea, vomiting, abdominal cramping, or diarrhea.

A beekeeper or bystander should treat any combination of these symptoms appearing after a sting — especially throat tightness, difficulty breathing, or fainting — as a medical emergency requiring immediate action, not a “wait and see” situation.

C. Recurrence Risk and Mortality Context

A person who has had one systemic/anaphylactic sting reaction faces a meaningfully elevated risk of a similar or worse reaction to a future sting — commonly cited in the range of 40%–60% recurrence risk, though the exact figure depends on the severity of the prior reaction and individual factors, which is why an allergist referral and evaluation (often including venom immunotherapy) is strongly recommended after any systemic reaction. For context on overall risk, fatal reactions to insect stings are rare in absolute terms — the CDC reports an average of about 62 deaths per year in the United States from hornet, wasp, and bee stings combined (2000–2017) — but a known sting allergy, especially after a prior systemic reaction, meaningfully raises personal risk, which is exactly why beekeepers and their household/helpers who carry a known allergy should have a clear, rehearsed emergency plan rather than relying on rarity alone.

D. Treatment and Emergency Response

Response should scale to the severity of the reaction:

- **Localized reaction** — remove the stinger immediately by whatever method is quickest (scraping with a fingernail or hive tool works well, but speed matters more than technique); wash the area; apply a cold pack to reduce swelling; an oral antihistamine or topical treatment can ease itching and discomfort.
- **Large local reaction** — same initial steps, plus elevation of the affected limb if practical and closer monitoring; an oral antihistamine and, if advised by a physician in advance, a short course of oral corticosteroids; seek medical attention if swelling is severe, affects the airway area (face/neck), or does not improve.
- **Systemic reaction / suspected anaphylaxis** — administer an epinephrine auto-injector (Epi-Pen) immediately if one is available and the person has a known prescription or clear systemic symptoms are present; call 911 immediately, even if symptoms seem to improve after the injection, since symptoms can return (a “biphasic” reaction); keep the person lying down with legs elevated if possible (unless vomiting or having difficulty breathing, in which case a more comfortable position should be used); administer a second dose of epinephrine after about 5–15 minutes if symptoms have not improved and a second auto-injector is available; monitor breathing and responsiveness continuously until emergency responders arrive.

Because anaphylaxis can progress within minutes, epinephrine should never be delayed in favor of “trying antihistamines first” once systemic symptoms are present — antihistamines treat itching and hives but do not reliably stop airway swelling or a cardiovascular collapse the way epinephrine does. Every apiary, and every beekeeper or helper with a known allergy, should keep at least one (ideally two) unexpired epinephrine auto-injectors on hand, know how to use them, and make sure others working alongside them know where the auto-injector is kept and how to administer it in an emergency.

Chapter Summary

- Nearly everyone has a local reaction; large local reactions (swelling well beyond the sting site) affect a minority and are not true allergy.
- Systemic reactions affect about 0.5–3.3 percent of stung adults and fewer children, and can progress to anaphylaxis within minutes.
- Anaphylaxis typically involves two or more body systems, but breathing difficulty or a drop in blood pressure alone is enough to treat it as an emergency.
- After one systemic reaction, the risk of another is commonly cited at 40–60 percent, so an allergist evaluation and venom immunotherapy are recommended.
- For suspected anaphylaxis, give epinephrine immediately, call 911, lay the person down with legs raised if possible, and give a second dose after 5–15 minutes if needed; antihistamines are not a substitute.

Review Questions

1. What are the three general categories of sting reaction?
2. Name the four body systems that can be involved in anaphylaxis.
3. What medication should be given first for suspected anaphylaxis?
4. Why should 911 be called even if symptoms improve after epinephrine?
5. About how many people die each year in the U.S. from hornet, wasp, and bee stings combined, according to the CDC?

Test bank practice: this chapter is covered by Questions 87–108 (Section 4) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

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- American Academy of Allergy, Asthma & Immunology (AAAAI), insect sting allergy and anaphylaxis resources: aaaai.org
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- CDC, “QuickStats: Number of Deaths from Hornet, Wasp, and Bee Stings, 2000–2017,” *Morbidity and Mortality Weekly Report*, July 2020: cdc.gov/mmwr

Chapter 5: Selecting an Apiary Site

Chapter Objectives

After studying this chapter, you should be able to:

- Evaluate a potential apiary site for flight path, sun, wind, drainage, and visibility.
- Explain why access, convenience, and a reliable water source matter.
- Apply good-neighbor and safety practices when siting hives.
- Decide how many hives a site can support and score candidate sites consistently.
- Check local ordinances and HOA rules and communicate with neighbors before installing hives.

A. Why Site Selection Matters

Honey bees are remarkably adaptable and can be kept successfully in urban, suburban, or rural settings alike — there is no single “correct” type of location. That said, some sites will let a colony thrive with minimal intervention, while others will constantly work against the bees (and the beekeeper). Evaluating a candidate site across a consistent set of factors before committing to it saves considerable frustration later, since an apiary is not easily relocated once established (see the “3 feet or 3 miles” rule in Chapter 7).

B. Location: Flight Path, Sun, and Wind

The hive entrance's flight path should never face directly across a walkway, driveway, or any other area where people or animals regularly pass — foragers fly a low, fast, direct line out of the entrance, and crossing that line is the most common source of unplanned stings near an apiary. Where space is tight, placing a solid obstacle (a fence, hedge, or wall) a few feet in front of the hive entrance forces departing and returning bees to fly up and over before leveling off, raising their flight path above head height and meaningfully reducing encounters with people nearby.

Low-lying areas should generally be avoided, since they trap cold air and moisture, both of which stress a colony (excess hive moisture is often more dangerous to overwintering bees than cold itself, see Chapter 8). A sunny site, ideally with a south- to southeast-facing entrance that catches early morning sun, is strongly preferred: morning sun warms the hive and gets foragers flying earlier in the day, and in the Southeast sunny, dry sites also discourage small hive beetles (see Chapter 11). Light afternoon shade can ease heat stress during South Carolina summers, but deep shade and damp ground should be avoided. Some wind protection — a hedge, fence, or structure to the north/northwest — helps reduce the cooling effect of prevailing winter winds without blocking the entrance's own flight path. Finally, all else being equal, a site that keeps the hives less visible to the general public reduces curiosity, tampering, and anxious neighbors.

C. Access and Convenience

A beekeeper should favor sites offering full, unimpeded access to the hives at any time: locked gates and sites that require advance permission for each visit both make routine inspection and swarm/emergency response needlessly difficult. Good, reliable vehicle access year-round is also important — hive bodies and supers full of honey are heavy, often 40–90 pounds depending on box size and fill, and carrying loaded equipment any real distance by hand is both impractical and a real injury risk. Overall, a convenient site that

a beekeeper visits often leads to a better-managed, better-understood colony than a site that is beautiful but inconvenient and therefore rarely visited.

D. Water Sources

Bees need a reliable water source for cooling the hive and diluting food, and they will travel a considerable distance to find one if none is available nearby — but a source less than about 1/4 mile from the hive is strongly preferred, both for the bees' efficiency and because once a colony has established a water source it is very difficult to retrain them to a different one. This matters most when there is a swimming pool or other sensitive water feature nearby: offering bees an attractive water source of their own at the time a hive is first established — before they find and fixate on the pool instead — heads off a recurring source of neighbor complaints. A simple, practical rule of thumb: if you would not drink the water yourself, do not offer it to the bees.

E. Safety and Good-Neighbor Practices

Beyond flight-path considerations, hives should be sited where they do not pose a threat to people or animals who are not expecting them — away from children's play areas, shared walkways, and livestock enclosures. Orienting hive entrances away from neighboring properties, sidewalks, and other shared spaces, and screening hives from view where practical, both reduce the odds of an unwanted encounter and support good relations with neighbors, which matters in both urban/suburban settings (where many municipalities have specific beekeeping ordinances) and rural ones. A site should also avoid locations regularly exposed to pesticide application (such as adjacent to heavily sprayed agricultural fields or golf courses) and locations vulnerable to vandalism or theft — visible roadside sites and unsecured public land are common problem spots.

F. How Many Hives at One Site

A single apiary site generally supports a minimum of two hives and a practical maximum of around twenty, though the right number for any given site depends heavily on available forage, management goals, and the resources the beekeeper wants to invest. Keeping at least two hives at one location (rather than just one) gives a beekeeper the ability to compare colonies directly against each other and to exchange resources — a frame of eggs, honey, or brood — between a weak colony and a strong one when needed, a meaningful management advantage a single, isolated hive does not offer.

G. A Simple Scoring Approach

When comparing candidate sites, it can help to score each one across the factors above (location/flight path, sun/wind exposure, access, water, safety, and convenience), awarding points for favorable conditions. A rough three-tier interpretation is useful for weighing the result:

Score range	Interpretation
Low (roughly 0–3 of 11 points)	This site does not appear favorable; consider other options.
Moderate (roughly 4–6 of 11 points)	Moderately favorable, but the bees may not produce or thrive as well as they could elsewhere.

Score range	Interpretation
High (roughly 7–11 of 11 points)	This location will probably work well.

No single factor should be treated as an automatic disqualifier in isolation — a site weak on one factor (say, partial afternoon shade) but strong on the others can still work well, especially if the beekeeper can compensate (for example, by providing supplemental water or wind protection). The goal of a structured review is simply to compare candidate sites consistently and catch a serious, hard-to-fix problem (such as a flight path crossing a shared walkway, or no realistic year-round vehicle access) before hives are already in place.

H. Local Rules and Talking with Neighbors

Before buying equipment, check what rules apply to the property. Many cities, towns, and counties regulate backyard beekeeping, commonly by limiting the number of hives per lot, requiring setbacks from property lines, or requiring a water source and a flyway barrier, and some homeowners' associations restrict or prohibit hives in their covenants. A short call to the local planning or zoning office (and a read of any HOA covenants) before the bees arrive avoids an expensive move later.

Good neighbor relations are as much about communication as placement. Talk with adjoining neighbors before installing hives: explain where the hives will sit and which way the entrances face, ask whether anyone in the household has a known sting allergy, and let them know whom to call if they see a swarm. Offering a jar of honey after the first harvest goes a long way. A beekeeper who manages for gentle stock, keeps colonies from swarming, and provides water away from neighbors' pools and birdbaths is far less likely to face complaints.

Chapter Summary

- Keep flight paths away from walkways and driveways; a fence or hedge in front of the entrance raises bees' flight above head height.
- Choose a sunny, well-drained site with morning sun, wind protection to the north or northwest, and some afternoon shade in hot Southeastern summers.
- Good vehicle access and a convenient location lead to better-managed colonies.
- Provide water within about 1/4 mile from the start so bees do not fixate on pools or birdbaths.
- Keep hives away from play areas, livestock, heavy pesticide use, and roadside theft or vandalism.
- Keep at least two hives so colonies can be compared and resources shared, and check zoning and HOA rules and talk with neighbors before the bees arrive.

Review Questions

1. Which direction should a hive entrance ideally face?
2. What simple structure placed in front of an entrance forces bees to fly up and over people's heads?
3. Within about what distance should bees have a reliable water source?
4. What is the recommended minimum number of hives at one site?
5. Name two kinds of local rules a new beekeeper should check before installing hives.

Test bank practice: this chapter is covered by Questions 109–131 (Section 5) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

- South Carolina Beekeepers Association, “Selecting an Apiary Site” (training presentation) and local chapter directory: scstatebeekeepers.com
- Sanford, M.T. & Bonney, R.E. Storey's Guide to Keeping Honey Bees, 2nd ed. Storey Publishing, 2018. Choosing and setting up an apiary.
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- MacFawn, D. Beekeeping Tips and Techniques for the Southeast United States. 2017. Siting and management under Southeastern conditions.
- Sammataro, D., Avitabile, A. & Caron, D.M. The Beekeeper's Handbook, 4th ed. Cornell University Press, 2011.
- Clemson Apiculture & Pollinator Program: clemson.edu/extension/pollinators/apiculture/index.html

Chapter 6: Beekeeping Equipment and Getting Started

Chapter Objectives

After studying this chapter, you should be able to:

- Explain why bee space made the modern Langstroth hive possible.
- Name the parts of a Langstroth hive from the bottom board to the outer cover, and describe the purpose of each.
- Describe the parts of a smoker, safe smoker fuels, and the essential tools and protective gear.
- Compare packages, nucs, established hives, and swarms as sources of bees, and install a package correctly.
- Compare hive styles, foundation types, and feeders, and estimate first-year costs.

A. Hive Systems, Tools, and Safety Equipment

Before movable-frame hives, beekeepers used fixed-comb systems built from whatever local materials were available: hollow-log hives in the forests of northern Europe (called “gums” in America), woven hives (wicker in the ancient Mediterranean, coiled-straw “skeps” in northwestern Europe), and clay pots or pipes in the Middle East and North Africa (see Chapter 1). All required destroying the comb (and often the colony) to harvest honey, since the comb could not be removed and inspected.

That changed once “bee space” — the roughly 3/16–3/8 inch gap bees leave open rather than filling with comb or propolis — was applied consistently to every side of a removable frame within a single hive body. European beekeepers, notably Jan Dzierzon from the 1830s, had already experimented with spacing and movable combs; Lorenzo Langstroth's own 1851 contribution was combining full bee space with a fully removable frame in a simple top-opening box, a design he patented in 1852 (see Chapter 1 for the fuller history). Langstroth, often called the “Father of American Beekeeping,” gave U.S. beekeeping the modular, stackable, top-opening hive that still dominates it today because it allows frame-by-frame inspection without destroying comb.

