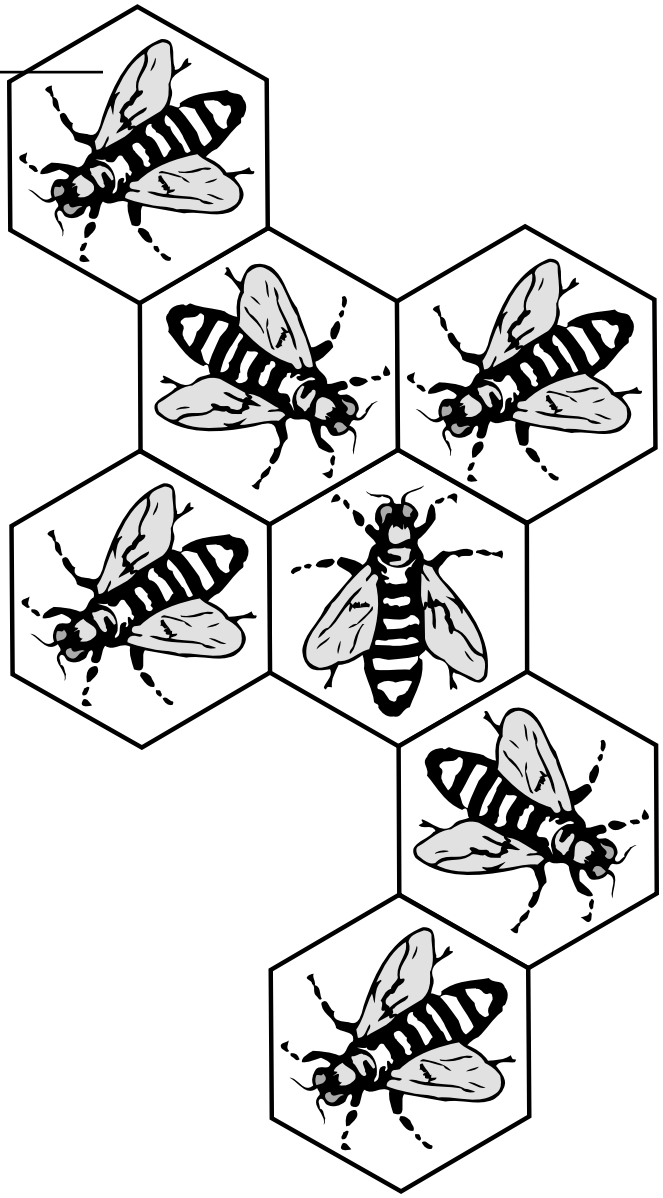
The "What" and "How" of Beekeeping in Hawai'i



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Beekeeping, the "farming of honey bees", can be an enjoyable hobby or a lucrative business if one has the basic skills and knowledge. In Hawai'i, with it's moderate climatic conditions, beekeeping can be done year round. This educational booklet will present the basics on the "what" and "how" on beekeeping that is easy to understand and learn.

In reading and learning from this booklet, a word of caution...."There are many ways to skin a cat"... and as so in beekeeping, there are many ways to keep bees which are probably as diverse as beekeepers themselves. This booklet provides a guide to the basic procedures used in beekeeping. Remember...what is described in this booklet is ONE way and is by no means the only way.

Introduction to Beekeeping course. Spring 1998

The Honey Bee

The Western honey bee, *Apis mellifera*, is an insect that belongs to the Order Hymenoptera, Family Apidae. In the world there are other types of bees that are closely related to the honey bee but they do not have the same colony and behavioral characteristics.

The honey bee is a social insect. It lives in a colony that is made up of three classes; one queen, several hundred drones, and several thousand workers.

The queen is a fertile female who lays all the eggs for the colony. The eggs are laid in honey comb cells and after the larvae hatch, it is the responsibility of the workers to care for the developing young. She can be recognized because she looks more like a wasp and is longer than the other type of bees in the colony. The queen has a stinger but the stinger is used only in battles with other queens.

The drones are males who are responsible for mating with the queen. They are relatively large and rounded and not wasplike. A drone does not have a stinger.

The workers are sterile females that conduct the remaining duties of the hive. The workers clean the hive, defend (they have stingers that are attached to a poison gland) and maintain the hive, feed the developing larvae, produce honey comb, and collect food for the hive in the form of pollen and nectar (which they turn into honey).

Beekeepers "keep bees" for several reasons. The primary reason for many is honey which is usually collected and sold in an extracted form. Other products which can be collected from a honey bee hive are: beeswax which bees use to construct the honey comb cells (used for egglaying and young development and for storage of pollen and honey), propolis which are plant resins and gums that the bees use as a hive sealant, pollen which is collected from flowers and used as a food source, and royal jelly which is a substance fed to young larvae as a food source and which is produced by the worker bee.

For agricultural purposes, the other main reason for having honey bees is to help in pollination. There are many types of plants and trees which are dependent on insects to help in pollination. Without adquate pollination, fruit set and therefore crop production can be low. Honey bees are considered good pollinators because when they collect pollen for their own needs, the pollen, which becomes trapped on their hairy bodies, is passed from flower to flower. Honey bees are very plant specific and only collect pollen from one plant species at a time and that is why they are so efficient in pollination.

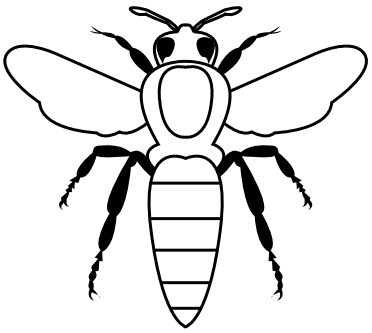
A frame of honey bees.

Honey Bee Anatomy and Biology

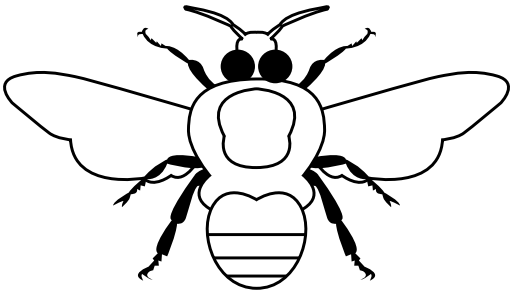
The honey bee has three basic body parts: head, thorax, abdomen. The head has one pair of antennae, one pair of compound eyes, and a set of mouthparts. The thorax has three pairs of legs and two pairs of wings. The abdomen has a stinger in both the queen and worker class but not in the drones.
As indicated in the previous section, there are three classes which make up a colony: queen, worker, and drone. The eggs of all classes, which are white and somewhat banana-shaped, are laid by the queen who inspects the type of cell and then lays the appropriate type of egg (fertilized or unfertilized) into the cell. If the queen determines that the cell is a worker cell, she will lay a fertilized egg. If the queen determines that the cell is a drone cell, she will lay an unfertilized egg. If the queen determines that the cell is a queen cell, she will lay a fertilized egg. Within three days, the eggs of all three classes will hatch into larvae. The larvae, which are white and wormlike in shape, are fed and cared for by the nurse worker bees of the colony. Larvae of all classes are fed royal jelly which is produced in special glands found in the head of the nurse bee. These special glands are most active in worker bees that are between 5 to 10 days old. After three days, larvae that are in drone cells (hatched from unfertilized eggs) and larvae that are in worker cells (hatched from fertilized eggs) are fed a diet of diluted honey and pollen. This diet is fed to the larvae for the duration of their larval feeding period. Larvae in queen cells (hatched from fertilized eggs) continue to be fed royal jelly for the duration of their larval period.

