Beekeeping in Asia

Table of contents

FAO Agricultural Services Bulletin 68/4
Food and Agriculture Organisation of the United Nations
Rome, 1990

by
Pongthep Akratanakul
Bee Research Laboratory
Department of Entomology
Kasetsart University
Kamphaeng Saen, Nakhon Pathom
Thailand

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization off the United Nations concerning the legal status of any country territory, city or area or of its authorities. or concerning the delimitation of its frontiers or boundaries

M-24
ISBN 92-5-102518-5

All rights reserved
No part of this publication may be reproduced, stored in a retrieval system, transmitted in any from or by any means, electronic, mechanical, photocopying or otherwise, with he prior permission of the copyright owner Applications for such permission, with a statement the purpose and extent of the reproduction, should be addressed to the Director. Publication Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla 00100 Rome Italy

© FAO 1987

Contents

Foreword

Contents - Next

With this brief introduction to Beekeeping in Asia, the Food and Agriculture Organization of the United Nations continues its programme of publications on apiculture which was initiated in early 1986 with the publication of Tropical and Sub-Tropical Apiculture. Two other volumes respectively entitled: A Practical Guide to Bee Pest and Diseases in Asia and Beekeeping in Latin America, will be published shortly, and it is hoped that other topical volumes will follow.

The potential that beekeeping offers to agriculture, rural employment, nutrition and income generation in developing countries is substantial. Honey provides a valuable food. Beeswax has many uses at home and in industry. Bees are important pollination agents and thus aid crop production. Beekeeping need not interfere with other rural farm activities. The whole family can be involved. The required inputs can be substantially produced locally.

In a continent as vast as Asia, differences in climate, levels of agricultural development, and bee races are so variable that no one book can cover all beekeeping situations. The author of this study draws heavily on his experiences with European honeybees introduced into northern Thailand, but he also discusses the principal features of beekeeping activities in the other zonal and socio-cultural contexts in Asia at different stages of development.

Both the experienced beekeeper and the novice will find a mine of useful information, guidance and suggestions in the publication and it is for this reason that FAO hopes that it will be a useful contribution to the economic development of the most populous continent in the world,

M.S.O. Nicholas
Director
Agricultural Services Division

Contents - Next

Chapter 1 Honeybees of the Genus apis

Contents - Previous - Next

Bees are insects of the Order Hymenoptera which feed on pollen and nectar. They constitute a group of about 20 000 species throughout the world, known taxonomically as the Superfamily Apoidea. Honeybees of the genus Apis belong to the family Apidae, a sub-group of this superfamily. Although the question of how many honeybee species exist is still debated among taxonomists, at least four species are commonly recognized: the dwarf, or midget, bee Apis florea, the giant, or rock, bee Apis dorsata, the oriental (Indian, Chinese, Japanese, etc.) bee Apis cerana, and the common (European, African, etc.) honeybee Apis mellifera. The existence of another giant tree, Apis laboriosa, has recently been confirmed from Nepal, but little is known about its biology.

All honeybee species are eusocial insects, that is to say that they engage in favourable social activity. A colony of honeybees consists of a queen, several thousand workers, and at certain seasons of the year - a few hundred drones. Among the members of the colony there is division of labour and specialization in the performance of biological functions.

The architectural design of the comb of all honeybee species is essentially similar: it consists of adjoining hexagonal cells made of wax secreted by the workers' wax glands. The bees use these cells to rear their brood and to store their food. The general utilization of comb space is also similar among the species: honey is stored in the upper part of the comb, with, beneath it, rows of pollen-storage cells, worker-brood cells, and drone-brood cells, in that order. The groundnut-shaped queen cells are normally built at the lower edge of the comb.

As an inherited behaviour characteristic, all honeybee colonies tend to store a certain amount of honey and pollen as their food reserve. The quantity of food stored depends upon several factors, including the seasonal availability of forage, the worker population of the colony and its rate of reproduction, the capacity of the nest, etc. Another important inherited behaviour characteristic lies in the colony's natural site of comb construction: whereas some Apis species build singlecomb nests in the open, others build multiple-comb nests in dark cavities.

A. The dwarf honeybee Apis florea

The distribution area of A. florea is generally confined to warm climates. In the west, the species is present in the warmer parts of Oman, Iran and Pakistan, through the Indian sub-continent and Sri Lanka. It is found as far east as Indonesia, but its primary distribution centre is southeast Asia. Rarely found at altitudes above 1500 m, the bee is absent north of the Himalayas. It is frequently found in tropical forests, in woods and even in farming areas. In southeast Asia it is not rare to find a nest of A. florea in a village.