A standard Langstroth hive, built from the bottom up, includes:

- **Screened bottom board** — the hive's floor; ventilates and aids in mite monitoring/control.
- **Entrance reducer / landing board** — controls entrance size for defense, ventilation, and robbing prevention.
- **Deep boxes (brood boxes)** — the bottom box(es) of the stack, where the colony rears brood and stores some food.
- **Queen excluder (optional)** — a screen with openings sized to pass workers but not the larger queen; placed between brood boxes and honey supers to keep the queen from laying in honey-storage comb.
- **Medium/shallow supers** — boxes placed above the brood chamber (and excluder, if used) specifically for collecting surplus honey.
- **Frames and foundation** — removable wooden or plastic frames that hold a sheet of foundation, giving bees a template to draw straight comb on. Using a frame size that does not match its box (e.g., a shallow frame in a deep box) leaves an oversized gap that bees will fill with burr comb.

- **Inner cover and outer cover** — a telescoping outer cover overlaps the sides of the hive, is more weatherproof, and (with an inner cover) provides better ventilation, but it does not stack as compactly as a flat migratory cover used by commercial operations moving hives frequently.

The two most important pieces of personal safety equipment in the bee yard are a veil (to protect the face and eyes) and a smoker. Smoke masks alarm pheromone and triggers bees to gorge on honey in instinctive preparation to flee a perceived fire, which makes them calmer and less inclined to sting. A bellows smoker consists of a fire box (where fuel smolders), a bellows (which pumps air through the fire box to keep it smoldering and push smoke out), and a funnel/chimney. Good fuels include pine straw, burlap, raw cotton, and cedar or other wood chips/shavings; used motor oil, tar paper, and old magazines should never be used, as they release toxic fumes.

A hive tool (for prying apart propolis-glued boxes and frames) rounds out the essential kit; a full bee suit and gloves add further protection but are considered less critical than the veil and smoker.

B. Starting New Honey Bee Colonies

New beekeepers typically acquire bees from one of four sources, each with trade-offs:

Source	Advantage	Disadvantage
Package (bees + caged queen, no comb)	Inexpensive; widely available	Slow to establish; no comb, brood, or food stores yet
Nucleus colony ("nuc")	Comes with drawn comb, frames, brood, and a laying queen	More expensive than a package; carries some pest/disease risk from the source apiary
Full/established hive	Fully established and productive immediately	Most expensive; inherits whatever pests, diseases, or genetics the colony already has
Collected swarm	Free	Unknown genetics, temperament, and health/pest status

Local bee clubs often bulk-order packages or nucs to reduce shipping costs, and many maintain a list of swarm collectors — another good reason to join a local beekeepers association.

Installing a package follows a set sequence: (1) assemble the new hive; (2) squirt a little sugar syrup on the bees through the package screen to calm them; (3) remove the queen cage from the package; (4) remove the cork from the cage's candy end; (5) install the queen cage between the center frames with the candy end facing up, so a dead attendant bee inside cannot block the exit (workers typically take 1–2 days to chew through the candy and release her, giving the colony time to accept her scent); (6) shake or place the bees into the box; (7) fill and install a syrup feeder; (8) close the hive and reduce the entrance; and (9) return to check that the queen has been released and that new comb and eggs are appearing. Because open (uncontained) syrup feeders can incite robbing between colonies, attract unwanted pests, and spread disease, beekeepers should use enclosed feeders whenever possible.

New beekeepers should inspect the colony 3–5 days after installation and confirm three signs of success: new comb being drawn, eggs present (confirming the queen survived and is laying), and nectar or syrup

being stored. Queen failure has become an increasingly common problem with packaged bees; if the colony has not begun producing brood within about a week, the beekeeper should contact the supplier promptly for a replacement queen.

C. Hive Styles, Box Choices, and Foundation

The standard 10-frame Langstroth hive is the most common choice in the U.S., but beginners should know the main alternatives:

- **8-frame Langstroth** — narrower boxes that are about 20 percent lighter when full, easier on backs, and fully compatible in frame size with 10-frame equipment.
- **All-medium setups** — using medium boxes for both brood and honey so every frame and box is interchangeable and no box is too heavy to lift.
- **Top-bar hive** — a long, horizontal box in which bees hang comb from wooden bars without frames; low cost and no heavy lifting, but comb is fragile, honey is harvested by crushing comb, and the parts are not standardized.
- **Warré hive** — a vertical stack of small top-bar boxes, traditionally added beneath the colony (“nading”) rather than on top.
- **Flow Hive** — a Langstroth-style hive (introduced in 2015) whose plastic split-cell frames let honey drain out through a tap without removing frames; the colony still needs the same inspections, swarm management, and mite control as any other hive.
- **Long Langstroth (horizontal) hives** — standard frames in one long box, with no boxes to lift.

Because frames, boxes, and equipment from suppliers and other beekeepers all fit standard Langstroth dimensions, most mentors recommend beginners start with Langstroth equipment and experiment with other styles later.

Frames hold one of three common foundation types: beeswax foundation (often reinforced with embedded wire), plastic foundation coated with beeswax (durable and easy to install, though bees may take to it more slowly), or no foundation at all (“foundationless” frames with a starter strip), which bees build freely but which produces more drone comb and more fragile combs. Brood boxes normally hold the full complement of frames (10 in a 10-frame box) so comb is drawn straight and evenly spaced, while some beekeepers space 9 frames in honey supers once the comb is drawn, which encourages bees to build thicker combs that are easier to uncap.

D. Feeders and Feeding Equipment

When colonies need syrup (see Chapter 7, Section B, for when and what to feed), the feeder matters as much as the recipe:

Feeder type	Advantages	Drawbacks
Entrance (Boardman) feeder	Inexpensive; easy to see and refill without opening the hive	Small capacity; encourages robbing; syrup warms and spoils in the sun; bees cannot reach it in cold weather
Hive-top (box) feeder	Large capacity; refilled without disturbing the brood nest	Bulky; some designs drown bees without floats or screens

Feeder type	Advantages	Drawbacks
Inverted pail or jar over the inner cover	Simple, inexpensive, and leak-controlled; syrup sits directly above the cluster	Needs an empty box around it; can drip in temperature swings
In-hive frame (division-board) feeder	Inside the hive, so robbing risk is low	Takes the place of a frame; bees drown unless floats or ladders are added; hive must be opened to refill
Open feeding (shared containers in the yard)	Feeds many colonies at once with little labor	Strongly encourages robbing, feeds neighbors' bees and wasps, and spreads disease; not recommended

Whatever feeder is used, add floats, mesh, or ladders so bees do not drown, keep syrup fresh, and use only white granulated (cane or beet) sugar; brown sugar, molasses, and powdered sugar containing cornstarch can cause dysentery. In cold weather, fondant or sugar boards placed directly over the cluster work better than liquid syrup.

E. Budgeting for the First Year

New beekeepers routinely underestimate start-up costs. A 2025 Mississippi State University Extension estimate put the cost of establishing a single 10-frame Langstroth hive, fully equipped by the end of the first year, at roughly \$1,070, before any honey-extraction equipment:

Category	Approximate cost	Examples
Hive bodies and frames	about \$250	Two deeps and two mediums with frames, plus a simple stand
Hive accessories	about \$200	Inner and outer covers, screened bottom board, entrance reducer, feeder, mite-count board
Bees	about \$180	One nucleus colony (packages cost somewhat less)
Protective gear and tools	about \$125	Suit or jacket with veil and gloves, hive tool, smoker, brush, frame grip
Supplies and treatments	about \$150	Sugar, pollen patties, miticide, beetle traps, queen excluder, smoker fuel
Miscellaneous	about \$175	Paint, gravel, and incidentals
Extraction equipment (optional)	about \$325	Often borrowed or rented from a local club in the first years

Prices vary by supplier and change from year to year, and each additional hive costs less because tools and protective gear are already on hand. Starting with two colonies rather than one is still recommended (see Chapter 5, Section F). Joining a local beekeepers association is one of the best ways to reduce costs, since many clubs bulk-order packages and nucs and lend extractors to members.

Chapter Summary

- Bee space, applied by Langstroth to every side of a removable frame, made frame-by-frame inspection possible.
- A Langstroth hive includes a bottom board, entrance reducer, brood boxes, optional queen excluder, honey supers, frames and foundation, and inner and outer covers.
- The veil and smoker are the essential safety equipment; use safe fuels such as pine straw or burlap, never oil, tar paper, or treated materials.
- Packages are inexpensive but slow to start; nucs establish faster; established hives and swarms carry unknown risks.
- Install the queen cage candy end up, feed, and check for comb, eggs, and stored syrup within about a week.
- Langstroth equipment is standardized; alternatives include 8-frame, all-medium, top-bar, Warré, Flow, and long hives; enclosed feeders reduce robbing, and a fully equipped first hive costs roughly \$1,000 or more.

Review Questions

1. What is the purpose of a queen excluder?
2. Name two safe smoker fuels.
3. What are the four common sources of new bees?
4. Which way should the candy end of a queen cage face when it is installed, and why?
5. Which type of feeding should be avoided because it encourages robbing and spreads disease?

Test bank practice: this chapter is covered by Questions 132–158 (Section 6) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

- Sanford, M.T. & Bonney, R.E. Storey's Guide to Keeping Honey Bees, 2nd ed. Storey Publishing, 2018. Hive components, tools, and installing packages and nucs.
- Delaplane, K.S. First Lessons in Beekeeping. Dadant & Sons, 2007.
- Sammataro, D., Avitabile, A. & Caron, D.M. The Beekeeper's Handbook, 4th ed. Cornell University Press, 2011. Detailed equipment diagrams and setup guidance.
- Clemson Apiculture & Pollinator Program, beginning beekeeper resources: clemson.edu/extension/pollinators/apiculture/index.html
- South Carolina Beekeepers Association, local chapter directory (club bulk orders, mentors, and swarm-collector lists): scstatebeekeepers.com

Chapter 7: Hive Management

Chapter Objectives

After studying this chapter, you should be able to:

- Describe the colony's natural tendencies: defensiveness, foraging, comb building, robbing, and swarming.
- Explain how to maintain vigorous colonies through purposeful inspections, good siting, and seasonal feeding.
- Describe the annual population cycle of a colony in South Carolina.
- Apply sustainable practices such as the "3 feet or 3 miles" rule, requeening, combining resources, and making splits.
- Move a hive safely, including in hot weather.

A. Natural Tendencies of Honey Bees

Defensive behavior

Before stinging, colonies give escalating warning cues: nervous or erratic movements on the comb, abrupt flights toward a beekeeper's hands or face, loud buzzing, and a smell often described as bananas (isoamyl acetate, the main component of alarm pheromone). Recognizing these cues early lets a beekeeper close up calmly rather than provoke further defensiveness. Things to avoid bringing into the bee yard include dark clothing, perfumes or bananas, dark-colored pets, and open-toed shoes, all of which can trigger defensive behavior or invite stings.

Foraging

Honey bees are dietary generalists, visiting a wide range of blooming plants, and they will fly well beyond the often-cited "1-2 mile" range when local forage is poor, sometimes several miles. They do not forage at night and generally stop foraging when air temperature drops below about 55°F. Larger colonies forage more efficiently, finding and exploiting resources faster than small colonies — one reason colony population is the single biggest factor a beekeeper can influence to increase honey yield. Beekeepers can gauge foraging activity without opening a hive by watching entrance traffic and guard bees, counting returning "landing" bees, looking for pollen loads on foragers' hind legs, and hefting (tipping or weighing) the hive to judge stored food.

Comb building

Bees build new comb primarily when nectar/food is available, since wax production is energetically expensive — it takes roughly 8 pounds of honey to produce 1 pound of beeswax (published estimates range from about 6 to 8 pounds). Feeding light (1:1) sugar syrup mimics a nectar flow and stimulates comb production, which is useful when hiving a new package or encouraging bees to draw new frames. Comb built in gaps larger than bee space, not confined to a frame, is called burr or bridge comb.

Robbing

Robbing occurs when a strong colony (or wasps) raids a weaker colony's stores, often during a nectar dearth, and can appear as a frenzy of bees trying to force entry anywhere they can. Beekeepers reduce

robbing risk by narrowing entrances on weak colonies, avoiding open feeders, not opening hives unnecessarily during a dearth, and combining weak colonies rather than letting them struggle alone.

Swarming

Swarming (detailed in Chapter 2) is the colony's normal reproductive process, but a beekeeper managing for honey production or pollination often wants to prevent or delay it. Effective strategies include adding supers or empty comb early to relieve congestion, keeping colonies headed by young, vigorously pheromone-producing queens (requeening every 1–2 years), destroying or removing swarm cells found during inspection, and proactively splitting a colony that is building swarm cells.

B. Maintaining Vigorous, Healthy Colonies

A first-year beekeeper's central job is not honey production but learning to “read” colonies: assessing condition, recognizing needs, and intervening appropriately. Every hive inspection should have a specific purpose (e.g., confirming the queen is laying, checking food stores) so that the hive is opened only as often and as briefly as necessary — opening a colony is stressful for the bees, and smoke should be used to reduce that stress.

Apiary site selection matters (see Chapter 5): good locations get morning sun and stay sunny and dry for most of the day (light afternoon shade can help in summer heat), are near a reliable water source, avoid areas where pesticides are regularly applied or livestock and foot traffic are heavy, and provide vehicle access for equipment.

South Carolina colonies face their greatest starvation risk in January through March, when stores from the previous fall are dwindling and little new nectar is available yet. Feeding schedules generally follow the season:

Feed	Purpose
1:1 simple syrup (spring/summer)	Stimulates comb production and brood rearing
2:1 heavy syrup or candy/fondant (fall/winter)	Prevents winter starvation
Pollen patties	Supplements protein when natural pollen is scarce

Drone production typically begins around February in South Carolina, ahead of the spring swarm season when mated queens will be needed, and colonies typically oust remaining drones in fall (October–November) once mating season ends and resources tighten.

