BEEKEEPING
Labratory Manual
FRSC 123

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Lab 1- The Honey Bee

- External Anatomy
- Internal Anatomy

Figure 1. Honey bee queen (left), worker (center), drone (right).


Honey Bee Anatomy

OBJECTIVES: To identify and learn the structure and function of the honey bee.

MATERIALS: Dissecting microscope        Pins
             Honey bees                     Dissecting trays
             Probe                          Isopropyl alcohol
             Tweezers

ACTIVITIES: The class will use microscopes and dissection to observe the anatomy of a honey bee.

Stinger

Figure 2. Stinger of worker bee.
External Anatomy

Identify: **Head**
- Mouthparts
- Antennae
- Compound eyes
- Ocelli (simple eyes)

**Thorax**
- Prothorax
- Mesothorax
- Metathorax
- Legs
- Spiracles
- Wings

**Abdomen**
- Tergites
- Sternites
- Stinger

Figure 3. External anatomy.
Fore Leg of Worker Bee

Identify: Antenna cleaner, open    Tarsal brush
         Antenna cleaner, closed

Figure 4. Antenna cleaner.

Figure 5. Fore leg of worker bee.
Hind Leg of Worker

Identify: Pollen-collecting rake
Pollen press
Corbicula

Figure 6. Hind leg of worker bee. Interior view
Wings of a Worker Bee

Identify:  Fore wing
         Hind wing
         Hooks
         Fold

Figure 7. Wings of a worker bee.
Internal Anatomy

Identify: Head
- Pharynx
- Brain
- Optic lobes

Thorax
- Esophagus
- Trachea
- Thoracic ganglia
- Wing and leg muscles

Abdomen
- Honey stomach
- Proventriculus
- Ventricle
- Small intestine
- Rectum
- Abdominal ganglia
- POISON SAC

Figure 8. Internal anatomy.
Lab 2- Beekeeping Equipment

- Tools of the Trade
- Building Frames and Boxes

Figure 9. Smoker.
**Beekeeping Equipment**

**OBJECTIVE:** To familiarize students with the equipment used by beekeepers.

**ACTIVITIES:** The instructor will demonstrate all items and explain their use in beekeeping. Personal beekeeping items will be ordered for class members.

**MATERIALS:**
- Hive tools
- Gloves
- Coveralls
- Bee brush
- Bee sting kits
- Hive bodies
  - Shallow, "3/4", "super"
  - Deep, "brood box"
- Bee escapes
  - Standard
  - Conical
- Foundation
  - Medium brood
  - Duragilt®
  - Plasticell®
  - Cut comb
- Syrup feeders
  - Division board
  - Entrance
- Uncapping knives
  - Hand
  - Planer
- Honey extractors
  - Hand-crank
  - Radial (20 frame)
- Veils
  - Zipper
  - Tie down
- Helmets
- Smokers
- Frame grips
- Queen excluders
- Fume pads
- Top/bottom boards
- Inner hive cover
- Drone/queen trap
- Pollen trap
- Frames
  - Shallow
  - Deep
  - Permacomb®
- Honey heater tank
- Honey filters
- Wax melter
- Pneumatic staple gun
- Staples
- Frame wood
Figure 10. Hive boxes.
Lab 3- The Apiary

- Apiary Characteristics
- Legal Considerations
- Nectar and Pollen Sources
- Hive Inspection
- Honey Bee Life Stages
- Bee Behavior
**The Apiary**

**OBJECTIVES:** To observe and evaluate campus apiary locations and identify the major nectar and pollen sources for bees near each apiary. To learn basic hive inspection techniques while observing the honey bee in all stages of life. Honey bee behavior will also be observed.

**MATERIALS:** Bee suit  
Hive tool  
Frame grips  
Bloom chart  
Smoker  
Burlap  
Bee brush

**ACTIVITIES:** The class will make a walking tour of the campus apiaries to observe hive orientation, bee activity and major nectar and pollen sources. We will discuss the advantages and disadvantages of each location for beekeeping. We will inspect bee hives and learn how to use the smoker, hive tool, and other beekeeping tools.