As its name implies, the dwarf honeybee is the smallest species of honeybee, troth In the body size of its workers and in the size of its nest. A nest of A. florea consists of a single comb, whose upper part expands to form a crest that surrounds the branch or other object from which the comb is suspended. Dwarf honeybees nest in the open, but not without camouflage: most nests are hung from slender branches of trees or shrubs covered with relatively dense foliage, usually from 1 to 8 metres above the ground. In Oman, where A. florea nests are frequently found in caves, such combs are without crests.

Combs of the dwarf honeybee are well covered with layers of workers clinging to each other' often three or four deep. About three quarters of the colony's worker population are employed in forming this living protective curtain of bees. When disturbed, this curtain shows a "shimmering" movement, the individual trees shaking their abdomens from side to side in a synchronous manner; at the same time, a hissing sound is released. If the colony is further disturbed, the worker trees raise their abdomens and take off from the curtain to attack the intruder.

The section of comb surrounding the support (in Fig. 1/1, a small tree branch) consists of adjoining honey-storage cells that form a crest, from whose inroad curved surface the trees take off and on which they land. The communication dance by scouts, announcing the discovery of a food source, also takes place on this platform. Adjacent to the rows of honey-storage cells is the section of comb which the workers use for storing pollen. Beneath this band of pollen-storage cells is the area where the worker brood is reared. Prior to the swarming season, drone-brood cells are added, adjoining the lower rows of the worker-brood cells. When a colony loses its queen, emergency queen-cells are built from normal cells containing young worker larvae.

To ward off ant attacks, the workers coat both ends of the nest support with sticky strips of propolis, or "plant gum", from 2.5 to 4 cm wide. A. florea is the only honeybee that uses this defensive technique.

During the season when there is an ample supply of nectar and honey, populous colonies of the dwarf honeybee send out multiple reproductive swarms. In addition, colonies of this tree have a high degree of mobility. Disturbance by natural enemies, exposure to inclement weather and scarcity of forage are among the major causes of colonies absconding.

In comparison with other honeybee species, the amount of honey that A. florea workers will store in their nests is small, usually not exceeding several hundred grams per colony. In some parts of Asla, the rural people have devised a scheme for harvesting this honey. First, nests or the bees are transferred from their natural sites to the village, and then, using twine and two short twigs, the nest is clamped and attached to a small branch of a tree. The upper part of the comb, containing the honey, is cut out, and the honey is squeezed out from it. A period of about six to eight weeks is allowed for the bees to repair the comb and replenish it with honey, and then it is harvested again. This method is not always reliable, however, because most colonies will abscond either shortly after their transfer to the new site or after the first or second harvest has taken place.

Where nests of A. florea are abundant, several rural families can subsist on the income generated from beehunting alone. Although the practice appears ecologically destructive, particularly insofar as it reduces a valuable population of natural pollinators, it does not always destroy the colony being hunted. Workers and laying queens of the dwarf honeybee are able to respond to nest predation quickly. The entire colony, accompanied by a laying queen, can fly several meters away to regroup, and later abscond. Some absconding colonies are able to survive to build their new combs in a nearby area.

B. The giant honeybee Apis dorsata

The distribution area of the giant honeybee is similar to that of the dwarf honeybee: it occurs from Pakistan (and, perhaps, parts of southern Afghanistan) in the west, through the Indian subcontinent and Sri Lanka to Indonesia and parts of the Philippines in the east. Its north-south distribution ranges from the southern part of China to Indonesia; it is found neither in New Guinea nor in Australia.

The giant honeybees of Nepal and the Himalayas have recently been reclassified as belonging to another species of Apis, A. laboriosa. It is not yet c]ear whether the giant honeybees of Sikkim and Assam in northern India, western Yunan Province in China, and northern Burma should he classified as A. dorsata or as A. laboriosa, but in the present state of our knowledge, it is safe to consider that all the giant trees constitute a single taxonomic identity. Although minor variations in anatomical, physiological and behavioral characteristics exist among the different geographical races of the giant honeybees, they are essentially similar in all their major biological attributes.