The larvae of all classes enter into a non-feeding pupal stage within a few days. During this period, the workers will seal the cell. Within a few more days, the adult will emerge from the cell. The entire period from time the egg is laid to the time of adult emerges from the cell differs among the classes. For the worker, the period is 21 days. The queen takes 15-16 days and the drone takes 24 days.

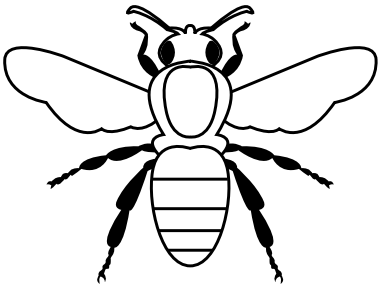
QUEEN



DRONE



WORKER



Basic Hive

In the wild, honey bee hives can be found in the hollow of trees or on the outside of well shaded trees, inside structures like houses and sheds, or discarded boxes to name a few. In the past, man used hollow wooden squares, woven baskets, or logs to house bees so that honey could be gathered easier than to search for honey bee colonies in the wild.

However, man learned that by placing bees into a movable hive (such that the frame pieces can be removed and replaced), the honey bee colony survived better than in the previous mentioned types of hives. Today the standard Langstroth hive is used by modern beekeepers.

The basic moveable hive consists of one to several hive bodies, a bottom board, and a cover. The hive body is a standard dimension of 19" x 16 and 1/2". The depth of the hive body is variable but basically only the deeps (9-5/8") and the shallows (5-11/16") are used. These hive bodies can then be stacked one on top of the other. Depending on where the eggs are laid, the hive bodies have different names.

In assembling the hive parts, the bottom board is placed first (1). The hive bodies are placed on top the bottom board and then the cover on top (2). There is a screen called the queen excluder which can be placed between two boxes so that the queen cannot move freely through all parts of the hive and the eggs are confined to a certain area since the screen holes in the queen excluder are too small for the queen to pass through.

The boxes which are below the queen excluder (usually the lowest one or two) are thereafter called the brood chamber(s) since the name for the developing bee larvae is brood. The hive bodies above the queen excluder which are then used solely for the storage of honey are called the super(s) (3). The entrance to the hive is at the bottom and is created by an opening in the bottom board. Above the top super is the cover (4). In Hawai'i, an additional roofing is sometimes provided to hives that are kept in the open since excessive rain can damage the hive.

The basic dimension and plans for the construction of a hive body, bottom board, and cover are found in Appendix A.

(1) Bottom board
(2) Hive body
(3) Second hive body or super
(4) Cover

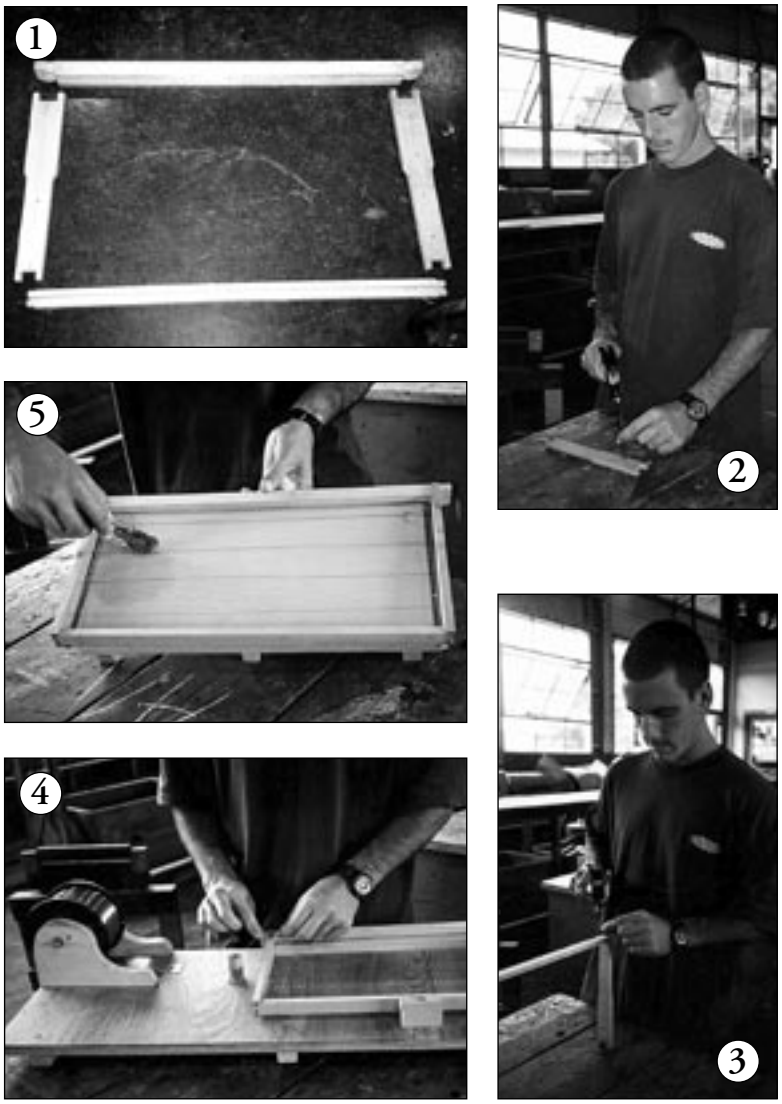
Frames come in standard dimensions and parts and are formed of plastic and/or wood and/or beeswax. The following are the basic parts to a frame: The top bar, the bottom bar, side bars, and the ears (1). The ears are the extensions on the top bar which allow the frame to hang suspended within the hive body.

Frames can be made entirely of plastic including the middle portion which is imprinted with a hexagonal shaped pattern from which the bees build the honey comb cells. This type of frame is purchased directly from a bee supply company fully assembled and ready to use.

Another type of frame is made of wooden pieces (described below) which must be nailed together. The wooden frame is then fitted with a beeswax coated plastic sheet (foundation) which is then inserted into the wooden frame. The foundation is the material upon which the bees will build the honey comb cells on both sides.