*Each student will be assigned to a hive for the quarter.*
REGULATIONS:

Ag commissioner Beekeeping Ordinance for San Luis Obispo County:

1. Ag Commissioner has right to enter apiaries for inspection.
2. Must register all apiaries with Ag Commissioner yearly ($10 fee-1995).
3. Distance regulations: except when pollinating crops, no apiary shall be within 200 feet of a road; within 100 feet of other property boundaries without consent; within 600 feet of occupied dwellings without consent.
4. Adequate supply of water must be provided at each apiary
5. Flight paths must not be a public nuisance or health hazard.
6. Violations - 48 hour compliance, or fine, or jail!

CONSIDERATIONS:

- **Shelter from wind**- Trees, shrubs or a hill are common wind breaks.
- **Water supply**- Creeks, etc. Avoid bees foraging from swimming pools.
- **Orientation of hives**- Bee entrance should face away from the wind, into full sun.
- **Flight paths**- Consider regulations and public. Use of fences and shrubs may aid in controlling flight path.
- **Predators**- Protect hives from bears, scrub jays, yellow jackets.
- **Pesticide Protection**- Check on pesticide usage in area. Avoid establishing an apiary next to a field that receives aerial spraying of insecticides that are toxic to bees.
- **Nectar and Pollen Source**- Place apiaries where there is adequate pollen and nectar for the colonies to develop strong bee populations in the spring and one or more major nectar flows during the remainder of the year that provides the bees with a large surplus of honey. It is best not to have long periods of little or no flow during the active season.
Avoiding Stings: No. 1 priority!

- Stings should be avoided since the odor of the venom irritates and arouses other bees (it also hurts!)
- People sensitive to bee stings take a risk in handling bees
- 90% of people are not sensitive to bee venom
- Most people become desensitized after a number of stings
- Bees do not sting at random since they forfeit their lives
- Cool, cloudy days: avoid working bees since they tend to be feisty
- Bees away from their hive usually will not sting unless provoked (exceptions do exist; e.g. “dry swarms”)

Other Things to Avoid:

- Shaking hive—be gentle!
- Sudden movements near hive
- Dark clothing—irritates bees
- Wool, mohair, felt fabrics—irritates bees
- Animal odors—don’t handle pets prior to working bees
- Jewelry—excites guard bees to sting

Smoker:

- Smoke disorganizes guard bees. It causes bees to gorge on honey prior to leaving the “burning” nest
- Smoke at hive entrance. After taking off lid, smoke over combs.
Table 1. Bloom Periods for Major Nectar and Pollen Plants at Cal Poly

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<th>February</th>
<th>March</th>
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<tr>
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<td>Almond</td>
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<td>Apple</td>
<td>Bacon avocado</td>
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<td>Evergreen pear</td>
<td>Apple</td>
<td>Apple</td>
<td>Apricot</td>
<td>Hass avocado</td>
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<td>Navel orange</td>
<td>Lemon</td>
<td>Fuerte avocado</td>
<td>Hass avocado</td>
<td>Satsuma mandarin</td>
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<td>Plum</td>
<td>Eucalyptus</td>
<td>Lemon</td>
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<td>Pear</td>
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Honey Bee Life Stages

Identify: Three castes: queen, worker, drone

- Eggs
- Uncapped larvae
- Capped larvae
- Pupae
- Worker cells
- Drone cells
- Queen cell

Figure 11. Honey bee life stages.
Figure 12. Drone and worker cells.

Figure 13. Swarm queen cell.
**Bee Behavior**

*What are those busy little bees doing in there?*

**Identify:**  
- Honey storage
- Pollen storage
- Royal jelly storage
- Guarding
- Nursing
- Dancing
- Cleaning

- Brood laying
- Queen cell construction
- Comb building
- Sealing with propolis
- Scent fanning
- Clustering
- Undertaking

**Pollen storage:**

![Figure 14. Pollen storage.](image-url)
Scent fanning:

Dancing:

Figure 15. Scent fanning.

Figure 16. Bee dancing.
Lab 4- Hive Management for Honey Production

- Supering Hives
- Equalizing Hive Strength
Management for Honey Production

OBJECTIVES: To provide honey storage space, prevent swarming, and to equalize strength of the colonies.