The giant honeybees are found predominantly in or near forests, although at times nests may be observed in towns near forest areas. The bee shares the openair, single-comb nesting habits of Apis florea, suspending its nest from the under surface of its support, such as a tree limb or cliff. In general, A. dorsata tends to nest high in the air, usually from 3 to 25 meters above the gound. In tropical forests in Thailand, many nests are suspended in Dipterocarpus trees from 12 to 25 meters high: this tree is probably preferred as a relatively safe nesting site because its smooth bark and its trunk rising for 4 to 5 meters before branching out make it very difficult of access to terrestrial predators. Nonetheless, about three-quarters of the worker population of a colony of giant honeybees is engaged in colony defence, forming a protective curtain three to four trees thick in the same way as Apis florea. While birds are common predators of A. dorsata, the workers' large body size protects them reasonably well against ant invasion, so that the sticky bands of propolis characterizing the nests of the dwarf honeybee are not found surrounding the nests of A. dorsata, nor are the nests hidden by dense foliage. Nests of A. dorsata may occur singly or in groups; it is not uncommon to find 10-20 nests in a single tall tree, known locally as a "bee tree". In India and Thailand, tree trees harbouring more than 100 nests are occasionally seen in or near the tropical forest.

The single-comb nest, which does not have the crest of honey-storage cells typical of A. florea nests, may at times be as much as one meter in width. The organization of the comb is similar to that in the other honeybee species: honey storage at the top, followed by pollen storage, worker brood and drone brood. At the lower part of the nest is the colony's active area, known as the "mouth", where workers take off and land, and where communication dances by scouts, announcing the discovery of food sources, take place. This dance takes place on the vertical surface of the comb, and during its progress, the bees must have a clear view of the sky to observe the exact location of the sun. Workers of A. dorsata are however able to fly at night, when the light of the moon is adequate.

In many places, the arrival of A. dorsata colonies is an annual event, occurring at the end of the rainy season or at the beginning of the dry season, when several species of nectaryielding plants are in bloom. This phenomenon leads to speculation that A. dorsata has a fixed pattern in its annual migratory route. Most professional bee-hunters know when and where the trees are to arrive, but they wait patiently until the end of the honey-flow period before taking down the nests. Observations in northern Thailand indicate that if the nests are left undisturbed, the colonies will eventually abscond or migrate when their food reserves have been depleted, usually at the end of the summer months. By the beginning of the rainy season, A. dorsata colonies are found deep in the lush jungles.

A. dorsata is well known for its viciousness when its nest is disturbed: the mass of defending workers can pursue attackers over long distances, sometimes more than 100 meters. Notwithstanding its ferocity, however, this tree's honey is highly prized locally, in some places commanding the best prices in local markets,

Nests of the giant honeybee have been hunted by man since antiquity, and today, organized bee hunting exists in many parts of Asia. In Thailand, bee-hunters must pay fees for permits to hunt the bee in state forests, and landowners possessing bee trees sell annual or biennial rights to hunt nests from such trees.

Some professional bee-hunters prefer to work at night. Smoke is used to pacify the bees, which are then scraped from the comb. The nest is cut and placed in a cloth bag, which is lowered to an assistant on the ground. This method does not result in all colonies being killed: about a fourth of the colonies in a bee tree that has been worked over are able to reconstruct their nests.

The recent intensification of bee hunting has caused an alarm in several Asian countries. There is general concern that the total number of A. dorsata nests all over Asia may be on the verge of declining, partly due to shrinking forest areas, the use of toxic pesticides in foraging farm lands, and bee hunting.

C. The oriental honeybee Apis cerana

For ages, colonies of the oriental honeybee Apis cerana have provided mankind with honey and beeswax, as well as furnishing invaluable service in the pollination of agricultural crops. This bee's range of distribution is far greater than those of A. florea and A. dorsata: it is found throughout the tropical, sub-tropical and temperate zones of Asia, occurring in the Indian sub-continent and Sri Lanka in the west, through southeast Asia, to Indonesia and the Philippines in the east. Further north, it is found in the southern USSR and China, through the Korean peninsula, to Japan. This wide range has led to important variations among the bee's geographical races: particularly between the tropical and temperate races, there are wide differences in workers' body size, nest size, colony population and swarming and absconding behaviour, The temperate and sub-tropical races appear to store greater quantities of food than the tropical races, which in turn are more mobile than the former, tending to swarm, abscond and migrate quite frequently.

In the wild, the oriental honeybees construct their multiple-comb nests in dark enclosures such as caves, rock cavities and hollow tree trunks. The normal nesting site is, in general, close to the ground, not more than 4-5 meters high. The bees' habit of nesting in the dark enables man to keep them in specially constructed vessels, and for thousands of years Apis cerana has been kept in various kinds of hives, i.e. clay pots, logs, boxes, wall openings, etc. Despite the relatively recent introduction of movable-frame hives, colonies of Apis cerana kept in traditional hives are still a common sight in the villages of most Asian countries. As a result, the feral nests of the oriental honeybee in tropical Asia sustain fewer casualities in being hunted by man than those of the dwarf and giant honeybees.