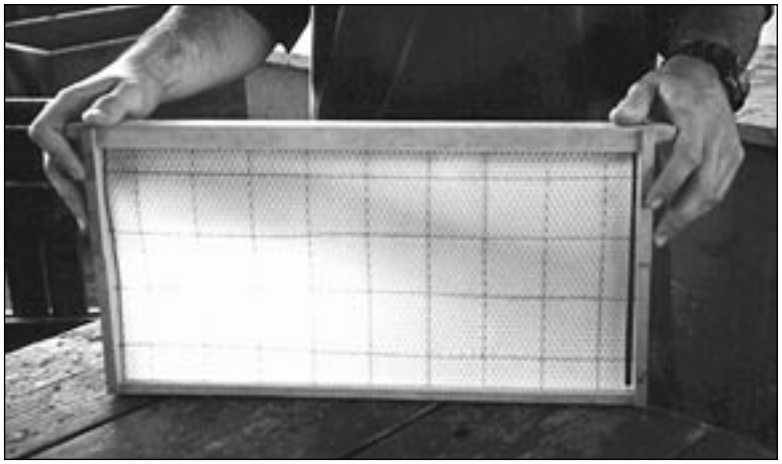
The third type of frame is made of wooden pieces as in the previously mentioned frame type but uses foundation made entirely of beeswax which has an imprinted hexagonal shape pattern and imbedded vertical wires.

For frames that require assembly, metal eyelets must be imbedded into the side bars (2) before the top bar and bottom bar are attached to the side bars. After nailing the four pieces together (3), horizontal wires are strung through the eyelets in the side bars (4). The wax foundation is then slipped into the frame and the foundation is then either mechanically imbedded or melted into the horizontal wires (5).



(1) Parts of a basic frame, (2) Metal eyelets imbedded, (3) Nailing pieces together, (4) Stringing of horizontal lines, (5) imbedding wax foundation

The finished frame



Beekeeping Equipment

Beekeepers rely on certain essential equipment for inspecting and observing the health of a bee hive or for removing frames for honey extraction. The basic equipment used are described below (1).

1. Smoker (see picture). The smoker is designed to produce smoke which is pumped into the hive prior to opening up the hive and while the beekeeper is working on the hive. The smoke has a calming effect on the bees. To start a smoker, paper is added to the smoker and lit. After the fire has started, dried leaf material, wood chips, burlap, or rolled up carboard (example materials that can be used) are added. The cover of the smoker is then closed and the bellow side pumped so that air is directed through the burning material in the smoker to smolder and produce smoke. The type of smoke produced should be "cool" smoke in that there is very little heat associated with the smoke that comes out of the smoker and by no means should there be any flames visible.

Basic beekeeping equipment

Materials needed for smoker.

Adding material to produce smoke.

Pumping smoker to produce smoke with cover closed.

2. Hive Tool (see picture). The hive tool is a multi-functional and essential piece of equipment for the beekeeper. The metal tool is used as a prying device to open the hive and loosen frames, a scraper to take built up propolis (plant resins and gums that bees use to seal up the hive) off the frames and inside of the hive, and a nail remover.

3. Bee Brush (see picture). The bee brush is used to remove bees from the frames and parts of the hive that need to be observed. It is a light weight brush which when used, should be directed at the 45° angle downwards to prevent "rolling" the bees into the brush when removing them.

4. Frame Grip (see picture). The frame grip is a metal clip which is spring loaded and can be opened and closed manually. The frame is opened and attached to the top bar of the frame and when closed, helps to remove the frame from the hive for honey removal or inspection.

Hive Tool

Bee Brush

Frame Grip

Protective Clothing

While no clothing is entirely bee sting proof. Certain clothing has been specially designed to keep beekeepers as cool as possible while providing a high level of protection from bee stings. The following clothing is recommended:

1. Bee suit (see picture). Usually made from cotton/polyester, a bee suit should be worn loosely over the body.
2. Helmet (see picture). The helemt can be made of various material including plastic or straw. If made of plastic, the helmet has ventilation holes to provide some coolness during use.
3. Veil (see picture). The veil is worn over the helmet to provide maximum sight for the beekeeper during use. The veil can be designed to be connected to the bee suit with a zipper or is attached around the body by string.
4. Gloves (see picture). Gloves can be of cloth or leather and has ventilation panels on the sleeve area. The gloves are worn over the hands and lower sleeve portion of the bee suit.
5. Shoes and leg straps (see picture). Covered shoes are recommended when working with bees. When the bees are of a more aggressive temperment, leg straps are recommended. Leg straps are used to close the bottom of the bee suit pant legs so that the bees do not crawl up into the suit. Another less expensive method is to use masking tape to attach the bottoms of the suit legs to the shoes.

Beekeeping clothing

Beekeeper dressed in clothing.

Inspecting A Hive

With the proper equipment and protective clothing, the beekeeper is now ready to inspect a hive for honey and healthy brood. The basic procedure would include the following:

1. Start smoker and make sure there is adequate material available so that the smoker can be restocked if necessary. The smoker needs to be refilled periodically if hive inspection or honey removal takes a while to complete.

2. Smoke entrance to hive (1). Wait several seconds. Using hive tool, pry open cover to hive and smoke the tops of the frames (2). Close cover after smoking and wait several seconds. Remove hive cover. With hive tool, scrape built up propolis off hive cover and place cover on the ground near hive (3).

3. When inspecting for honey (4), frames above the queen excluder should be checked as follows: using a hive tool, remove excess propolis on the top bars. Also loosen frames with hive tool. Using frame grip, clamp top bar of one of the middle frames. Using hive tool loosen ear portion of frame so that frame can be removed from the hive body. Check progress of frame to see how much of the honey comb cells are capped. If 75% of both sides of the frame are completely capped, the frame is ready for extracting. Replace frame and check all of the other frames to see how many frames are ready for extracting (5). Individual frames that are fully capped or entire hive bodies can be removed. During the entire inspection process, be sure not to stand directly in front of the hive entrance.

4. When inspecting a hive for healthy brood, the following procedure should be used: Using a hive tool, separate each of the supers (hive bodies above the queen excluder) and remove from top of hive. Place on side on top of hive cover.

(1) Smoke hive entrance
(2) Smoke under cover.
(3) Remove propolis.

5. Remove queen excluder but make sure that the queen is not on the queen excluder. Place queen excluder on supers.

6. Using frame grip, clamp onto the top bars of one of the middle frames. With the hive tool loosen the ears of the frame and remove frame. Use bee brush to gently remove bees from frame so that it can be inspected.

7. To check for healthy eggs. Make sure one egg is laid per cell and that the eggs should be banana shaped and a whitish color.

8. To check for healthy larvae. the younger larvae will be at the bse of the cell in a "C-shape" and should be a white color. The older larvae should be more upright and a white color.

9. To check for healthy pupae. The cells containing pupae should be completely sealed. The caps should be slightly domed for worker pupae and very domed and larger for drone pupae.

10. Frames containing brood (eggs, larvae, pupae) should on the middle frames of the brood chamber. The outer frames will have very little brood and mostly honey and pollen.

11. When inspecting the brood chambers it is important that the frames be placed back into the hive body in the same positions.