C. Seasonal Cycles

A honey bee colony is perennial, adjusting its structure through a predictable annual rhythm: spring build-up (increasing workforce and drone production ahead of the nectar flow) → the spring nectar flow and peak swarming season (roughly March–May in SC) → summer dearth (reduced forage, slower growth) → a secondary fall nectar flow as meadowland wildflowers bloom → fall contraction (reduced brood rearing, drones ousted) → winter clustering (survival on stored food) → back to spring build-up. In South Carolina, a colony's worker population typically climbs from about February through May, levels off from June through

October, and declines from November through January. Because trees, shrubs, and woody vines dominate the spring bloom while meadowland wildflowers dominate the fall bloom, timing supering and feeding to these two general nectar flows is central to sound management.

D. Sustainable Practices

Colonies can in principle persist indefinitely, but limited forage, requeening failure, weather, beekeeper error, and pests/diseases can all end a colony. Good sustainable practice includes the “3 feet or 3 miles” rule when relocating a hive: a move of less than 3 feet lets foragers reorient gradually, while a move of 3 or more miles is far enough that foragers reorient to the new location entirely; anything in between (such as moving a hive 100 yards within the same apiary) risks stranding older foragers, who will return to the original spot, become lost, or drift into a neighboring colony.

When requeening a colony, a queenless period is usually needed before the new queen is introduced, because the old queen's pheromones must dissipate from the colony before workers will accept a replacement rather than “balling” (mobbing) her. Combining resources between weak colonies — for example, giving a queenless, broodless colony a frame of eggs so workers can raise a new queen, or giving a food-short colony a frame of honey/pollen or supplemental feed — is a routine way to rescue struggling colonies rather than losing them outright.

Making splits (dividing one colony into two) is the most cost-effective way to grow a beekeeping operation. Using “Bee Math,” a simple “walk-away split” (giving a queenless half a frame of eggs and letting the bees raise their own queen, with no additional intervention) takes a minimum of about 42 days before new workers emerge: roughly 16 days to raise a new queen from an egg, about 5–7 days more before she is mated and laying, and another 21 days for the first new workers to develop from her eggs. (Because bees often start a queen from a young larva rather than an egg, she can emerge a few days sooner, but 42 days is the standard “Bee Math” planning figure.)

E. Moving Hives

Sooner or later every beekeeper moves a hive, whether across the yard, to a new apiary, or into a pollination contract. Prepare the colony the day before: strap the hive together with a ratchet strap so boxes and bottom board cannot shift, and make sure no gaps would let bees escape. Close the entrance at dusk or after dark, when the foragers are home, using screen wire or a screened entrance block rather than solid wood so the colony can breathe. In the Southeast, overheating is the main danger: a closed, crowded hive can die within hours on a hot day, so move at night or in the cool early morning, use a screened top or bottom for ventilation when possible, and never leave a closed hive sitting in the sun. Load hives with frames running front to back in the vehicle so combs do not swing, and open the entrance as soon as the hive is in its new location.

The “3 feet or 3 miles” rule (Section D) governs the distance. When a colony must be moved a short distance within the same property, beekeepers use one of three approaches: move the colony more than 3 miles away for about three weeks and then bring it back to the new spot; move it no more than about 3 feet every day or two until it reaches the new location; or move it directly and lean a leafy branch or other obstruction against the entrance so the foragers are forced to stop and reorient, accepting some loss of older foragers that return to the old site. (Queen management, splits, swarm capture, and combining colonies are covered in Chapter 9.)

Chapter Summary

- Colonies warn before stinging, forage well beyond 1–2 miles when needed, stop flying below about 55°F, and build comb mainly during nectar flows (6–8 pounds of honey per pound of wax).
- Robbing occurs during dearths and is reduced by small entrances, enclosed feeders, and few hive openings; swarming is reduced by giving room, young queens, and splitting.
- Every inspection should have a purpose; feed 1:1 syrup to stimulate, 2:1 syrup or fondant to prevent starvation, and pollen patties when pollen is scarce.
- In South Carolina, starvation risk peaks January–March, populations build February–May, and drones are expelled in fall.
- Move hives less than 3 feet or more than 3 miles; a walk-away split takes about 42 days to produce new workers.
- Move colonies at night with screened ventilation, because closed hives can overheat quickly in Southeastern heat.

Review Questions

1. About how many pounds of honey do bees consume to produce one pound of beeswax?
2. Below about what temperature do honey bees generally stop foraging?
3. What is the “3 feet or 3 miles” rule?
4. Which months carry the greatest starvation risk for colonies in South Carolina?
5. About how many days does a walk-away split take before its first new workers emerge?

Test bank practice: this chapter is covered by Questions 159–179 (Section 7) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

- Sanford, M.T. & Bonney, R.E. Storey's Guide to Keeping Honey Bees, 2nd ed. Storey Publishing, 2018.
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- Caron, D.M. with Connor, L.J. Honey Bee Biology and Beekeeping, 3rd ed. Wicwas Press, 2022.
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- South Carolina Beekeepers Association, local chapter mentorship and field days: scstatebeekeepers.com

Chapter 8: Seasonal Management

Chapter Objectives

After studying this chapter, you should be able to:

- Explain why beekeeping is both seasonal and local.
- List the five things every colony needs and how the beekeeper's role in each changes through the year.
- Describe spring, summer, fall, and winter priorities in the Southeast.
- Conduct a methodical inspection, read a frame, and evaluate a brood pattern.
- Distinguish robbing from orientation flights and the three kinds of queen cells.
- Prepare a colony for winter using a checklist.

A. Two Guiding Principles

Two ideas anchor all seasonal management decisions. First, beekeeping is seasonal — what a colony needs, and what a beekeeper should be doing about it, changes continuously across the year, so there is no single “correct” hive configuration that holds true in every month. Second, all beekeeping is local — the same calendar date can call for very different management in the South Carolina Piedmont than in the Coastal Plain, or in South Carolina versus a northern state, because bloom timing, dearth periods, and winter severity all vary regionally. Before opening a hive, a beekeeper should always ask, “Why am I going into this hive today?” — every inspection should have a specific purpose rather than being opened out of habit.

The underlying philosophy of good seasonal management is often summarized as “help the bees be bees”: management is largely about providing the support that allows a colony to succeed at its own normal, instinctive goals (rearing brood, storing food, maintaining a defensible cavity) rather than working against the colony's natural tendencies.

B. The Five Things Every Colony Needs

Regardless of season, a colony's survival depends on a beekeeper helping to secure five essentials. Seasonal management is best understood as how the beekeeper's role in meeting each of these five needs shifts throughout the year:

- **1. A dry cavity of the correct volume** — enough space to prevent overcrowding and swarming, but not so much that the colony cannot defend or heat/cool it; good drainage and ventilation to prevent moisture buildup, which is often more dangerous to overwintering bees than cold itself.
- **2. Food and water** — adequate honey/pollen stores (or supplemental feeding) matched to the season, plus access to a reliable water source.
- **3. The correct population** — enough bees to perform all colony tasks and defend the hive, without so much crowding that it triggers swarming.
- **4. Assistance with pests and parasites** — monitoring and, when needed, treating Varroa mites, small hive beetle, and other pests at the levels appropriate to the season (see Chapter 11).
- **5. A safe environment** — protection from extreme weather, pesticide exposure, predators, and human or livestock disturbance.

C. The Seasonal Wheel: Applying the Five Needs Across the Year

Spring

Spring is a season of rapid growth: the queen's laying rate accelerates, the population builds quickly to take advantage of the spring nectar flow, and swarming risk peaks as the colony becomes congested. Beekeeper priorities include adding supers or drawn comb ahead of need (addressing cavity volume before it becomes limiting), confirming the queen survived winter and is laying well, beginning spring Varroa monitoring, and watching closely for swarm cells and congestion.

Summer

Early summer often continues strong nectar flow and population growth, but many regions (including much of South Carolina) move into a summer dearth by mid-to-late summer as blooming slows in the heat. Beekeeper priorities shift toward monitoring food stores so a dearth does not quietly starve a colony, watching for and preventing robbing between colonies, continuing mite monitoring (populations typically build through summer), and ensuring adequate ventilation and shade as temperatures climb.

Fall

Fall brings a secondary nectar flow as meadowland wildflowers bloom, but it is above all the critical window to prepare a colony for winter. Priorities include a thorough fall mite treatment (mite loads often peak in late summer/early fall, and the bees raised in fall are the “winter bees” that must survive to spring, so treating before this generation is reared is important), confirming adequate honey/pollen stores for winter, consolidating or combining weak colonies rather than letting them struggle alone, reducing entrances as robbing risk rises with the dearth, and allowing the colony to naturally oust remaining drones as it contracts for winter.

Winter

Winter management is mostly about restraint: minimizing hive openings (which release the cluster's hard-won heat) while still monitoring from outside for warning signs — listening or feeling for cluster activity, checking that snow/ice is not blocking the entrance, and watching stored-food weight. South Carolina colonies face their greatest starvation risk in January through March, as fall stores dwindle before significant new nectar becomes available, so emergency feeding (dry sugar, fondant, or candy boards, since liquid syrup is poorly taken up in cold weather) may be needed late in winter even though the colony appears otherwise healthy.

A sample early-year (January) action list illustrates how specific seasonal management can get: heft hives to estimate remaining stores; add emergency dry feed if stores feel light; clear entrances of dead bees and debris after cold snaps; begin planning spring equipment needs (new boxes, frames, foundation) before the spring rush; order replacement packages, nucs, or queens early, since suppliers sell out; and review the previous year's inspection notes to plan requeening or splits for the coming season. Local SC county beekeeper associations frequently publish their own month-by-month calendars tailored to their specific region's bloom and dearth timing — a valuable supplement to this general framework.

D. Working the Hive Through the Seasons

Every inspection follows a consistent sequence, regardless of season: approach and observe first (entrance traffic, landing board activity, general behavior), then decide whether and how deeply to open the hive based on that purpose. The best time to open a hive is generally between about 10 a.m. and 2 p.m., when

most foragers are out and fewer bees are home to encounter; windy, rainy, or cold days (below about 55°F) should be avoided, since they strand foragers at home and stress the colony further by releasing cluster warmth. A beekeeper should always wear at least a veil, stand to the side or rear of the entrance rather than in its flight path, and avoid shaking or jarring the hive.

Once inside, frames should always be worked in order and returned to their original position and orientation — numbering or dating frames helps track this over successive inspections. The first frame removed should typically be an outer frame next to the hive wall, creating working space and reducing the chance of accidentally rolling (crushing) the queen as subsequent frames are moved.

What a beekeeper expects to see depends heavily on the season: spring inspections typically show bees drawing new wax, raising expanding brood, and storing fresh nectar and pollen, while fall and winter inspections should instead confirm adequate brood (tapering as the season turns) and ample food stores. A normal brood pattern is dense and fairly solid — mostly capped brood with few empty cells scattered through the pattern — while a spotty, inconsistent pattern (many empty cells interspersed with capped cells) can signal a failing queen, disease, or genetic issues and warrants closer follow-up. Beekeepers should also check that the colony is not overcrowded (a rough benchmark is bees covering more than about 75–80% of available frames), look for queen cells as a sign of swarm preparation or supersedure, and note any signs of disease, pests, or deformed bees for follow-up (see Chapter 11).

Reading a frame and the brood nest

A colony organizes its nest in a predictable pattern, and recognizing it is one of the first practical skills a new beekeeper is tested on. On a frame from the center of the brood nest, capped worker brood occupies the center of the comb, with a ring of younger brood (eggs and larvae) around it, a band of pollen (bee bread) outside the brood, and honey stored in the upper corners and along the top bar; uncapped nectar is often stored around the edges and lower corners during a flow. Across the whole box the same arrangement repeats in three dimensions: the brood nest sits roughly as a ball in the middle frames, flanked by frames of pollen and then honey toward the outer walls, with more honey stored above.

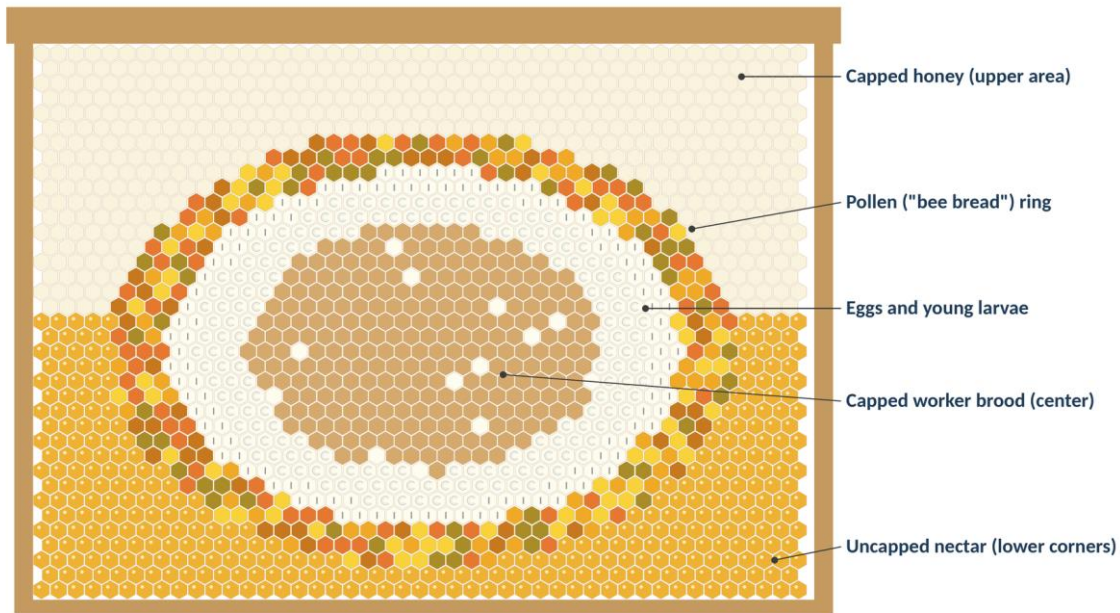


Figure 8.1. Schematic layout of a brood frame from the center of the nest: capped brood in the middle, younger brood around it, a ring of pollen, and honey above and at the sides. Original illustration for this guide.