MATERIALS: Bee suit Smoker Hive tool Supers with drawn comb Big muscles!

ACTIVITIES: Supers will be added to hives to provide storage space and prevent swarming. Location of weaker hives will be exchanged with location of stronger hives to equalize hive strength throughout the apiary.

*There will be a lot of heavy lifting during today's lab. Be sure to inform instructor of any injury which lifting aggravates.
Supering Hives

1. Check each hive for crowding.
2. If it looks crowded, add empty supers in this order:

```
- 1
- 2
- 3
- 4
```

![Figure 17. Supering.](image)

The general idea is to allow the bees to completely fill the super closest to the brood before moving it up. When the super closest to the brood nest is full, insert a super from above with space left below it.
Equalizing Hive Strength

- Equalize adult populations by swapping hive locations during hours of nectar flow. Foraging bees return to their original hive location. The weaker hive immediately gains adult bees, and congestion is relieved in the stronger hive.

- To equalize brood nest populations, remove brood frames from crowded hives and place into weaker hives. Be sure not to transfer queens in this process.

Figure 18. Equalizing.
Lab 5- Moving Hives

Figure 19. Hand truck.
Honey Harvesting

OBJECTIVE: To learn how to remove a honey crop from the hives.

MATERIALS: Bee suit Smoker
Bee escape boards Bee repellent
Bee brushes Bee blower
Flat bed truck Drip boards

ACTIVITY: Bees will be removed from honey supers using bee escapes, repellents and bee blowers.

Bee escapes
1. Place bee escape under the top honey super.
2. Bees will move down, but will be unable to return up into the super.
3. Check super after one day.
4. Remove super if free of bees.
5. Move bee escape below next super.

Repellents
1. Pour repellent on fume pad. Avoid spilling on gloves, boots, coveralls.
2. Plug your nose, it stinks!
3. Replace hive lid with fume pad.
4. Wait for bees to move down (about five to ten minutes).
5. Once bees are out of the super, remove and load into truck.

Bee blower
1. Remove honey supers from hives.
2. Tilt supers on end, blow bees from frames.
3. Load supers onto truck, cover stacks with fume pads.
Lab 7- Processing Honey and Wax

- Processing Equipment
- Honey Processing Techniques
- Melting Wax Cappings
Processing Honey and Wax

OBJECTIVE: To learn how to remove and process honey and wax cappings from bee hives.

MATERIALS: Hive tools Radial extractor Honey jars Labels Honey storage tanks Uncapping knives Honey filters Honey heater/strainer tank Wax melters

ACTIVITIES: Honey frames will be uncapped, honey extracted, heated, and filtered for jarring. Wax cappings will be melted to form cakes.

Figure 10. Honey harvesting equipment.
1. Uncap the frames to expose honey.
   Heated knives, sharp knives and jiggle knives are used to uncap frames.

2. Spin honey out of uncapped frames using an extractor.

3. Heat and filter honey.
   Heat thins the honey, allowing it to flow through the cheesecloth filter.

4. Let honey stand for a few days.
   Impurities will settle out and can be skimmed from the top.

5. Jar honey.

   Blanching will improve the clarity of the honey if it is not already adequate.

7. Label honey jars.
Lab 8- Dividing Hives

- With and Without Requeening
- Requeening With Queen Cages
- Queen Banks
Dividing Hives

OBJECTIVE: To divide existing hives in order increase the total number of hives in the apiary.

MATERIALS: Smoker Bee suit
Hive tool Lids
Laying queens Frames of drawn comb
Brood boxes Bottom boards

ACTIVITY: Hives will be opened, young brood removed and placed into a new hive. The new hives will be allowed to requeen naturally or new queens will be introduced.
Dividing Hives Without Requeening

1. Open brood nest of an established hive.
2. Remove a few frames of young brood. Check to make sure the queen is not on the frame. Place in new brood box.
3. Worker eggs or larvae three days or younger are needed for a new queen to be reared by the new hive.
4. Be sure to leave enough brood in the parent hive.
5. Replace removed frames with empty drawn comb (preferred) or foundation.
6. A second hive will usually need to be opened to fill new hive with three to six brood frames.
7. Complete the brood box with frames of honey, foundation and pollen.
8. Swap locations of established hive and new hive to equalize populations.
9. Check parent and new hives in a few days.