12. Continue to use smoke freely during honey removal or brood inspection. Do not pound or disturb the hive with sudden vibrations during inspection or honey removal. When through, replaced all hive bodies.

(4) Inspecting for honey.
(5) Frame ready for extracting.

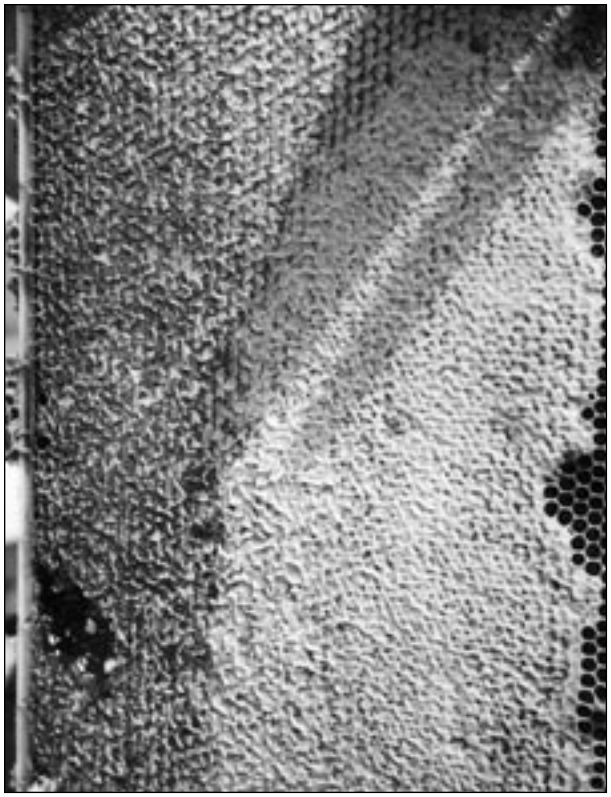
Extracting Honey

There are different methods for extracting honey depending on the number of frames that need to be extracted and how frequently one needs to extract.

1. When choosing frames from the hive that are ready for extracting, choose those that have at least 75% capped cells. Honey is considered "ripe" only when the bees seal the top of the cell with wax. Prior to sealing, the honey is considered "green" and is still in the process of being converted from nectar to honey. If too much "green" honey is extracted, the moisture content of the honey extracted will be too high and the honey will be subject to fermentation. Also when removing frames, make sure to always leave some honey for the bees to prevent robbing. When there is insufficient nectar available in the f ield or no honey in the hive, foragers will try to "rob" or steal honey from a neighboring hive.

2. Once the frames have been removed from the hive, excess propolis on the frames is removed with a hive tool (see picture).

3. The cells are then upcapped using an electric upcapping knife (see picture). If only a few frames are to be uncapped, a large knife dipped in hot water can beused. Once the cells are uncapped, any remaining uncapped cells are opened using a scratcher (see picture). The scratcher has long metal prongs that are punched into the uncapped cells to open them up for extraction.



Frame ready for extracting

Uncapping cells.

4. Once all the cells on both sides of the frame are uncapped, the frame is placed into a manual or electric extractor. There are very small extractors which accomodate as little as two frames to larger commercial extractors which accomodate 20 or more frames and even supers. Using centrifugal force, the honey within the cells are pulled out as the uncapping unit spins. Once both sides of the frames are empty of honey, the process is repeated with remaining f rames.

5 . For just a few frames, the uncapped frame can be set onto a wire rack with a tray below and overnight the honey will drip out. The frame is then turned over to remove the honey from the other side.

6. The extracted honey is then strained and placed into a holding tank or bucket for settling. The honey should be allowed to settle overnight so that the air bubbles, wax pieces and rubbish that were not strained out initially floats to the top. There are special buckets with draining gates at the bottom which allows the settled honey to be removed without disturbing the debris on the top.

7. After extraction, the wax cappings can be placed into a colander or strainer to remove the excess honey. This honey can be saved for use but not for commercial purposes. The wax can now be cleaned and processed (see section on wax).

There are other forms of honey such as creamed honey which uses extracted honey which is further processed so that the consistency of the honey is more like butter or jam.

Beekeepers can also make chunk or comb honey which uses special frames and boxes and is sold with the honey still in the comb. Materials for this type of honey comb production can be ordered from a bee supplier or manufacturer.

Scratcher.

Into extractor.

Wax cappings.

Beeswax

Beeswax is produced by worker bees and used in the construction of honey comb cells. These cells are used to store pollen and honey for food and used by the queen to deposit eggs (one per cell) which will hatch into a larva and develop into an adult worker, drone or queen.

Beeswax is produced by worker bees that are about two weeks old days old. These worker bees consume large amounts of honey then hang onto frames motionless upside down while four pairs of wax glands on the underside of the abdomen produce wax scales.These wax scales are then picked up by thelegs of the bee and placed into its mouth. The wax is then softened and used to build hexagonal shaped cells onto the frames.In addition, beeswax is also used to seal the tops of cells when the process of turning the collected nectar to honey is completed.

Research studies have shown that the average amount of honey consumed for every pounds of wax produced by worker bees is about 8 pounds. Thus, beekeepers should try to recycle as much comb as possible so that the bees can produce more honey.

In the process of extracting honey (see section on extracting honey), the wax cappings are separated from the extracted honey. The wax cappings can then be cleaned and melted for use. Cleaned beeswax can be used for (to name a few) candle making, returning it to the bee company for a discount on wax foundation, art, and cosmetics.

Beeswax

Honey comb cells

There are different methods for melting wax 1. Solar wax melter, 2. Sack method, and 3. Simple straining.

Solar wax melter. The solar wax melter is an apparatus which can be constructed with simple materials. It does not extract a large percentage of the wax f rom the cappings (about 30-40%) but it requires very little labor. The solar wax melter consists of a large glass covered wooden box with a metal bottom. The wax cappings are placed into the box on the metal plate. The box is then closed and directed towards the sun.

The wax from the melted combs moves down the plate through a metal sieve and into a container which can be removed. The container is periodically changed as it fills and allowed to cool to form a hardened wax block.

Sack Method. In the sack method, the cappings are placed into a burlap or other cloth sack. The sack is submerged into a tank of hot water. With a stick, the bag is continuously stirred which releases the melted wax f rom the bag into the water. When the sack is empty of cappings and only the rubbish parts are left in the sack, the sack is removed and the water/wax mixture is allowed to cool. The wax layer will harden on the top of the water layer and can be removed.

Simple straining. The cappings are added to hot water and the mixture strained for rubbish. The solution is allowed to cool and the wax layer will harden on the top.

Swarms

A swarm is a collection of bees that has left its original hive. It is composed of several thousand bees and a queen. It is nature's way of producing more hives and colonizing bees into new areas.

There are several reasons why swarming occurs which include improper ventilation of the hive or poor egglaying capabilities of the queen.