What you see	How to recognize it
Eggs	Tiny, white, rice-shaped, about 1/16 inch long, one per cell at the bottom; stand upright on day 1 and lean over by day 3. Easiest to see with the sun over your shoulder.
Open larvae	Pearly white, C-shaped grubs lying in a pool of brood food; grow quickly to fill the cell.
Capped worker brood	Flat to slightly domed, tan or light brown porous cappings in a solid pattern.
Capped drone brood	Larger, bullet-shaped, strongly domed cappings, usually along the bottom edges of frames.
Pollen (bee bread)	Packed, matte cells of many colors (yellow, orange, red, gray), often in a band around the brood.
Nectar	Glistening liquid in uncapped cells; it spills if the frame is turned flat.
Capped honey	Smooth, white or off-white wax cappings, typically in the upper part of the frame.
Propolis	Sticky reddish-brown to dark resin sealing cracks, frame rests, and the inner cover.

Reasons bees raise queen cells

- **Swarming** — the colony is reproducing itself and preparing to split; swarm cells are most often found hanging at the bottom edges of frames and are usually well developed.
- **Supersedure** — workers are replacing a failing (but still present) queen; supersedure cells are typically found in the middle of the comb.

- **Emergency** — the queen has died suddenly and must be replaced; emergency cells are also usually found mid-frame, but are often shorter and built from existing worker cells/older comb rather than from a purpose-built queen cup.

A completed, methodical inspection should always be documented — whether on a simple notecard or a standardized hive inspection sheet recording weather, population, brood pattern, stores, and any queen cells or health concerns found. Written records build a season-over-season record that makes patterns (a consistently weak colony, a queen that needs replacing, a recurring pest problem) far easier to spot than relying on memory alone.

Robbing versus orientation flights: a common beginner mix-up

New beekeepers frequently mistake robbing for the much more benign orientation flights of young bees, so distinguishing the two is an important practical skill. Orientation flights happen on calm, sunny afternoons as young bees hover in loose figure-eight patterns facing the hive, memorizing its location before they begin foraging; this looks busy and can seem alarming but involves no fighting, and the bees are calm. Robbing, by contrast, shows fighting bees tumbling and grappling at the landing board, an erratic, frantic flight pattern all around the hive and entrance (rather than calm hovering), and often wax debris or dead bees accumulating at the entrance as the colony's own defenders battle intruders. A robbing event calls for immediate entrance reduction (or full closure) on the colony under attack, while an orientation flight calls for no action at all.

E. Preparing Colonies for Winter: A Checklist

Winter preparation in the Southeast is spread over late summer and fall, and the details appear throughout this guide. Pulled together, a typical checklist is:

- **Treat for Varroa early** — complete mite treatment by late summer or early fall so the long-lived winter bees are raised mite-free (see Chapter 11, Section D).
- **Confirm a laying queen** — check for eggs and a solid brood pattern in early fall; requeen or combine any colony with a failing queen while there is still time (see Chapter 9).
- **Check food stores** — heft the hive and look at the frames. University of Georgia guidance for the Southeast is about 1.5 frames of capped honey for every frame of bees; feed 2:1 syrup in early fall to any colony that falls short, while it is still warm enough for bees to take it.
- **Combine weak colonies** — a small colony is unlikely to survive winter; combine it with a stronger one using the newspaper method (see Chapter 9, Section G).
- **Reduce the space** — remove empty supers and the queen excluder so the cluster can move up freely through its stores.
- **Reduce entrances and add mouse guards** — before cold weather, to block mice and robbing.
- **Manage moisture** — tilt the hive slightly forward so water drains out, and provide some upper ventilation; condensation dripping on the cluster is more dangerous than cold.
- **Block the wind** — a fence, hedge, or building to the north or northwest helps.
- **Keep records and leave them alone** — note each colony's condition, then limit openings to brief checks on mild days (above about 50–55°F), and add emergency fondant or dry sugar in late winter if hives feel light.

Chapter Summary

- Management changes with the season and the region; always know why you are opening a hive.

- Every colony needs a dry cavity of the right size, food and water, the correct population, help with pests, and a safe environment.
- Spring brings build-up and swarming; summer brings dearth and robbing risk; fall is the time to treat mites and secure stores; winter calls for restraint and emergency feeding if needed.
- Inspect between about 10 a.m. and 2 p.m. in good weather, work frames in order, and record what you find.
- On a brood frame, capped brood sits in the center, surrounded by younger brood, then pollen, with honey above; a spotty pattern warrants follow-up.
- Swarm cells hang from frame bottoms; supersedure and emergency cells are mid-frame; orientation flights are calm, while robbing is frantic with fighting.
- Prepare for winter by treating mites early, confirming the queen, securing about 1.5 frames of capped honey per frame of bees, combining weak colonies, and controlling moisture.

Review Questions

1. Name the five things every colony needs.
2. What is the best time of day to inspect a hive?
3. Where on the comb are swarm cells usually found?
4. On a frame from the center of the brood nest, where is pollen usually stored?
5. What Southeastern guideline does UGA give for the amount of capped honey a colony needs for winter?

Test bank practice: this chapter is covered by Questions 180–199 (Section 8) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

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- Honey Bee Health Coalition, Tools for Varroa Management (timing mite control before winter bees are reared): honeybeehealthcoalition.org/varroa
- Storch, H. At the Hive Entrance: Observation Handbook. European Apicultural Editions, 1985. Reading robbing, orientation flights, and colony condition from outside.
- Local South Carolina beekeeper association calendars (e.g., Mid-State and Chester County), via the SCBA chapter directory: scstatebeekeepers.com

Chapter 9: Queens and Colony Increase

Chapter Objectives

After studying this chapter, you should be able to:

- Describe the queen’s development, mating, egg laying, and life span.
- Find a queen and mark her using the international color code.
- Recognize a queenless colony, laying workers, a drone-laying queen, and a failing queen.
- Requeen a colony and introduce a caged queen successfully.
- Capture a swarm and set out an effective bait hive.
- Make splits, combine colonies with the newspaper method, and outline how queens are reared.

A. The Queen's Role and Life

A colony’s queen is its only fully developed female and its mother: every worker and drone in a healthy colony is her offspring. A virgin queen emerges about 16 days after the egg is laid (see Chapter 2, Section B), spends several days maturing, and then makes one or more mating flights, usually within her first one to two weeks of adult life, to a drone congregation area where she mates in the air with roughly a dozen or more drones. She stores the sperm, several million cells, in an organ called the spermatheca and draws on it for the rest of her life, fertilizing eggs to produce workers and laying unfertilized eggs to produce drones. A queen begins laying a few days after her final mating flight and does not mate again.

At the peak of spring build-up a productive queen can lay 1,500 or more eggs a day. Queens can live three to five years, but egg-laying and pheromone output usually decline after the first year or two, which is why many beekeepers requeen every one to two years (see Chapter 7, Section A). The queen does not “rule” the colony; her pheromones (chiefly queen mandibular pheromone) signal her presence and help regulate worker behavior, and the workers decide when to replace her or swarm.

B. Finding and Marking the Queen

Finding the queen gets easier with practice. Use light smoke so bees do not run, work the brood frames first, and look on frames with eggs and young larvae. The queen is longer than workers, with a long, tapered abdomen that extends well past her wings, longer legs, and a shiny, less hairy thorax; workers often face her in a ring (her “retinue”). Scan the frame quickly as it is lifted, check the side facing away from you first, and look at the bottom bars and box walls. Confirming eggs is often enough: eggs standing upright in cells mean a laying queen was present within the last three days.

Marking a queen with a dot of paint on her thorax makes her easier to find and shows her age. Beekeepers use an international color code based on the last digit of the year she was raised:

Year ends in	Color	Recent and upcoming years
1 or 6	White	2021, 2026
2 or 7	Yellow	2022, 2027
3 or 8	Red	2023, 2028

Year ends in	Color	Recent and upcoming years
4 or 9	Green	2024, 2029
5 or 0	Blue	2025, 2030

A common mnemonic is “**Will You Raise Good Bees?**” (white, yellow, red, green, blue). Marking is done with a queen-marking pen or paint and a marking cage or tube, avoiding the wings, legs, and head. Some beekeepers also clip one wing so a swarming queen cannot fly far, but clipping does not stop the colony from preparing to swarm.

C. Recognizing Queen Problems

Queen problems are among the most common reasons a colony fails, and catching them early is critical. The main situations are:

Situation	What the beekeeper sees	Typical response
Queenless (recently)	No eggs or young larvae; emergency queen cells may be present; bees may be noisy (“roaring”) and agitated	Let the bees finish their queen cells, give a frame of eggs from another colony, or introduce a mated queen
Laying workers	Several eggs per cell, often stuck to the cell walls rather than centered at the bottom; scattered drone brood in worker cells (raised “bullet” cappings); no queen	Combine with a queenright colony, or shake the bees out well away from the hive; or add a frame of open brood weekly for several weeks before requeening
Drone-laying queen	Single eggs centered in cells, but the brood is mostly drones in worker-size cells; a queen is present	The queen is poorly mated, sperm-depleted, or failing; replace her
Failing queen	Spotty, scattered brood pattern; small brood area for the season; supersedure cells	Requeen, after ruling out disease, mites, or poor nutrition as the cause

Remember that a spotty brood pattern can also be caused by disease, heavy Varroa infestation, hygienic removal of diseased brood, or inbreeding, so look at the larvae closely before blaming the queen (see Chapter 11).

D. Requeening and Queen Introduction

Requeening replaces an old, failing, or poorly tempered queen with a new one, most often a mated queen bought from a reputable breeder. The usual sequence is: find and remove the old queen; wait about 24 hours so the colony recognizes that it is queenless; then introduce the new queen in her cage. Most queen cages are sealed with a candy plug: remove the cork over the candy end, wedge the cage between two brood frames with the screen exposed so workers can feed and smell her, and let the workers eat through the candy over several days. Check in 3–5 days that she has been released and, a week or so later, that she is laying, but avoid disturbing the colony more than necessary right after release, which can cause the workers to ball (attack) her.

Introduction succeeds most often when the colony is queenless but not long queenless, has no queen cells, and is not being robbed, and when a nectar flow or light feeding is under way. A push-in cage pressed over emerging brood, or introducing the queen into a small nucleus colony first, gives even higher acceptance. Mean or unusually defensive colonies are commonly requeened with gentler stock; this is also the standard remedy for suspected Africanized temperament (see Chapter 11, Section B). Colonies with laying workers are the hardest to requeen and are usually combined instead.

E. Swarm Prevention, Capture, and Bait Hives

Swarm prevention (relieving congestion, keeping young queens, removing swarm cells, and splitting) is covered in Chapter 7, Section A. When a swarm does issue, it usually settles in a cluster on a branch or post within a few hundred feet of the hive while scout bees search for a new home, and it can stay there from a few hours to a couple of days. Swarming bees are full of honey and generally gentle, which makes this an easy and rewarding job for a new beekeeper.

To capture a swarm, hold a box (a nuc box, an empty hive body, or even a cardboard box) beneath the cluster and give the branch a sharp shake so the bees drop in; cut the branch if needed. If the queen is in the box, bees on the outside will fan their Nasonov glands at the entrance and march in; if they fly back to the branch, the queen was missed. Leave the box nearby until dusk so the stragglers can join, then move the bees to their new hive. Giving the swarm a frame of open brood helps anchor it and discourages absconding, and feeding 1:1 syrup helps it draw comb quickly. Because swarm origins and health are unknown, treat a new swarm as a separate colony, check it for disease, and monitor its mites. Many local associations keep a swarm-call list, and beekeepers should never attempt to remove colonies living inside walls or structures (cutouts) without experience.

Bait hives (swarm traps) attract swarms looking for a home. Research by Thomas Seeley at Cornell found that scouts prefer a cavity of about 40 liters (roughly the volume of a deep Langstroth box), an entrance of about 12.5 square centimeters (about 2 square inches) near the bottom, a location well off the ground (around 15 feet was preferred over 3 feet), and the smell of a former bee home. An old, dark brood comb inside, plus a drop of lemongrass oil or a commercial swarm lure (which mimics Nasonov pheromone), makes a bait hive much more attractive. Set bait hives out before the spring swarm season and check them weekly.

F. Splits and Making Increase

Splitting a strong colony is the most cost-effective way to grow an apiary and a highly effective form of swarm control. Splits are made in spring or early summer when the colony is strong, drones are flying, and a nectar flow is on or the beekeeper is ready to feed. Common methods include:

- **Walk-away split** — divide the frames of brood, bees, and food between two boxes, leaving the queen in one and eggs in the other; the queenless half raises its own queen (see the 42-day “Bee Math” in Chapter 7, Section D).
- **Even split with a purchased queen** — divide the colony evenly and give the queenless half a mated queen, which saves several weeks of brood rearing.
- **Nuc split** — remove two to four frames of brood, bees, and food (with the old queen or a new one) into a nucleus box, often to relieve congestion before swarm season.

- **Queen-cell split** — when a colony has started swarm cells, divide it so each new unit receives frames with good queen cells.

Each split should have enough bees to cover and keep its brood warm, food stores or a feeder, and a reduced entrance to guard against robbing. Splitting usually reduces the honey crop from the parent colony that season, so some beekeepers prefer to split after the main harvest.