Dividing Hives With Requeening

Follow same method described above, then follow techniques below:

Marking the Queen
1. Clip one of the queen's wings to prevent her from swarming.
2. Mark a dot on top of her thorax with queen marking paint for ease in finding her in future inspections.

Direct replacement of failing or missing queen.
1. Kill old queen if possible.
2. Destroy queen cells.
3. Remove attendant bees from queen cage.
4. Remove cork from candy plug end.
5. Find brood frames with emerging bees. Place cage candy-end down between those frames.
6. Check colony a few days later for eggs.
Requeening using a nucleus hive
1. Establish a nuc. hive with a queen.
2. Place a sheet of newspaper on top of the queenless colony. Then place the nucleus hive on top of the paper.
3. Check colony within a few days.

Queen Banks

Observe the storage of caged queens in a queen bank colony.

Figure 21. Queen bank.
Lab 9- Managing Hive Health

- Disease Prevention
- Diagnosis and Treatment
- Pest Management

Figure 22. Varroa mite on pupa.
**OBJECTIVES:**

To learn to recognize symptoms and signs of the major honeybee diseases and pests, along with preventive and therapeutic methods.

**MATERIALS:**

Granulated sugar  
Terramycin  
Lopping shears  
Herbicide & sprayer  
Vegetable oil  
Ziploc® sampling bags  
Apistan® Strips  
Vegetable shortening  

Powdered sugar  
Fumadil-B®  
Hoes  
Certan®  
Spray bottle  
Menthol  
Granular insecticide

**ACTIVITIES:**

Examples of disease and pest problems will be observed. Weed, insect and disease preventive and therapeutic treatments will be demonstrated by the instructor. Samples of honey bees will be returned to the laboratory for detection of tracheal and varroa mites.
Prevention

**Terramycin** - antibiotic for American foul brood disease.
- **Dusting** Mix Terramycin with powdered sugar. Dust on ends of top bars of brood nest frames.
- **Bulk feeding** Mix Terramycin into sugar syrup.
- **Extender patty** Mix Terramycin with sugar and vegetable shortening. Place patty on top of brood nest frames.

**Fumadil-B** - antibiotic for *Nosema apis*.
- **Bulk feeding** Mix fumagillin into sugar syrup.
- **Extender patty**

**Certan** - bacterial insecticide for Greater wax moth.

**Fumitoxin** - fumigant for wax moths.

Fumigate all boxes and frames before returning to the apiary.

**Menthol** - crystals used for tracheal mites.

**Apistan** - Varroa miticide.

Place two Apistan strips between two frames in the brood box of each hive.
Diagnosis and Treatment

Hopefully preventative measures have kept the hives healthy. Checking brood health regularly will alert beekeepers of any problems.

Checking brood health:
- Look for regularity in the arrangement of eggs, open larvae, capped brood and emerging bees
- Larvae in open cells should be plump, glistening, and pearly white.
- Brood cappings normally are uniform and raised slightly above the comb surface.
- Cappings are free of visible holes until emerging bees cut their way out of the cells.

If anything is abnormal, observe symptoms to make a diagnosis.

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<td>• pepperbox appearance of brood</td>
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<td>• sunken, dark brown, or punctured cappings</td>
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<tr>
<td>• dull white, brown or black larvae</td>
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<tr>
<td>• stirred larvae has ropy texture</td>
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<tr>
<td>• scales in cell bottoms</td>
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<th>Symptoms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• chalky &quot;mummies&quot; found in cells of brood nest, hive entrance, and on bottom board</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnosis:</th>
<th>Chalkbrood (fungus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment:</td>
<td>Maintain strong, populous colonies. Use bee stocks that show evidence of resistance.</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Diagnosis</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>• disjointed wings</td>
<td><em>Nosema</em> (microsporidian)</td>
</tr>
<tr>
<td>• distended abdomens</td>
<td></td>
</tr>
<tr>
<td>• absence of stinging reflex</td>
<td></td>
</tr>
<tr>
<td>• bees crawling on ground, unable to fly</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Diagnosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• small red mites present on bees. Most common on drone pupae.</td>
<td><em>Varroa jacobsoni mites</em></td>
<td>Apistan® Strips</td>
</tr>
</tbody>
</table>
Lab 10 - Honey Evaluation
Honey Evaluation

***Remember to bring your lunch to lab!***

OBJECTIVE: To compare physical and taste characteristics of honey from several different floral and processing types.