Once a swarm leaves its hive, it will search for a new shelter as a permanent home. The swarm may move several times, staying a few hours to a few days, in a temporary location until the scout bees have located a permanent site or another temporary location. When the bees are at a temporary location, they mainly cluster around one another forming what looks like a "ball of bees". As they move from location to location, they move in mass which appears to be a thick cloud of bees all moving in the same direction.

Prior to swarming, the queen of the original hive will lay a series of eggs in queen cells and in most cases just prior to the emergence of the new queen, the original queen will leave with a portion of the workers. The first newly emerged queen will kill off the developing queens in the other cells and take over the original colony.

Signs that a hive is preparing to swarm include: 1. large numbers of bees clustered at the entrance and 2. a large number of developing queen cells.

To prevent swarming, the beekeeper must make sure that there is adequate space and ventilation in the brood chamber and that the queen is very productive.

Capturing a swarm is an easy way to get started with a hive if you do not have access to a strong hive to make a split. A cardboard box or burlap bag large enough to slip over the swarm is needed. If the swarm is on a branch of a tree with no extending branches, the bag or box can be placed directly below and with a sudden motion downward of the branch, the bees are dislodged from the branch and the box or bag closed. If there are branches or other objects in the way, clip and remove as much as possible to inusre that most of the swarm is directly below the box or bag. Most of the bees should be in the bag or box af ter shaking and can be transported to the desired site. A bottom board and hive body should be in place. If available a frame of honey and young brood should be placed in the hive to help the swarm get started. The young brood helps the colony establish itself should the queen be missed or die during the transport procedure.

Splits

A split is a procedure by which the beekeeper takes one hive and "splits" it to make two hives. The basic purpose to making a split is to acquire more hives. Other ways of acquiring more hives, in addition to dividing an existing hive or buying one, is to find swarms and wild hives but these are not always available.

Prior to doing a split, order a caged queen. The basic procedure in making a split is to have a hive box with bottom board ready next to the hive that will be split. Select a hive that is very strong and has a large number of bees. Remove two to four frames of brood with bees and place it into the new hive box. Make sure that the queen is not on any of the brood frames that are placed into the new box. An additional frame of pollen with honey can also be placed into the new hive box. Replcace empty frames into hive from which the brood and pollen frames were removed. Place the caged queen between two frames of brood, screen side exposed, and place box in desired location. Within a few days, the queen will be released from the cage and begin egg-laying. It also helps queen acceptance if a honey flow is in progress or the beekeeper can simulate a honey flow by scratching some of the capped honey open.

If no caged queen is available, a mature queen cell (usually there are a few always present in a hive at some stage of development) from another hive can be used in its place but there will be a longer time needed before egg-laying occurs and there is a chance that something might happen to the newly emerged queen in which case, the process of finding a new queen will have to be attempted again.

Another method is a two day process but when doing many splits at once becomes much more efficient. Remove two to four frames of brood from a strong hive one story high. Place a queen excluder on top of the existing hive body and place a new hive body on top. Shake all the bees off the frames in front of the entrance and place the clean brood frames into the new hive body which had been placed on top of the existing hive. Place the cover on the new hive body such that the set-up looks like a two-story hive and return the next day. The new hive body with the two to four brood frames should have an adequate number of bees without a queen. Remove the new top hive body and place a bottom board underneath and transport to desired location. Remove queen excluder from existing hive and place another cover on top. Now place a caged queen or mature queen cell as described in the one day system method.

Placing frames into hive for splits.

Making a split.

Requeening

The process of requeening is designed to replace the existing queen with a new one because she is failing or the bees of the hive are not performing satisfactorily. In most places, requeening is done in early spring so that the queen is established and ready for later spring build-up. However, here in Hawai'i, requeening can be done during a wider time period.

The first step is to find the queen (1). If a queen excluder is used, she will be located below the queen excluder which restricts the area you must search for her. Confined to the brood area, the queen is mostly likely on or near the frames in the middle of the hive body. Remove one frame at a time and looks for her one both sides of the frame. If she is not on the first frame removed, place that frame on the outside of the hive and select the next frame. Continue the process of looking for the queen until she is found. Once the queen is located, most beekeepers use their fingers to kill her though there is a special metal device called a queen catcher that can be used to retrieve and hold the queen. Once the queen is killed, inspection of all brood frames should be made to destroy all queen cells (2).

The caged queen is then introduced (3). The cage is placed between two frames of brood with the screened side exposed so that the queen can be attended to by the worker bees in the hive thereby helping to spread her chemical markings throughout the hive. The candy filled tube portion of the cage should be directed slightly downward to allow any melted candy to drip to the hive floor instead of on the queen.

Within a few days the queen should be released from her cage and inspection of the brood frames after 7 days for eggs is the sign that she has been accepted by the colony and is egg-laying properly.

(1) Finding a queen.
(2) Destroying existing queen cells.
(3) Introducing queen in cage.

Year Round Hive Management

Hawaii's climate is relatively mild throughout the year and therefore there is usually some type of plant in flower at any given time. However, most of the large nectar flows occur during the spring. Thus, beekeepers fall into two categories: 1. migratory beekeepers who move their hives as the honey flows move and 2. non-migratory beekeepers who do not move their hives at all during the year.

Non-migratory beekeepers must pay close attention to the amount of honey removed from each hive to insure that during times when there is very little blooming in their area, the bees have adequate food supplies until the next honey flow. During times when there is little nectar activity, be careful to look for robbing (bees stealing honey from another hive). Water should be provided in drier areas so that the bees do not end up being a problem in neighboring areas as they search out water sources such as wading pools, decorative water gardens, or leaking hose pipes. Additional hive bodies need to be added when the bees are actively collecting nectar.

Basic fall management includes checking hives for diseases and treatment if necessary. Some beekeepers routinely treat their hives for American Foulbrood but this must be done when there is no honey flow going on. Nosema can also be present and needs to be treated. Requeening is done during this time of the year as well. Depending on when the beekeeper needs the bees, additional supplements of sugar syrup and pollen can be given to the hives in fall.

Spring management includes rotation of the brood boxes so that the queen lays more eggs equally in both brood boxes. This is needed to build up the number of bees per colony. Additional boxes are added during this time if needed and queen excluders are replaced. After much of the spring and summer honey flows, the queen excluders are removed and the extra supers are not replaced back on the hive.

Diseases and Treatment

Bee diseases fall into two categories: 1. Brood diseases, diseases that affect the larvae and pupae and 2. Adult diseases, diseases that affect adult bees only.

The primary brood diseases found here in Hawai'i are American Foulbrood and Chalkbrood.

Chalkbrood is caused by a fungus and occurs in the brood area in locations with high rainfall or sites that have high moisture. The most obvious symptom is dead larvae covered with a powdery white or white-black fuzz. Basic trreatment is to move the hive to a drier location or widen the entrance to create better circulation within the hive.

American Foulbrood is caused by a spore-forming bacteria. Basic symptoms include punctured cappings of the sealed brood, scattered brood pattern, foul order, and sticky dead remains of the larvae in the open cells. Treatment for this disease is burning of the entire hive or treatment with the antibiotic, Teramycin.