G. Combining Colonies

Combining two colonies into one is the standard way to rescue a weak, queenless, or laying-worker colony, or to go into winter with strong units. The usual technique is the **newspaper method**: remove the poorer queen (if there is one), place a single sheet of newspaper over the top box of the stronger, queenright colony, cut a few small slits in it, and set the weaker colony's box on top. Over one to three days the bees chew through the paper, become accustomed to each other's scent, and merge peacefully. Afterward, rearrange the frames so the brood is together and remove the empty boxes. Never combine a colony showing signs of disease, since that simply spreads it, and remember that combining two weak colonies rarely makes one strong colony if the underlying problem is mites, disease, or starvation.

H. Queen Rearing Basics

Beekeepers can raise their own queens from their best colonies, selecting for gentleness, productivity, overwintering ability, and hygienic behavior or mite resistance. Commercial queen producers typically **graft**, transferring larvae less than about 24 hours old into artificial queen cups placed in a strong queenless "cell builder" colony; the finished queen cells are placed into small mating nucs, where the virgin queens emerge and fly out to mate. Simpler methods that do not require grafting include the Miller method (letting bees build queen cells on a ragged-edged piece of new comb), the Hopkins method, and cell punch or plastic cell-cup systems. For most beginners, letting a strong split raise its own queen from eggs is queen rearing enough, but understanding the process explains why young larvae, a strong population, and plenty of nurse bees and food all matter when a colony replaces its queen.

Chapter Summary

- A queen mates in flight with many drones at a drone congregation area in her first weeks of life, stores the sperm in her spermatheca, and never mates again.
- Productive queens lay 1,500 or more eggs a day at peak; most beekeepers requeen every one to two years.
- Queens are marked by year: white (1/6), yellow (2/7), red (3/8), green (4/9), blue (5/0); "Will You Raise Good Bees?"
- Laying workers lay several eggs per cell and produce only drones; a drone-laying queen lays single eggs that become drones; both require action.
- Remove the old queen, wait about 24 hours, introduce the new queen in a candy-plugged cage, and check release in 3–5 days.
- Capture swarms by shaking them into a box; bait hives of about 40 liters with a small, low entrance, set high and scented with old comb, attract swarms.
- Splits grow an apiary and control swarming; combine weak colonies with the newspaper method, never combining diseased colonies.

Review Questions

1. In what organ does a queen store sperm?
2. What color is used to mark a queen raised in 2026?
3. How long should a beekeeper usually wait after removing an old queen before introducing a new one?
4. What is the purpose of the sheet of newspaper when combining colonies?
5. What cavity volume do swarm scouts prefer, according to Seeley's research?

Test bank practice: this chapter is covered by Questions 200–222 (Section 9) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

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- Honey Bee Health Coalition, Best Management Practices for Hive Health (queen health and colony assessment): honeybeehealthcoalition.org

Chapter 10: Forage, Nutrition, and Pollinator Protection

Chapter Objectives

After studying this chapter, you should be able to:

- Name the materials bees collect from plants and explain how nutrition affects colony health.
- Identify major nectar and pollen plants of the Southeast by season.
- Recognize plants that can harm bees or honey and how to reduce the risk.
- Describe ways to improve forage around an apiary.
- Explain how pesticides harm bees, recognize and report a pesticide kill, and take steps to prevent one.
- Explain how honey bees pollinate crops.

A. What Colonies Need from Plants

A colony's food comes almost entirely from plants: nectar for carbohydrates (energy), pollen for protein, fats, vitamins, and minerals, plant resins for propolis, and, in some places, honeydew (the sugary excretion of aphids and scale insects). A large colony may collect roughly 40 to 100 pounds of pollen a year, nearly all of it consumed as bee bread by nurse bees, who convert it into brood food. Pollen quality varies widely between plant species, so a colony with access to many different pollen sources over the season is better nourished than one surrounded by a single crop.

Good nutrition is not just about avoiding starvation. Well-fed bees have larger fat bodies, rear more brood, live longer, and tolerate viruses, Nosema, and pesticide exposure better. This matters most in late summer and fall, when the colony rears the long-lived winter bees that must carry it to spring (see Chapter 8). When natural pollen is scarce, beekeepers can feed pollen substitutes or supplements (patties), and when nectar is scarce, sugar syrup (see Chapter 7, Section B, and Chapter 6, Section D), but no substitute fully matches the value of diverse natural forage.

B. Major Bee Plants of the Southeast

Bloom times shift by several weeks between the coast and the mountains, and from year to year with weather, so every beekeeper should keep notes on what is blooming near their own apiary. The calendar below is approximate for the South Carolina Midlands and Piedmont:

Season	Important plants	Notes
Late winter (Jan–Mar)	Red maple, henbit and purple dead-nettle, willows, dandelion, early fruit trees (plum, peach, pear)	Mostly pollen and build-up nectar; red maple pollen often triggers spring brood rearing
Spring (Mar–May)	Fruit trees, redbud, wild cherry, blueberry, clovers, hollies (including yaupon and, on the coast, gallberry), tulip poplar, black locust, blackberry, tupelo (river swamps), Chinese privet	The main honey flow for most of the state; tulip poplar and blackberry are major sources
Summer (Jun–Aug)	Sourwood (upper Piedmont and mountains), sumac, cotton, soybeans, vitex, crape myrtle (pollen), sweet pepperbush, buttonbush	Many Midlands and coastal areas enter a summer dearth by early summer

Season	Important plants	Notes
Fall (Sep–Nov)	Goldenrod, asters, Spanish needles (<i>Bidens</i>), smartweeds	Secondary flow; goldenrod honey has a strong odor while it ripens

Several Southeastern honey plants produce distinctive varietal honeys valued by consumers, including tupelo, sourwood, and gallberry (see Chapter 12, Section A).

C. Plants That Can Harm Bees or Honey

A small number of plants are harmful, though they are rarely abundant enough to be a serious threat. In the Southeast the best known are **Carolina (yellow) jessamine**, whose nectar and pollen are toxic to bees and can kill brood in years when it is abundant in early spring; and **summer titi** (*Cyrilla racemiflora*), whose nectar or pollen causes “purple brood,” in which larvae and pupae turn blue-purple and die (spring titi, a different plant, is a good honey plant). **Mountain laurel, rhododendrons, and some azaleas** produce grayanotoxins that can carry into honey; such honey (“mad honey”) is rare in the U.S. but can make people ill. Where these plants grow in large stands, beekeepers can move colonies during the bloom or feed light syrup to dilute the effect.

D. Improving Forage

Beekeepers cannot control the landscape for miles around an apiary, but they can add to it. Planting a succession of native trees, shrubs, and wildflowers so something is blooming from late winter to frost helps both honey bees and native bees, especially plants that bloom during the summer dearth. Good choices for the Southeast include red maple, redbud, tulip poplar, hollies, sourwood, vitex, clovers, partridge pea, mountain mint, and goldenrod and asters. Leaving clover and henbit in lawns, delaying mowing of roadsides and field edges until after bloom, and avoiding nursery plants treated with systemic insecticides all help.

E. Pesticides and Bees

Pesticides are among the most visible hazards to honey bees. Bees can be killed outright by direct contact with sprays or dusts, or harmed more slowly by residues carried home in nectar, pollen, and water, which can contaminate stored food and comb. Systemic insecticides such as the neonicotinoids are taken up throughout the plant, including pollen and nectar. Insecticides pose the greatest risk, but some fungicides and fungicide–insecticide combinations can also harm bees, and the miticides beekeepers themselves use are pesticides too, so they must always be applied exactly as the label directs.

Recognizing a pesticide kill. Signs of acute poisoning include large numbers of dead or dying bees in front of the hive (often within a day of an application), bees trembling, crawling, spinning, or unable to fly, bees with tongues extended, a sudden loss of the foraging force, and sometimes dead brood. Several colonies in the same apiary are usually affected at once. These signs can resemble some viral diseases, so context matters.

What to do. Record the date, time, and what you see; photograph the dead bees and affected hives; collect a sample of at least a cup of freshly dead bees in a clean container and freeze it; note any recent spraying nearby; and report it promptly to the state pesticide regulatory agency, which in South Carolina is the Clemson Department of Pesticide Regulation (see Chapter 11, Section E). Investigations are much more likely to succeed if they begin quickly.

Prevention. Most pesticide kills are preventable with communication. Introduce yourself to neighboring farmers, landscapers, and mosquito-control programs and let them know where your hives are; many counties and mosquito-control districts will notify registered beekeepers before spraying. Free online registries such as FieldWatch's BeeCheck, available in many states, let beekeepers map their hives for applicators. Pesticide labels are the law: since 2013 the U.S. EPA has required a "Protection of Pollinators" advisory box on the labels of neonicotinoid products used outdoors, and labels with bee-hazard statements prohibit application while bees are actively foraging on blooming plants. When a spray is announced, colonies can be moved, or covered with wet burlap for the morning of the application, and applications made late in the evening, when bees are not flying, are far safer.

F. How Honey Bees Pollinate

Pollination is the transfer of pollen from the male parts of a flower (anthers) to the female part (stigma), and many crops set more and better fruit when insects carry pollen between flowers or plants. Honey bees are effective pollinators because their branched body hairs pick up pollen grains, because a forager tends to stay with one kind of flower on a given trip ("flower fidelity"), and because beekeepers can move thousands of foragers to a crop exactly when it blooms. Native bees, including bumble bees and blueberry bees, are often more efficient per visit on some crops, which is why protecting their habitat matters to growers too. Contract pollination is covered in Chapter 12, Section E.

Chapter Summary

- Bees collect nectar (energy), pollen (protein, fats, vitamins, minerals), resin (propolis), and water; diverse pollen sources make for better-nourished, more resilient colonies.
- In the Southeast, red maple and henbit start the year, tulip poplar, blackberry, and tupelo anchor the spring flow, sourwood and summer plants follow, and goldenrod and asters dominate fall.
- Carolina jessamine and summer titi can harm brood, and mountain laurel and rhododendron can produce toxic honey; move colonies or feed syrup during heavy bloom.
- Plant a succession of native bloom, especially for the summer dearth, and avoid plants treated with systemic insecticides.
- A pesticide kill shows piles of dead or trembling bees in several hives at once; document it, freeze a sample, and report it to the Clemson Department of Pesticide Regulation.
- Prevent exposure by communicating with applicators, registering hives where possible, following labels (including the EPA pollinator box), and favoring evening applications.

Review Questions

1. What does pollen provide to a colony?
2. Name a major spring honey plant and a major fall honey plant in the Southeast.
3. What brood problem is caused by summer titi?
4. Which agency investigates suspected pesticide kills in South Carolina?
5. What should a beekeeper collect and freeze after a suspected pesticide kill?

Test bank practice: this chapter is covered by Questions 223–245 (Section 10) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

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- U.S. EPA, “Protecting Bees and Other Pollinators from Pesticides” and the pollinator protection label box: epa.gov/pollinator-protection
- Clemson Department of Pesticide Regulation (reporting suspected pesticide incidents): clemson.edu/public/regulatory/pesticide-regulation
- FieldWatch (DriftWatch and BeeCheck registries): fieldwatch.com
- Xerces Society, pollinator plant lists for the Southeast: xerces.org

Chapter 11: Predators, Pests, and Diseases of Honey Bee Colonies

Chapter Objectives

After studying this chapter, you should be able to:

- Identify the predators of honey bees in the Southeast, including invasive hornets, and how to deter them.
- Apply integrated pest management to small hive beetles, wax moths, mice, and ants.
- Describe Africanized honey bees and how to respond to them.
- Recognize Varroa, tracheal mites, Nosema, and the major fungal, viral, and bacterial brood diseases, and distinguish AFB from EFB.
- Monitor Varroa, apply thresholds, rotate treatments, and choose resistant stock.
- Identify the South Carolina agencies that regulate bee movement and investigate pesticide kills.

A. Predators of Honey Bees in the Southeastern United States

Many animals opportunistically eat individual foraging bees, but a healthy colony easily absorbs those losses by rearing tens of thousands of new workers annually. Far fewer predators are able to breach and destroy an entire colony. In the southeastern U.S., black bears and striped skunks are the two predators that can destroy or drive out an entire colony. Bears tear hives apart to eat the brood and honey and are best stopped with a properly built and maintained electric fence installed before damage begins. Skunks rarely break into a hive; instead they scratch at the entrance at night and eat the guards and workers that come out, night after night, until the colony is badly weakened (scratch marks, trampled ground in front of the hive, and an unusually defensive colony are the signs). Raising hives on stands, which forces a skunk to expose its belly to stings, is an effective deterrent. Raccoons and opossums can cause similar entrance damage. Yellowjackets, which reach peak populations in fall, will opportunistically rob already-weakened colonies but rarely threaten a strong, healthy hive.

Two invasive hornet species have drawn national attention. The Northern Giant Hornet (“murder hornet,” *Vespa mandarinia*) was first detected in the U.S. near Blaine, in Whatcom County in far northwestern Washington State, in December 2019 (not Seattle, as some study materials state), and was considered the only insect in North America capable of killing an otherwise healthy colony outright, slaughtering workers to seize the brood. After an intensive eradication campaign, Washington State and federal agriculture officials declared it eradicated from the United States in December 2024. The yellow-legged hornet (*Vespa velutina*), a serious problem for beekeepers in Europe, was first found in the U.S. near Savannah, GA, in August 2023, within a few miles of the South Carolina line. It is now in South Carolina: queens and nests were found in Beaufort County in spring 2024, and it has spread steadily since. The first nest outside the Lowcountry was found in York County on December 8, 2025. By mid-September 2026, Clemson reported 566 nests removed or scheduled for removal (nearly all in the Lowcountry), with monitoring traps deployed across 13 counties (Allendale, Beaufort, Berkeley, Charleston, Cherokee, Chester, Colleton, Dorchester, Hampton, Jasper, Lancaster, Union, and York). Because the hornet is still spreading, check Clemson's latest update for current counties. The hornets hover outside hive entrances and pick off returning foragers. Report suspected sightings, with a photo, through Clemson's online reporting tool (linked from clemson.edu/ylh), and never try to remove a nest yourself.