MATERIALS:
- Refractometer
- Liquid honey
- Chunk honey
- Honey candy
- Napkins
- LoVibond honey grader
- Spun honey
- Tasting sticks
- Drinking water

ACTIVITIES: A variety of liquid honey will be tested for color and moisture content. The class will taste a variety of honey products to compare and contrast their properties (and have fun!).
Lab 11- Queen Rearing

• Small Scale Queen Rearing
Queen Rearing

OBJECTIVES: To learn effective techniques of handling queens, working with nucleus hives and rearing queens.

MATERIALS: Queens
Queen marking paint
Small scissors
Nuc. boxes
Sharp knife

Toothpicks
Smoker
Newspaper
Grafting equipment

ACTIVITIES: New queens will be reared and placed into weak hives. Queen builder colonies will be set up for use with the natural, Miller, and Doolittle queen rearing methods. Miller frames will be prepared for introduction into a queen builder hive. Young female larvae from a breeder colony will be grafted into queen cell cups for placement into a queen builder via the Doolittle method.
4 Natural Methods:

1. Remove queen from colony. Supercedeure replaces her.
2. Cage queen away from brood nest. Supercedeure replaces her.
3. Create a queenless colony using brood from strong hives. A new queen will be made by a queenless colony.
4. Use a divider board to separate into two brood nests. The side without a queen will make a new queen.

Miller Method:

1. Make a Miller frame with foundation strips. This frame is two strips of foundation about four inches wide at the top and tapered to a point at half the depth of the frame.
2. Place Miller frame into strong breeder colony brood nest for one week. By the end of the week the foundation should be drawn out with worker cells and partly filled with eggs and young larvae.
3. In the mean time, create a cell-building colony using a queen and two frames of young brood from a strong colony.
4. Remove Miller frame from breeder colony.
5. Cut strip with a sharp knife to expose youngest larvae. Insert frame in the center of a cell-building colony. The bees will build queen cells along the border of the comb.
6. In ten days carefully cut off the cells.
7. Place new queen cells into nuclei.
8. Remove queen cells and Miller frame after ten days.

Nucleus Method:

1. Place one frame of brood, one of pollen, and one of honey into nuc.
2. Use entrance feeder.
3. If cool weather allows, plug entrance with green grass.
**Doolittle Grafting Method:**

1. Create cell cups using melted wax and a cup former.
2. Place twelve cells on a bar.
3. Using an eyedropper, place a small amount of royal jelly in each cell cup.
4. Transfer worker larvae 36 hours old or younger onto royal jelly.
5. Place frame with cell cups in center of a cell-building colony.
6. Remove after ten days and distribute among queen mating nuclei.
Lab 12- Swarm Capture

Figure 23. Swarm on a branch.
Swarm Capture

OBJECTIVE: To learn how to hive a honey bee swarm.

MATERIALS: Hive body with frames of honey, pollen, drawn comb
Smoker
Entrance reducer
Bee brush
Limb trimmer
Cloth or newspaper
Cardboard box
Spray bottle with sugar syrup

ACTIVITIES: The class will capture a swarm, place it into a hive body
and return it to a campus apiary.
Swarm in a tree or shrub
1. Cut limb (gently).
2. Place limb in front of hive entrance on a cloth or newspaper.
3. Watch the bees crawl in!
4. If the limb cannot be cut, brush or scoop swarm into a cardboard box, then empty in front of hive entrance.

Swarm in a hole in the ground
1. Remove swarm by digging out and scooping bees.
2. Place bees into box.

The New Hive
1. After hiving the swarm loosely place the cover allowing ventilation for the first 24 hours.
2. The hive should be filled with empty comb and foundation.
3. A frame of unsealed brood may help to hold the swarm.