The primary adult diseases found in Hawai'i is Nosema. Nosema is caused by a protozoan. If affects the queen, drone and worker adults. Symptoms include: large numbers of bees crawling around the entrance, lack of stinging ability, and inability to fly. In the queen, decreased egg-laying capacity and for workers and drones in addition to the above mentioned symptoms, reduced life span. When dissecting an infected bee, the midgut would be swollen and white in color. Control is treatment with Fumagillin.

It is always important to be aware of diseased or potentially diseased hives. Equipment used on such hives should be sterilized before being used on a healthy hive to prevent the spread of disease.

Pests of the Hive

In Hawai'i, strong hives usually are not susceptible to many pests. Some pests would include: termites which utilize the hive bodies since the wood is untreated, toads that eat bees as they move in and out of the hive, ants which move into the hive to remove honey and larvae, and the wax moth.

Careful monitoring can eliminate problems of termites. Raising the hives off the ground and providing barriers on the stands can eliminate problems of toads and ants.

Wax moths attack weak hives laying their eggs in the cracks of the hive. The larvae hatch and burrow through the wax leaving webbing tracks which destroy the comb as the larvae feed on the pollen and honey. When the larvae pupate, they move onto the top bars of the frames where the pupae are visible. Weak hives are susceptible to wax moth damage. Increasing the strength of the hive or consolidating the frames and bees should help after the frames with wax moth larvae are removed.

Nectar & Honey

The USDA defines honey as nectar and saccharine secretions from plants which are gathered, modified and stored in the comb of honey bee contianing no more than 25% water. Therefore honey is a "beemade" product.

There is a beneficial relationship between certain flowering plants and honey bees. As a means to insure pollination and fruit set, plants produce a sweet substance (nectar) which attract the bees. The bees gather the nectar and store it in their "honey stomachs" (upper part of the digestive tract). As the bees move from flower to flower gathering the nectar for their own purposes, they move pollen from one flower to flower, thus achieving pollination for the plant.

When the bee returns to the hive with the nectar, it regurgitates the nectar, adds enzymes, passes the nectar to another bee who places it into a honey comb cell. The nectar will then undergo a series of chemical changes and water reduction. Only when the entire chemical process is complete and the moisture content of the solution is below an average of 20% moisture, will the bees seal the top of the cell with wax.

Whenever you see a plant name associated with a honey, it is because the nectar used to make the honey was from that particular plant source.

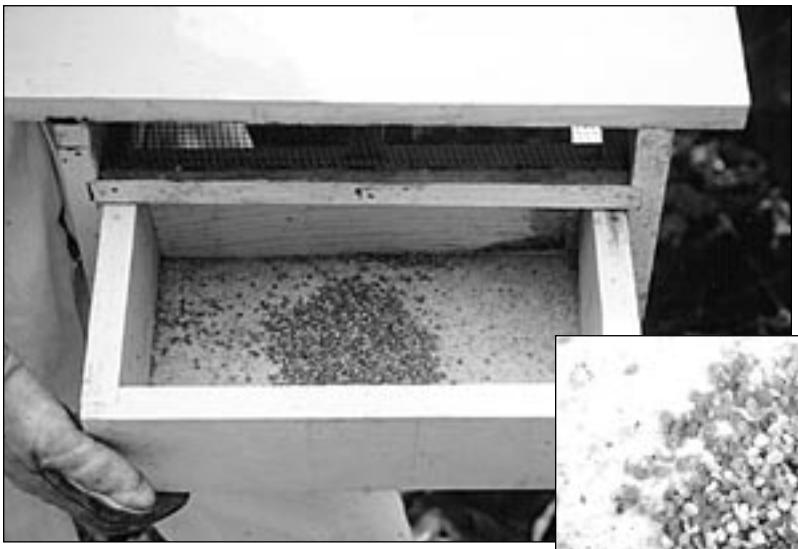
Pollen and Pollen Traps

Pollen is the male part of a flowering plant. It is usually a small particle which is rich in amino-acids and B vitamins. As described in the section on nectar and honey, flowering plants that depend on honey bees to move the pollen from flower to flower in the process of pollination produce nectar. The reason why the pollen is so easily moved by the bee from flower to flower is due to their hairy bodies.

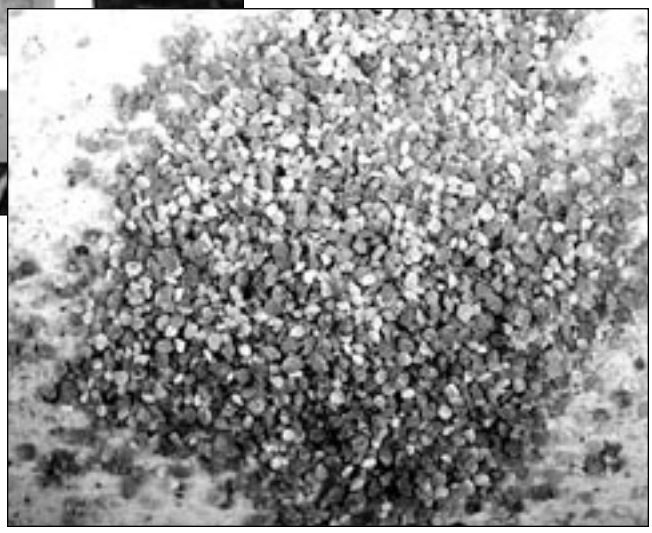
The number of pollen grains produced by the plant is very numerous and as such in addition to collecting nectar from the flowers, the bees also collect pollen. The pollen serves as a food source for the bees and especially for the older drone and worker larvae. The pollen grains on the body of the bees is carefully combed out and pressed into a special holding area on the hindlegs of the worker bee known as the corbiculum or pollen basket. Upon returning to the hive, the bee removes the pollen pellet and pushes it into an open cell.

Special devices called pollen traps can be attached to the hive so that the pollen pellets on the hindlegs of returning bees can be collected before they enter the hive. The pollen trap is a placed at the entrance to the hive and is fitted with a screen closure which allows the bees to enter the hive after the pellets are removed from their legs since the pellets make the bees too wide to enter the hive (thus they only can enter the hive after the pellet is removed). The pellets drop into a collecting drawer and the beekeeper need only open the drawer to remove the pellet.

If using a pollen trap, make sure not to leave the trap on for long periods of time since the bees of the hive need some pollen for their own needs. Using a trap a few days a month should be more than enough to provide the beekeeper with pollen for his own needs.



Pollen trap



Collected pollen pellets

Checklist of Important Skills

Do you know how to.....
Identify all three classes of bees?
Build hive bodies?
Build frames?
Use beekeeping equipment?
Extract honey?
Collect a swarm?
Requeen?
Make a split?
Identify bee diseases?

If you checked off each box, you are ready to venture on your own into the exciting world of beekeeping.
Good Luck!