B. Major Pests of Honey Bees

The IPM approach

Integrated pest management (IPM) is a way of making decisions, not a single product. It has six steps that apply to every pest and disease in this chapter: (1) **identify** the pest or disease correctly; (2) **monitor** how many are present, at regular intervals; (3) compare the count against an **action threshold**, the level at which damage is likely enough to justify treatment; (4) **choose** among control options, favoring the least harmful that will work; (5) **act**; and (6) **record and evaluate** the results so the next decision is better. Control options are commonly grouped as cultural (management practices and site choice), mechanical or physical (traps, screens, freezing), biological (living organisms such as nematodes or resistant bee stock), and chemical (registered treatments, used according to the label and rotated to slow resistance). IPM accepts that a low level of a pest is tolerable and aims to keep it below the damaging level rather than to eliminate it.

Small hive beetle (SHB)

The small hive beetle is not native to North America and has few natural predators here. It is a kleptoparasite of honey (feeding on stores and defecating in them, causing fermentation and “slime”) and a predator of brood, progressing through egg → larva → pupa → adult. Adults fly in following the scent of bees and bee products; larvae feed in the hive, then leave to pupate in the soil beneath and around the hive before emerging as new adults. Feeding pollen patties inside a hive can attract SHB, while placing hives in dry, sunny locations (rather than moist, shady ones) is a key deterrent. Integrated pest management (IPM) uses multiple complementary control types:

Control type	Example for small hive beetle
Cultural	Siting hives in dry, sunny locations; keeping colonies strong
Mechanical	In-hive traps or entanglement cloths that capture adult beetles
Biological	Applying beneficial (entomopathogenic) nematodes to soil under hives to attack pupating beetles
Chemical	Drenching soil around the hive with an approved soil insecticide (e.g., GardStar) to kill pupae — for soil use only, never applied inside a working hive

Wax moths

Wax moths are scavengers of comb, not living bees, and a strong colony easily polices and controls them as long as there are enough bees to patrol every comb. They become a serious problem only in stored, unoccupied comb no longer protected by a patrolling colony. IPM strategies for stored equipment include cultural controls (staggering boxes in a covered, sunny/ventilated location), biological controls (*Bacillus thuringiensis*, sold as Certan, sprayed on comb), mechanical controls (freezing frames, then storing them sealed), and chemical controls (fumigating stacked boxes with paradichlorobenzene crystals, sold as Paramoth).

Africanized honey bees

Africanized honey bees (hybrids descended from *A. m. scutellata*) are established in Florida, across the southwestern U.S. from Texas through California (with detections north into Nevada and Utah), and in parts of Oklahoma, Arkansas, and Louisiana, and are known for heightened defensiveness. Distinguishing them from European honey bees requires laboratory testing, not visual inspection; a South Carolina beekeeper who suspects a colony may be Africanized should contact the Clemson Apiary Inspection Program (CAIP) for testing.

Africanized colonies differ from European colonies mainly in behavior: they respond to disturbance in much greater numbers, sting more, and pursue a perceived threat much farther (sometimes a quarter mile or more); they swarm more often, abscond more readily, and will nest in small, unusual cavities such as water-meter boxes, overturned flowerpots, and old tires. The public advice for anyone attacked by bees is to run away immediately, cover the face, and get inside a building or car, without stopping to swat and without jumping into water, where bees will wait. Beekeepers in areas where Africanized bees occur requeen regularly with queens from known European stock and requeen any colony that becomes unusually defensive.

Vairimorpha (formerly Nosema)

Vairimorpha (the microsporidian gut parasites long known as *Nosema apis* and *Nosema ceranae*, reclassified in 2020) is an internal, gut-infecting parasite that is difficult to diagnose from external symptoms alone; confirmation requires examining bee guts under a microscope. Symptoms can include distended abdomens, K-wing (wings held at an odd angle), poor brood pattern, and weak, crawling, or flightless bees; dysentery (brown fecal streaks on the hive front) may accompany *Nosema apis* infections but is not a reliable sign, since other conditions cause it and *N. ceranae*, now the dominant species, often produces no dysentery at all. Management centers on good nutrition, avoiding long confinement, and discontinuing open feeding; fumagillin (Fumagilin-B) has been the traditional medication where available.

Tracheal mites

The tracheal mite (*Acarapis woodi*) is a microscopic mite that lives and breeds inside the breathing tubes (tracheae) of adult bees, entering through a spiracle on the thorax of very young bees. Infested bees may crawl near the hive unable to fly and show K-wing, but these signs are not specific, and diagnosis requires dissecting bees under a microscope. Traditional controls include menthol (Mite-A-Thol), grease patties (about 2 parts sugar to 1 part vegetable shortening), which make it harder for mites to find young hosts, and thymol products. Tracheal mites caused heavy losses in the U.S. in the late 1980s and 1990s but are far less important today, largely because resistant stock is widespread and some Varroa treatments also suppress them.

Mice and ants

Mice move into hives in fall and winter, when the cluster is too tight to defend the bottom box, and chew comb and frames to build nests; install a mouse guard or a small entrance reducer before cold weather arrives. Most ants are nuisances that scavenge stores rather than true threats, but in the Southeast fire ants can overwhelm weak colonies. Keep the area under the hive clear of debris, set hive-stand legs in containers of water or oil where ants are a problem, and never spray insecticides on or around a working hive.

Threats on the horizon

Several pests not yet established in the U.S., or only rarely seen, are worth recognizing:

- **Tropilaelaps mites** (*Tropilaelaps* spp.) — Asian parasitic brood mites that reproduce faster than Varroa and are considered one of the most serious threats to honey bees; they are not present in the U.S., but new populations have appeared beyond their native Asian range, including western Russia and the country of Georgia, and U.S. officials treat their introduction as a major concern. Suspected finds should be reported to state apiary officials immediately.
- **Bee louse** (*Braula coeca*) — a tiny, wingless fly that rides on adult bees (often the queen) and steals food from their mouths; it causes little harm and has become rare in the U.S. since the widespread use of miticides.
- **"Zombie fly"** (*Apocephalus borealis*) — a native phorid fly found parasitizing honey bees in California in 2012; infected bees leave the hive at night, are often found near lights, and die, after which fly larvae emerge from them. Its significance to colony health is still unclear.

C. Primary Diseases of Honey Bees

Understanding whether a disease is caused by a fungus, virus, or bacterium helps predict how it behaves and how (or whether) it can be managed:

Pathogen type	Diseases	General pattern
Fungus	Chalkbrood, stonebrood	Larvae die and become hard, chalk-like “mummies” (chalkbrood: white, gray, or black; stonebrood: hard and yellow-green); favored by cool, damp conditions and poor ventilation; usually resolved by good colony management, with requeening if it persists.
Virus	Sacbrood (“snotbrood”), Deformed Wing Virus (DWV)	Sacbrood larvae die within an unbroken sac-like skin that resembles mucus; DWV is strongly amplified by Varroa mites and causes visibly deformed wings. Viruses rarely kill a colony outright but are made far worse by Varroa and poor nutrition.
Bacteria	European Foulbrood (EFB), American Foulbrood (AFB)	EFB usually kills young larvae before their cells are capped, leaving twisted, discolored larvae; AFB kills larvae after the cell is capped, leaving sunken, greasy, often perforated cappings. EFB is a stress-related disease that most often appears in late winter or spring, when brood rearing outpaces the nurse-bee population, and colonies can often overcome it on their own once the spring nectar flow improves their nutrition. AFB is far more serious: it cannot be cured, and an infected hive must be destroyed to prevent it spreading to other colonies.

Beekeepers distinguish AFB from EFB partly with the diagnostic “ropey test”: a toothpick inserted into liquefied larval remains that stretches out to about an inch or more in a thin, ropey strand indicates AFB, while EFB-affected larvae generally do not rope out at all, or stretch only minimally, since EFB kills larvae earlier and through a different bacterial mechanism. Because federal rules now require a veterinarian's Veterinary Feed Directive (VFD) to obtain antibiotics for honey bees (beekeepers can no longer simply purchase them), any suspected foulbrood should be confirmed and managed promptly with professional guidance.

Other viruses and non-infectious disorders

Besides sacbrood and DWV, beekeepers should recognize chronic bee paralysis virus, in which adult bees tremble, cannot fly, and become hairless, greasy, and black, and the acute paralysis viruses (including Israeli acute paralysis virus), which, like DWV, are spread and amplified by Varroa. Several common problems are not infectious diseases at all:

Disorder	Signs	Cause and prevention
Parasitic mite syndrome (PMS)	Spotty brood with sunken, chewed cappings and discolored, melting larvae that can resemble EFB; many mites visible	Heavy Varroa infestation with associated viruses; reduce mite levels promptly
Chilled brood	Dead brood at the edges of the brood nest, often after a cold snap	Too few bees to cover the brood, from a sudden cold spell or overly aggressive splitting or manipulation
Starvation	Many dead bees head-first in cells, often with no honey in the hive or next to the cluster	Insufficient stores or a cluster separated from its food; monitor weight and feed (see Chapter 8)
Pesticide poisoning	Piles of dead or trembling bees at the entrance, often in several hives at once	Exposure to insecticides; see Chapter 10, Section E
Colony collapse disorder (CCD)	Sudden loss of most adult workers, with a queen, brood, and food left behind and few dead bees present	Named in 2006; no single cause found; Varroa, viruses, pesticides, and poor nutrition are all thought to contribute; few cases fitting the original definition have been reported in recent years

D. Varroa Mites

Varroa destructor is widely regarded as the single greatest threat to honey bee colonies today. Varroa originally parasitized the eastern honey bee (*Apis cerana*), which tolerates it well. It moved onto *A. mellifera* in Asia around the mid-20th century and spread worldwide over the following decades, becoming a global problem in the 1980s (it reached the U.S. in 1987); *A. mellifera* has no comparable natural resistance. Varroa is an external parasite that feeds on larvae, pupae, and adult bees and reproduces inside capped brood cells, preferentially on drone brood (because drones take longer to develop, giving mites more time to reproduce). Varroa is specific to *Apis* honey bees: it does not reproduce on adult bees, and it cannot survive and reproduce on bumble bees (*Bombus* spp.), whose colonies lack the capped brood cells the mite needs.

Beyond direct feeding damage, Varroa transmits and amplifies an array of deadly viruses, especially DWV, making it the primary driver behind most modern colony losses.

Regular monitoring is essential; the most common direct method is an alcohol wash of a sample of adult bees, compared against an action threshold. The single figure most commonly taught to beginners is about 2% (2 mites per 100 bees), above which treatment is recommended. Many extension guides refine this by season: about 1 mite per 100 bees (1%) in late winter/early spring, before the colony has built up, and about 2–3 mites per 100 bees (2–3%) during the growing season (roughly May–October). Populations build through the season and typically peak in late summer/fall, not winter. Hygienic behavior — workers detecting and removing mite-infested brood, which leaves a spotty brood pattern — is a naturally occurring, selectable trait that helps some colonies suppress mite growth.

Monitoring methods

Method	How it works	Pros and cons
Alcohol (or soapy-water) wash	About 300 bees (roughly 1/2 cup) from a brood frame are shaken in alcohol or soapy water to dislodge mites, which are counted; $\text{mites} \div 3 = \text{mites per 100 bees}$	Most accurate; kills the sample (check that the queen is not in it)
Powdered-sugar roll	The same sample is rolled in powdered sugar, which makes mites fall off; the bees survive	Non-lethal; slightly less accurate, especially in humid weather
Sticky board (natural mite drop)	A sticky sheet under a screened bottom board collects mites that fall in 24–72 hours	Does not disturb the colony; counts vary widely and are hard to compare with thresholds
Drone-brood uncapping	Capped drone pupae are lifted with an uncapping fork and checked for mites	Quick visual check in spring; only a rough indication

Whatever method is used, sample regularly (at least monthly from spring through fall) and record the results, since the trend matters as much as any single count.

Registered treatments include organic acids such as oxalic acid (applied by vaporizer or dribble and commonly used in spring and fall; because it does not penetrate wax cappings, it works best when little or no capped brood is present, such as a late-fall broodless period or after a brood break) and formic acid (the pungent acid ants produce, which also penetrates cappings to reach mites inside brood cells). Formic acid and thymol are temperature-sensitive treatments: each product has a label temperature range, and applying them in mid-summer heat can harm bees and brood (the reason study materials give for avoiding them in summer). Several synthetic and organic-acid treatments (e.g., CheckMite+, Apivar, HopGuard, MiteAway) are formulated as strips that hang between frames in the brood area for ease of application. Beekeepers who consistently monitor and treat Varroa have measurably more productive colonies that survive longer than those who do not.

Treatment resistance and rotation

Varroa populations have developed resistance to several synthetic miticides used too often, including fluvalinate (Apistan) and coumaphos (CheckMite+), and USDA researchers have documented mites resistant

to amitraz (Apivar) in U.S. apiaries. To slow resistance, beekeepers should use a treatment only when monitoring shows it is needed, follow the label exactly (dose, timing, and duration), rotate between products with different modes of action (for example, an organic acid, a thymol product, and amitraz in different seasons), and check mite levels after treatment to confirm it worked. Combining treatments with non-chemical tools such as brood breaks, drone-brood removal, and resistant stock reduces how often chemicals are needed.

Mite-resistant bee stocks

Several stocks have been bred to suppress Varroa: **Russian** honey bees (imported by the USDA from the Primorsky region of eastern Russia beginning in 1997); bees with **Varroa Sensitive Hygiene (VSH)**, a trait developed by the USDA in Baton Rouge in which workers find and remove mite-infested pupae; **Pol-line** bees, which combine VSH with commercial Italian stock; and **Minnesota Hygienic** bees, selected at the University of Minnesota for removing diseased and dead brood. Resistant stocks reduce, but rarely eliminate, the need to monitor and treat.

E. South Carolina Regulations

Because American Foulbrood is incurable and highly contagious, most U.S. states regulate and inspect for it (not every state has an active inspection program), along with the general movement of bees, to prevent its spread. In South Carolina:

- The Clemson Apiary Inspection Program (CAIP), part of Clemson's Department of Plant Industry (Regulatory Services), inspects and certifies hives, issues import/export permits, and enforces the SC Honey Bee Law (S.C. Code Title 46, Chapter 37). A beekeeper moving colonies out of state must have CAIP inspect and certify the hives first; a beekeeper moving bees or used equipment into SC must obtain an entry permit from CAIP (Clemson's Department of Plant Industry) and provide a certificate of inspection from the state of origin, based on an inspection made within 60 days before shipment.
- The Clemson Department of Pesticide Regulation (DPR) investigates suspected pesticide kills and enforces pesticide law; a beekeeper who suspects an entire colony was killed by pesticide exposure should contact DPR immediately.
- The Clemson Apiculture and Pollinator Program (CAPP) provides consulting, research, and education services to the state's beekeepers.

Applicators using any pesticide near bees are always required to consult and follow the product label, which is the binding legal document governing that pesticide's use.

For recognizing, reporting, and preventing pesticide kills, see Chapter 10, Section E.

Chapter Summary

- Bears and skunks are the main colony-level predators in the Southeast; the yellow-legged hornet is spreading in South Carolina and should be reported to Clemson.
- IPM combines identification, monitoring, thresholds, and cultural, mechanical, biological, and chemical controls; small hive beetles are best managed with strong colonies, sunny sites, traps, and soil treatments.
- Wax moths attack unprotected stored comb; Africanized bees are more defensive and require laboratory identification.
- Nosema and tracheal mites require microscopic diagnosis; chalkbrood is fungal, sacbrood and DWV are viral, and EFB and AFB are bacterial, with AFB incurable and identified partly by the ropey test.

- Varroa is the greatest threat to colonies; monitor with an alcohol wash or sugar roll, treat above about 2–3 mites per 100 bees, rotate products, and consider resistant stock.
- In South Carolina, the Clemson Apiary Inspection Program regulates bee movement and inspections, and the Department of Pesticide Regulation investigates pesticide kills.

Review Questions

1. Which foulbrood disease cannot be cured?
2. What threshold of Varroa mites per 100 bees is most commonly taught as the point to treat?
3. In an alcohol wash of about 300 bees, how do you convert the mite count to mites per 100 bees?
4. Which brood disease produces hard, chalk-like mummies?
5. What are the six steps of integrated pest management?

Test bank practice: this chapter is covered by Questions 246–291 (Section 11) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

- Honey Bee Health Coalition, Tools for Varroa Management (current edition) and Varroa Management Decision Tool: honeybeehealthcoalition.org/varroa
- eXtension Bee Health, multi-university resource on pests and diseases: bee-health.extension.org
- Clemson Department of Plant Industry, Apiary Inspection Program (permits, inspections, SC Honey Bee Law): clemson.edu/public/regulatory/plant-industry/honey-bee/index.html
- Clemson Regulatory Services, yellow-legged hornet updates and reporting: clemson.edu/ylh and blogs.clemson.edu/regulatory
- South Carolina Code of Laws, Title 46, Chapter 37 (Introduction of Honey Bees into State): scstatehouse.gov/code/t46c037.php
- University of Florida/IFAS Extension EDIS fact sheets on small hive beetle, Varroa, and Africanized honey bees (J.D. Ellis and colleagues): edis.ifas.ufl.edu
- Bee Informed Partnership, colony loss surveys and management data: beeinformed.org

Chapter 12: Honey Bee Products

Chapter Objectives

After studying this chapter, you should be able to:

- Explain how honey is made and the facts about honey most often tested, including moisture, weight, and composition.
- Harvest, extract, and bottle honey, and choose a method for clearing bees from supers.
- Describe South Carolina's three pathways for selling honey and the basic labeling requirements.
- Describe the forms and varietal types of honey.
- Explain how beeswax, propolis, bee bread, royal jelly, pollen, and mead are produced and used.
- Describe the requirements of a sound pollination contract.

A. Producing and Selling Honey in South Carolina

Honey is the beekeeper's best-known and most accessible source of income. Bees must visit roughly 2 million individual flowers and fly the equivalent of tens of thousands of trips to produce just one pound of honey, drying collected nectar from a much higher starting moisture down to about 18.6% or less before capping it. That 18.6% figure, the one most commonly taught, is also the maximum moisture allowed for U.S. Grade A honey. Honey toward the drier end, below about 17–18%, is the most resistant to fermentation, because osmotolerant yeasts cannot reliably grow at that sugar concentration; honey near or above 18.6% is more fermentation-prone, especially if its natural yeast count is high. A gallon of finished honey weighs about 12 pounds, and it is roughly 80% sugar by composition. Honey's mild antimicrobial properties come from trace hydrogen peroxide (produced by an enzyme the bees add to nectar), together with its very high sugar content, which draws water out of microbes, and its acidity. Honey should never be fed to infants under one year old, since it can carry *Clostridium botulinum* spores that a mature digestive system handles safely but an infant's cannot, risking infant botulism.

A few more frequently tested honey facts: a single worker produces only about 1/12 teaspoon of honey in her lifetime; honey is acidic (pH below 4, averaging about 3.9); honey is hygroscopic, meaning it absorbs moisture from the air if left uncovered, so containers and supers should be kept closed; bees normally store honey above the brood area; a full medium frame holds roughly 4 pounds of honey; and a strong colony can produce on the order of 50–100 pounds in a good year, though yields vary widely with location, season, and colony strength.

Beekeepers measure moisture content with a refractometer, an optical instrument that reads the angle at which light refracts through a honey sample — higher moisture refracts light differently than lower moisture, giving a fast, accurate reading without needing to evaporate a sample.

Harvesting honey

Removing bees from full honey supers is labor-intensive work, and beekeepers choose among several techniques depending on scale:

Method	Advantage	Disadvantage
Shaking/brushing frames	Cheapest method	Labor-intensive; practical only for a few supers at a time
Blowers	Fast; good for large numbers of supers	Can injure and agitate bees
Fume boards	Clears bees within minutes	Can affect honey flavor; requires extra equipment and repellent chemicals
Bee escapes	Removes bees with the least agitation	Requires multiple bee-yard visits; leaves honey unguarded against small hive beetles in the meantime

Honey should generally not be harvested on rainy, overcast days (nectar/honey moisture runs higher), and harvested supers should be extracted within 24–48 hours or frozen if extraction must wait, to limit pest and fermentation risk. Comb should be uncapped, then spun in a tangential or radial extractor; the crush-and-strain method (crushing comb and straining out the honey) works for a hobbyist with one or two hives but destroys the comb — forcing bees to rebuild it from scratch — and can leave the honey less clear than extraction. After extraction and filtering, honey should sit in a holding tank for at least 24 hours before bottling, allowing fine sediment to settle and tiny air bubbles to rise out, clarifying the final product. All honey is naturally supersaturated with sugar and will granulate (form sugar crystals) over time; this is normal and does not indicate spoiled honey. Granulation is reversed by warming the honey gently in a water bath not exceeding about 110°F — higher heat degrades flavor, color, and beneficial enzymes.

Selling honey legally in South Carolina

Because honey is sold primarily as a food, the SC Department of Agriculture's Food Safety Compliance division regulates how it may be labeled and sold. South Carolina offers three pathways. (1) Registered facility: producers extracting and bottling in an approved, SCDA-inspected honey house and filing a Registration Verification Certificate (RVC) may sell without restriction on where or to whom the honey is sold, including wholesale and out of state. (2) Exemption from registration: a beekeeper selling only directly to consumers in South Carolina (for example, at farmers markets) may sell up to 400 gallons (4,800 lb) a year without a registered facility, using a compliant label. (3) Home-Based Food Production Law (enacted 2012; expanded in 2022): a beekeeper may extract and bottle honey in a home kitchen and sell it within South Carolina, provided the label states that the product was processed and prepared by a home-based food operation not subject to South Carolina's food safety regulations. Both the exemption and home-based pathways restrict where and to whom honey can be sold compared with the RVC pathway. Check SCDA's current Honey Sales Guide for limits and label details, which can change.

South Carolina's honey labeling terminology distinguishes altered honey (any product made from honey-based ingredients and processes only — e.g., blending different honeys, infusing with hot peppers, creaming, or adding a chunk of comb into a jar of extracted honey) from adulterated honey (any product with non-honey substances added, such as corn syrup or food dye), which is not permitted.

Labeling details and honey-house hygiene

Under federal and South Carolina labeling rules, a honey label must show the word “Honey” (with any floral source, if claimed, such as “Sourwood Honey”) as the statement of identity on the front panel; the net weight in both U.S. and metric units, placed in the bottom third of the front panel (honey is sold by weight, not volume, so a 1-pint jar holds about 1.5 pounds); and the name and address of the producer, packer, or distributor. Floral-source names should be truthful, meaning the honey should come predominantly from that plant. There is no federal legal definition of “raw” honey, so beekeepers who use the term should be able to explain what it means for their product, and no honey label should make health or medical claims. Products with added ingredients need an ingredient list.

Honey is a food, so it should be extracted and bottled under clean conditions: a clean, screened room free of pets, dust, and pests; food-grade stainless-steel or food-grade plastic equipment (never galvanized metal, which reacts with honey’s acids); clean, dry containers with tight lids; and hand washing and clean clothing for everyone handling the honey. SCDA’s Honey Sales Guide gives current requirements for each sales pathway.

Forms and varieties of honey

Honey reaches consumers in several forms: **extracted (liquid) honey**, the most common; **comb honey**, sold in the wax comb the bees built (as section comb, round plastic sections, or cut comb); **chunk honey**, a piece of comb in a jar filled with liquid honey; and **creamed (whipped or spun) honey**, made by controlled crystallization. The standard method for creamed honey, developed by Elton Dyce at Cornell in the 1930s, mixes about one part finely crystallized “seed” honey into roughly ten parts liquid honey and holds it at about 57°F (14°C) until it sets into a smooth, spreadable texture.

Honey color and flavor depend on the floral source, and the Southeast is known for several prized varietal honeys: **tupelo**, light and mild, which is so high in fructose that it rarely granulates; **sourwood**, a light, spicy honey from the mountains and upper Piedmont; **gallberry**, from the coastal plain; and the darker **tulip poplar** honey. Most honey sold locally is labeled simply as wildflower honey.

B. Nectar Sources and Seasonal Flows

Because nectar is abundant only during certain windows, beekeepers add supers just ahead of the two main South Carolina nectar flows: in February–March, before the spring flow (which runs roughly March–May across most of the state), and in July–August, before the late-summer/fall flow. Supering ahead of the flow lets the colony capture the surplus instead of the beekeeper reacting after the flow has begun. Trees, shrubs, and woody vines are generally the dominant nectar source in spring, field crops and ornamentals contribute through the summer, and meadowland wildflowers generally dominate the fall flow. South Carolina spans four broad ecoregions — Blue Ridge, Piedmont, Sandhills, and Coastal Plain — each with different native plant communities, so a beekeeper should learn the flowering calendar specific to their own region. Because colony population size is the one factor most within a beekeeper’s control, and it directly determines how efficiently a colony can exploit a nectar flow, building strong colony numbers ahead of a flow is the most effective way to maximize honey production.

C. Beeswax

Beeswax is a valuable byproduct generated as cappings are removed during extraction, and it can also be collected from burr comb and retired foundation. It is naturally white when produced but yellows (and eventually darkens further) as it absorbs compounds from brood, pollen, propolis, and honey. Beeswax melts around 145°F; beekeepers should avoid heating it above about 200°F, since higher heat darkens the wax and destroys its natural pleasant odor. Comb debris (cocoons, pollen, propolis, bee parts) is separated from the wax by rendering — melting the comb in a hot water bath so the lighter wax rises free of the heavier debris. Because it burns completely, is non-toxic, and has a naturally pleasant color and odor, beeswax is valued for candles, cosmetics (lip balm, lotions), furniture polish, and as a lubricant/coating in mechanical uses. Unlike honey, beeswax is not a regulated food product in South Carolina, so no SCDA label approval is required to sell it, though it should be stored in a cool, dark location, since heat and sunlight cause it to darken and lose its color and odor over time.

D. Propolis, Bee Bread, and Other Hive Products

Propolis, made by bees from collected tree resins, has antimicrobial and antioxidant properties and has been explored for cosmetic and supplement uses; because it will not dissolve in water, it is typically dissolved in alcohol to make what is technically called a tincture. Bee bread is pollen that bees pack into comb cells mixed with nectar or honey and glandular secretions, where microbes (chiefly lactic-acid bacteria, plus some yeasts) help preserve it; it is traditionally described as fermented, though recent research suggests the pollen changes less than once thought, and it supplies the colony's protein, fat, and mineral needs. Because it is perishable once removed from the hive, bee bread intended for storage should be dried in a dehydrator or frozen until use — cooking or boiling destroys its nutritional value. The use of bees and bee products (propolis, royal jelly, venom, and others) for holistic or therapeutic purposes is called apitherapy.

Other hive products. *Royal jelly*, secreted by the hypopharyngeal and mandibular glands of nurse bees, is harvested commercially from queen cells about three days after larvae are placed in them; most royal jelly sold in the U.S. is imported. *Pollen* can be collected with a pollen trap, a screen at the entrance that knocks some of the pollen loads off returning foragers into a drawer; trapped pollen should be collected every day or two and dried or frozen, and traps should not be left on continuously, since the colony needs pollen to rear brood. *Mead* is honey wine, made by fermenting diluted honey (commonly about 2–3 pounds of honey per gallon of water) with yeast. Federal law allows adults to make wine and mead at home for personal use (up to 100 gallons a year for a one-adult household and 200 gallons for two or more adults), but selling it requires federal and state alcohol permits.