Acknowledgments

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(Appendix A) A Simple Plan For A Standard 10 Frame Langstroth Bee Hive

Hand Tools: Framing Square, Combination Square, Tape Measure, Hammer and Pencil
Power Tools: Table Saw, Radial Arm Saw, Dado Blade.
Materials:
1. 1" x 12" x 6' pine (shelving, untreated)
2. 1/2" x 24" x 36" exterior plywood (untreated)
3. Nails
4. Glue

Cutting List:

1. HIVE

A. End board	2 pieces	16-1/4" x 9-5/8" x 3/4"
B. Side board	2 pieces	19" x 9-5/8" x 3/4"
C. Handles	4 pieces	4-1/2" x 1-1/4" x 3/4"
D. Nails	20	#4 D. C.
	10	#2 Box nails

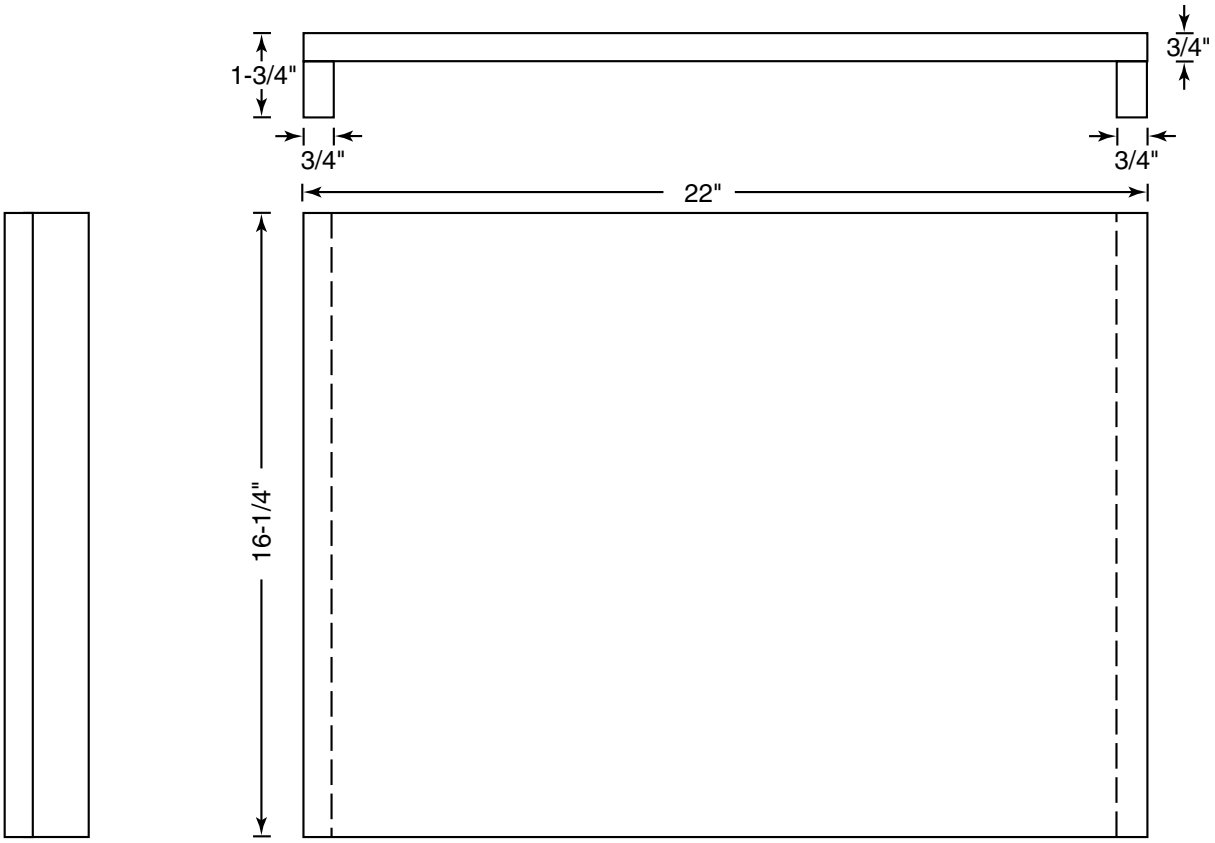
2. COVER

A. Exterior Plywood	1 piece	22" x 16-1/4" x 1/2"
B. End Pieces	2 pieces	16-1/4" x 1-1/2" x 3/4" pine
C. Nails	12	#4 D. C.

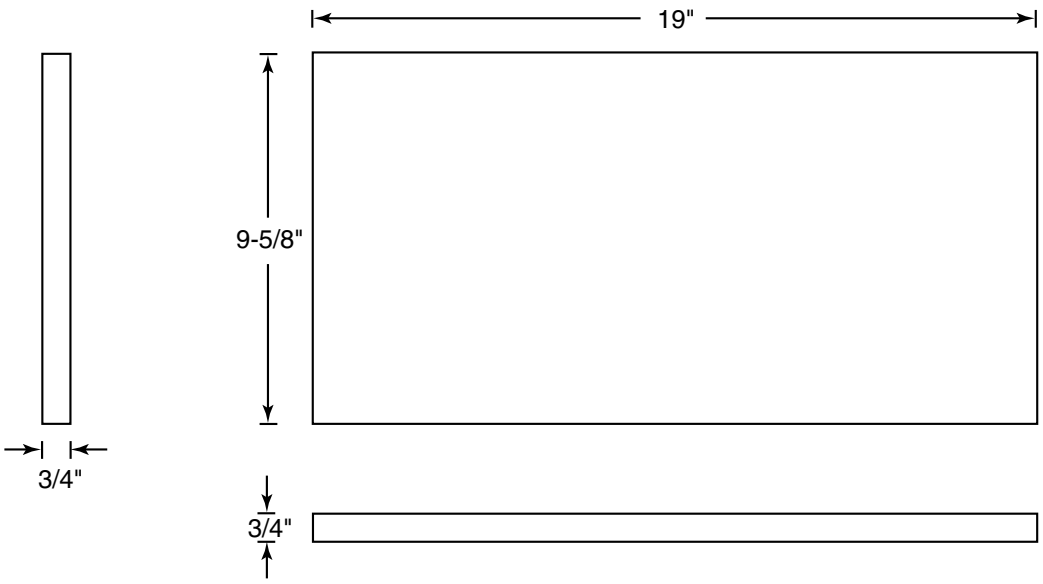
3. BOTTOM BOARD

A. Exterior Plywood	1 piece	22" x 16-1/4" x 1/2"
B. Side piece	2 pieces	3/4" x 3/4" x 21-1/4" pine
C. End piece	1 piece	3/4" x 3/4" x 16-1/4" pine
D. Nails	20	#2 Box nails

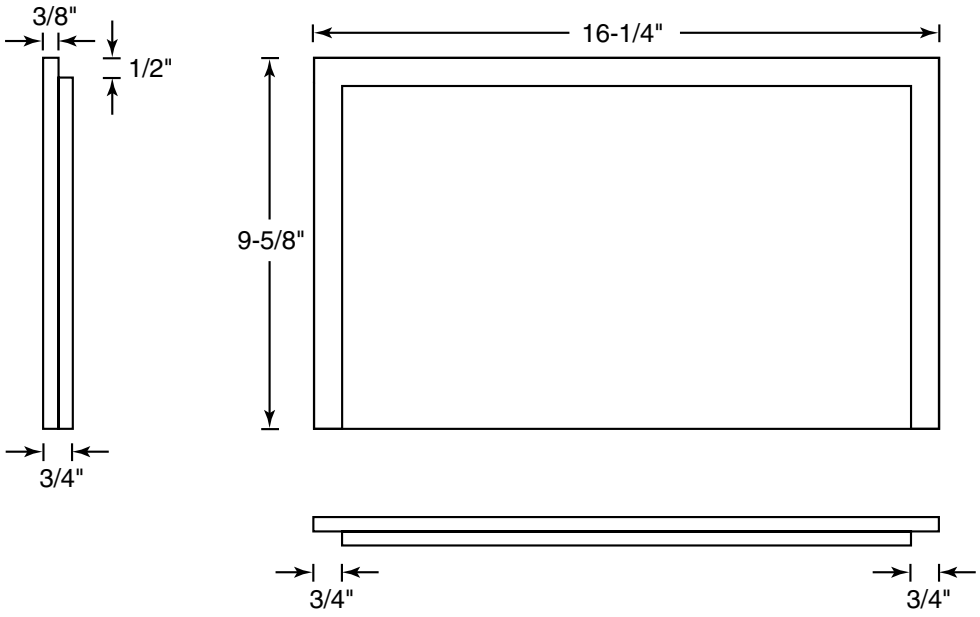
Procedure:
1. Study plans carefully.
2. All cuts with the power saws must be exact and square.
3. Rip 1" x 12" x 6' pine shelving to 9-5/8" width; save the cut piece for parts of the cover board, bottom board and handles for the hive body.
4. Cut the side and end boards of the hive using the 1" x 9-5/8" x 6'.
   a. Before cutting, make sure that the radial arm saw is cutting square.
   b. Check the end of the board to see if it is square, if not, cut about 1/2" off with the radial arm saw.
5. Side pieces of the hive box measures 19" x 9-5/8" x 3/4".
6. end pieces of the hive box measures 16-1/4" x 9-5/8" x 3/4" and this piece requires additional cuts using the dado blade on the table saw.
   a. 2 Rabbet joints 3/8" deep and 3/4" wide for joining the side boards to the end board.
   b. 1 Rabbet cut at the inside top of the end board for the frame rest. This rabbet cut is 3/8" deep and 1/2" wide.
7. To assemble hive box, glue side pieces to end pieces and nail with #4 D. C.
8. Cut ripped peice from the 1' x 12" x 6' with the radial arm saw to make four handles. Glue and nail handles on all sides of the bee hive box and make sure that the handles are centered.
9. Cover board.
   a. Cut plywood to size (see cutting list on page one)
   b. Cut ripped piece from 1" x 12" x 6' pine to make the two end pieces (16-1/4" x 1-1/2" x 3/4") with the radial arm saw.
   c. Glue and nail as shown in diagram for cover board.
10. Bottom board.
    a. Cut plywood to size (see cutting list on page one)
    b. Cut ripped piece from 1" x 12" x 6' pine to make the two side pieces (3/4" x 3/4" x 21-1/4")
    c. Cut ripped piece from 1" x 12" x 6' pine to make the one end piece (3/4" x 3/4" x 16-1/4")
    d. Glue and nail end and side pieces on bottom board as shown on Bottom board diagram.
11. To make additional boxes, follow procedure direction 1 through 8 and buy an additional 1" x 12" x 6' pine.
12. Materials can be purchased at any home improvement center.



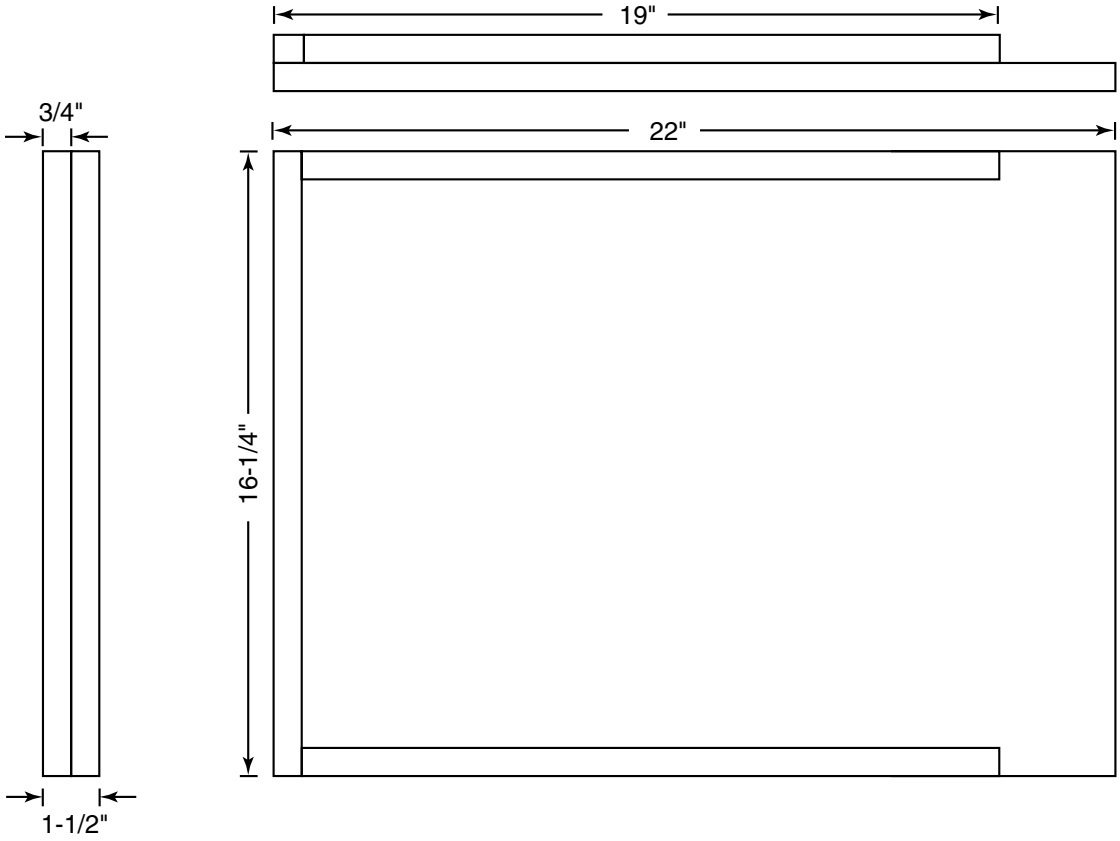
COVER



SIDE BOARD



END BOARD



BOTTOM BOARD