E. Selling and Renting Bees

As a beekeeper's experience and colony count grow, selling packages, nucs, or full hives becomes a realistic secondary income source, alongside leasing colonies for contract pollination. New and experienced beekeepers alike may purchase a nuc for the fastest head start into a new colony, since it already comes with woodenware, drawn comb, brood, and food stores; most experienced beekeepers eventually split their own colonies to produce packages, nucs, or queens rather than continuing to purchase them.

South Carolina's demand for contract pollination is smaller than in states with massive single-crop operations (California almonds, Washington cherries, Michigan blueberries), but SC crops such as peaches, plums, apples, blueberries, watermelon, pumpkins, and cucurbits such as cucumbers and squash commonly

benefit from contract pollination, unlike self-pollinating or wind-pollinated crops such as beans, peas, tomatoes, and corn. To ensure good crop pollination under a contract, beekeepers should place at least two hives per crop acre (recommended stocking rates vary by crop, so follow the grower's or extension agent's figure where one is given), ensure colonies are strong (at least six full frames of active brood), place hives as close to the target crop as practical, and use a written, signed contract stating both parties' expectations. Keeping unrelated forage blooming nearby or heavily feeding bees during bloom are not recommended, since either can distract foragers from the crop that needs pollinating.

Chapter Summary

- Bees visit about 2 million flowers per pound of honey and cap it at about 18.6 percent moisture or less, the Grade A limit; a gallon weighs about 12 pounds.
- Measure moisture with a refractometer, extract promptly, let honey settle 24 hours before bottling, and warm granulated honey no hotter than about 110°F.
- South Carolina offers three sales pathways: a registered facility, a 400-gallon direct-sale exemption, and the home-based food law; labels need “Honey,” net weight in the bottom third, and the producer’s name and address.
- Honey is sold as extracted, comb, chunk, or creamed honey, and the Southeast is known for tupelo, sourwood, and gallberry honeys.
- Beeswax melts around 145°F and is rendered in hot water; propolis, bee bread, royal jelly, pollen, and mead are other products of the hive.
- Contract pollination calls for strong colonies (at least six frames of brood), about two or more hives per acre, close placement, and a written contract.

Review Questions

1. What is the maximum moisture content for U.S. Grade A honey?
2. About how much does a gallon of honey weigh?
3. What instrument measures honey’s moisture content?
4. At about what temperature does beeswax melt?
5. What is the difference between altered and adulterated honey?

Test bank practice: this chapter is covered by Questions 292–334 (Section 12) of the Certified Beekeeper Test Bank; each answer there lists its matching Study Guide section.

References for Further Study

- SC Department of Agriculture, Food Safety Compliance (honey labeling, Registration Verification Certificate, home-based food guidance): agriculture.sc.gov/divisions/consumer-protection/food-safety-compliance/
- USDA Agricultural Marketing Service, U.S. Standards for Grades of Extracted Honey (Grade A moisture limit of 18.6%): ams.usda.gov
- National Honey Board, honey composition, facts, and handling: honey.com
- Sanford, M.T. & Bonney, R.E. *Storey's Guide to Keeping Honey Bees*, 2nd ed. Storey Publishing, 2018. Harvesting, extracting, and hive products.
- Graham, J.M. (ed.). *The Hive and the Honey Bee*, revised ed. Dadant & Sons, 2015. Comprehensive reference on honey, wax, and hive products.

- Delaplane, K.S. & Mayer, D.F. Crop Pollination by Bees. CABI Publishing, 2000.
- Clemson Apiculture & Pollinator Program, bloom resources and honey sales guidance: clemson.edu/extension/pollinators/apiculture/index.html

Glossary of Beekeeping Terms

The terms below are commonly used throughout this study guide and the companion test bank. Terms already defined in detail within a chapter (such as the major pest and disease names in Chapter 11) are generally not repeated here except for a short cross-reference.

A–C

Abscond — The entire colony abruptly leaves the hive, usually due to an intolerable condition (poor ventilation, heat, pests, disease) rather than normal reproduction — distinct from swarming.

Apiary / Beeyard — The location where hives and colonies are kept.

Apiculture — The science, study, and practice of keeping bees.

Bait hive (swarm trap) — An empty hive or box set out to attract a swarm looking for a new home (see Chapter 9).

Bearding — Bees clustering on the outside front of the hive, usually to cool the colony in hot weather.

Bee bread — Pollen collected by bees and packed into comb cells with nectar and glandular secretions, where it is preserved (traditionally described as lightly fermented); the colony's protein source.

Bee space — The roughly 3/16–3/8 inch (commonly given as 1/4–3/8 inch) gap bees leave open rather than filling with propolis or burr comb; the principle underlying the modern movable-frame hive.

Brace/Burr comb — Comb built outside the intended frame structure, often bridging gaps larger than bee space.

Brood — Collectively, the egg, larva, and pupa stages of developing bees.

Capping — The thin wax layer bees place over a cell of ripened honey or over a brood cell ready to pupate.

Cleansing flight — A flight taken to void the digestive tract after a period of confinement, such as winter clustering.

Cluster — Bees grouped tightly together to conserve or generate heat, most notably in winter.

Colony Collapse Disorder (CCD) — A pattern in which the majority of a colony's worker bees disappear, leaving behind a queen, brood, and food stores but too few workers to sustain the colony.

Comb — The double-sided array of hexagonal wax cells bees build to store food and raise brood.

Creamed honey — Honey crystallized under controlled conditions into a smooth, spreadable texture; also called whipped or spun honey.

D–L

Dearth — A period when little or no nectar or pollen is available.

Drawn comb — Comb in which the cells have already been fully built out by the bees, ready for use.

Drone congregation area — A location where drones from many colonies gather in flight, awaiting queens to mate.

Drone-laying queen — A queen that lays mostly unfertilized (drone) eggs because she is poorly mated, out of sperm, or failing.

Fat bodies — Tissue in the abdomen that stores protein and fat reserves; especially large in long-lived winter bees.

Festooning — Bees linking together in chains, often associated with wax secretion, bearding, or swarm preparation.

Flow (nectar flow) — A period of abundant nectar availability, allowing bees to produce surplus honey.

Foundation — A commercial sheet, typically beeswax or plastic, used as a template to guide bees in building straight, evenly spaced comb.

Hive tool — A flat, bladed pry bar used to separate propolis-glued hive parts and frames.

Hypopharyngeal glands — Glands in the heads of young workers that produce brood food and royal jelly.

Integrated pest management (IPM) — A decision process that combines identification, monitoring, action thresholds, and several kinds of control (see Chapter 11).

Langstroth hive — The modern, stackable, movable-frame hive design patented by Lorenzo Langstroth in 1852; the first to combine full bee space with a removable frame in a practical, widely adopted form, building on earlier European movable-frame and spacing concepts (see Chapter 1 and Chapter 6).

Laying worker — An unmated worker that lays unfertilized eggs in a long-queenless colony, producing only drones.

M–R

Mead — Honey wine, made by fermenting diluted honey with yeast.

Nasonov gland — A scent gland near the tip of the worker's abdomen whose pheromone guides nestmates to the hive, a swarm, water, or food.

Neonicotinoids — A class of systemic insecticides that move into a plant's pollen and nectar.

Newspaper method — Combining two colonies separated by a sheet of newspaper so they merge gradually.

Nosema / Vairimorpha — An internal gut parasite of adult bees (see Chapter 11).

Nuc (nucleus colony) — A small starter colony, typically on 2–5 frames, including comb, brood, food, and usually a laying queen.

Nuptial/mating flight — The flight during which a virgin queen mates with multiple drones in the air.

Package bees — A quantity of adult bees (commonly 2–5 lbs), with or without a caged queen, shipped in a screened box with no comb.

Pheromone — A chemical signal bees produce to communicate or trigger a specific response in other bees.

Piping — A distinctive sound a queen makes, especially before and after emerging from her queen cell.

Pollen trap — A device at the hive entrance that strips pollen loads from returning foragers into a collection drawer.

Propolis (“bee glue”) — A resinous material bees collect from plants and use to seal gaps and disinfect the hive.

Queen excluder — A screen sized to pass workers but not the larger queen, used to keep the queen out of honey supers.

Robbing — Bees from one colony (or wasps) forcibly stealing stored food from another, typically weaker, colony.

Royal jelly — A protein-rich secretion of nurse bees fed to all young larvae and, throughout development, to queen larvae.

S–W

Spermatheca — The organ in which a queen stores sperm from her mating flights for the rest of her life.

Sugar roll — A non-lethal Varroa monitoring method in which a sample of bees is rolled in powdered sugar to dislodge mites.

Supersedure — The colony's own replacement of a failing queen with a newly reared one, typically without swarming.

Swarm — A reproductive event in which roughly half to two-thirds of a colony's workers leave with the old queen to found a new colony, leaving a new queen behind.

Top bar hive (TBH) — An alternative hive design using top bars rather than removable frames, without standardized dimensions.

Tracheal mite (*Acarapis woodi*) — A microscopic mite that lives in the breathing tubes of adult bees; much less of a problem today than in the 1980s–90s (see Chapter 11).

Varroa destructor — The external parasitic mite considered the single greatest threat to modern honey bee colonies (see Chapter 11).

Varroa Sensitive Hygiene (VSH) — A heritable trait in which workers find and remove brood infested with reproducing Varroa mites.

Walkaway split — A simple method of making a new colony by giving a queenless group of bees a frame of eggs/young larvae and allowing them to raise their own queen.

Warré hive — A vertical top-bar hive of small boxes, traditionally added beneath the colony rather than on top.

Winter cluster — The tightly packed group bees form to generate and conserve heat through winter.

Answers to Chapter Review Questions

Chapter 1: History of Beekeeping

1. 1622, in the Jamestown colony of Virginia (shipped by the Virginia Company).
2. Lorenzo Langstroth.
3. Franz von Hruschka, in 1865.
4. The comb could not be removed and inspected without cutting it out, which usually destroyed it (and often the colony) at harvest.
5. Harry H. Laidlaw Jr.

Chapter 2: Honey Bee Biology and Behavior

1. A worker takes 21 days; a queen takes 16 days.
2. About 92–95°F.
3. Queen mandibular pheromone (QMP).
4. The direction of the food source relative to the sun.
5. The Nasonov (scent) gland.

Chapter 3: Safety in the Bee Yard

1. To the side or rear of the hive, never in front of the entrance.
2. It masks alarm pheromone, and it causes bees to gorge on honey, making them calmer.
3. A veil.
4. Speed: remove the stinger as quickly as possible by any method.
5. A honey bee.

Chapter 4: Allergic Reactions and Anaphylaxis

1. Localized (normal), large local, and systemic (allergic) reactions.
2. Skin, respiratory, cardiovascular, and gastrointestinal.
3. Epinephrine (an epinephrine auto-injector).
4. Symptoms can return hours later (a biphasic reaction), and the person needs medical evaluation.
5. About 62 deaths per year (2000–2017 average).

Chapter 5: Selecting an Apiary Site

1. South to southeast, to catch the morning sun.
2. A fence, hedge, or wall placed a few feet in front of the entrance.
3. Within about 1/4 mile.

4. Two.

5. Any two of: city, town, or county ordinances (hive limits, setbacks, water, flyway barriers) and homeowners' association covenants.

Chapter 6: Beekeeping Equipment and Getting Started

1. To keep the queen out of the honey supers while letting workers pass.

2. Any two of: pine straw, burlap, raw cotton, wood chips or shavings.

3. Packages, nucleus colonies (nucs), established hives, and swarms.

4. Candy end up, so that a dead attendant bee cannot block the exit.

5. Open feeding (shared syrup containers in the yard).

Chapter 7: Hive Management

1. About 6–8 pounds (8 pounds is the figure most often taught).

2. About 55°F.

3. Move a hive less than 3 feet or more than 3 miles, so foragers either find it or reorient completely.

4. January through March.

5. About 42 days.

Chapter 8: Seasonal Management

1. A dry cavity of the correct volume, food and water, the correct population, assistance with pests and parasites, and a safe environment.

2. Between about 10 a.m. and 2 p.m., in good weather.

3. Hanging from the bottom edges of the frames.

4. In a band surrounding the brood.

5. About 1.5 frames of capped honey for every frame of bees.

Chapter 9: Queens and Colony Increase

1. The spermatheca.

2. White.

3. About 24 hours.

4. It lets the two colonies merge gradually as the bees chew through it and their scents blend, preventing fighting.

5. About 40 liters (roughly the volume of a deep Langstroth box).

Chapter 10: Forage, Nutrition, and Pollinator Protection

1. Protein, fats, vitamins, and minerals.

2. Spring: tulip poplar, blackberry, clovers, or tupelo (any one); fall: goldenrod or asters (any one).
3. Purple brood, in which larvae and pupae turn blue-purple and die.
4. The Clemson Department of Pesticide Regulation.
5. At least a cup of freshly dead bees in a clean container.

Chapter 11: Predators, Pests, and Diseases of Honey Bee Colonies

1. American foulbrood (AFB).
2. About 2 mites per 100 bees (2 percent), refined by season to about 1 percent in early spring and 2–3 percent during the growing season.
3. Divide the mite count by 3.
4. Chalkbrood.
5. Identify, monitor, compare with an action threshold, choose control options, act, and record and evaluate.

Chapter 12: Honey Bee Products

1. 18.6 percent.
2. About 12 pounds.
3. A refractometer.
4. About 145°F.
5. Altered honey contains only honey-based ingredients and processes (blending, infusing, creaming, adding comb); adulterated honey has non-honey substances such as corn syrup or dye added and is not permitted.