The several combs of an A. cerana colony are built parallel to each other, and a uniform distance known as the "bee space" is respected between them. The body size of the workers of this tree is much smaller than that of the A. dorsata workers, and its brood comb consists of cells of two sizes: smaller for the worker brood and larger for the drone brood. The queen cells are built on the lower edge of the comb. As in the other Apis species, honey is stored in the upper part of the combs, but also in the outer combs, adjacent to the hive walls.

Following the invention of the movable-frame hive for the European honeybee about a century ago, traditional beekeeping with A. cerana has been partially replaced by this modern method in several Asian countries, and at the same time attempts have been made - with varying degrees of success - to improve hiving techniques and colony management.

D. The common, or european, honeybee Apis mellifera

There are many geographical races of the common honeybee Apis mellifera, distributed widely throughout Europe, Africa, and parts of western Asia, as well as in the Americas. All these races display similarities in their basic biological attributes, e.g. the construction of multiple-comb nests in dark cavities, colony social organization and division of labour, etc,

In the wild, the natural nesting sites of A. mellifera are similar to those of A. cerana: caves, rock cavities and hollow trees. The nests are composed of multiple combs, parallel to each other, with a relatively uniform bee space. The nest usually has a single entrance. The temperate races prefer nest cavities of about 45 Litres in volume and avoid those smaller than 10, or larger than 100, litres. Colonies of the European races are composed of relatively large populations, usually between 15 000 and 60 000.

Many feral nests of A. mellifera in the northeastern forests of the United States have been reported to store 25 to 30 kg of honey per colony, and even more, during the nectar-flow spring season, and properly managed, commercially operated, colonies yield much more.

Anthropomorphically speaking, this behaviour of the temperate races is obviously an evolutionary advantage: without it, the colony faces starvation during the cold winter months, when food is not naturally available and the temperature is too low to permit flight activity. The shortage of natural forage and the cold temperatures prevailing from late autumn until early spring appear to play an important role in exercising rigid natural-selection pressures on the colonies. As a result, both feral and hived colonies of temperate-zone A. mellifera are less likely to abscond than the tropical races.

The past three centuries have seen the introduction of the common honeybee to all the habitable continents. Outside Asia, beekeeping with A. mellifera constitutes an integral part of modern agricultural systems, furnishing crop pollination services as well as honey and beeswax. Although this bee is one of the most studied animals, many aspects of its biology being fully known, efforts over the past few decades to introduce A. mellifera into Asia have encountered a number of problems, such as the inter-species transmission of bee pests and diseases.

But successes have been reported from several Asian countries as regards the commercial viability and the likelihood of a profitable economic return of beekeeping with A. mellifera. It appears that the adaptability of the bees, appropriate beekeeping technology, better understanding of forage ecology and socio-economic suitability are among the most important factors underlying the further development of beekeeping with the common honeybee in Asia.

E. Honeybee species kept by man

Among the four commonly-recognized species of Apis, only A. cerana and A. mellifera are kept commercially by man. Behavioural limitations of the dwarf and giant honeybees, particularly their practice of open-air nesting, prevents their being kept in man-made hives for reasonably long periods, while hiving colonies in specially-constructed containers is essential in that it enables the colonies to be manipulated.

In many parts of the world, including several countries in Asia, commercial beekeeping depends on moving the honeybee colonies to places where forage is abundant at certain periods of the year. Such migratory beekeeping often calls for the colonies to be moved several times a year, over distances which may range from a few kilometres to several hundred kilometres from the home base. This approach is practicable only when the colonies are in movable-frame hives, which can he transported without danger to the hives or the colonies. From the practical standpoint, therefore, beekeeping can he A dependable agricultural occupation only when the beekeeper can determine and control the number of hives he owns.

Generally speaking, there are two possible approaches to the development of commercial beekeeping in Asia: the introduction of modern beekeeping with A. mellifera or the improvement of existing techniques for using A. cerana. Notwithstanding the difficulties involved in establishing new apiaries of the introduced colonies and in developing colony management techniques suitable to local conditions, A. mellifera colonies are generally more productive than those of A. cerana where forage is abundant, and the development of beekeeping with A. mellifera in Japan, the Republic of Korea, China and northern Thailand is based on this finding.

On the other hand, where forage is available only marginally, colonies of A. cerana survive better and can produce with lower management inputs than colonies of A. mellifera. It is the absconding behaviour of most, if not all, tropical races of A. cerana that creates a major obstacle to the development of beekeeping with this bee in rural areas in southern Asia. Since this behaviour is apparently triggered, at least to some extent, by an unfavourable hive environment, proper colony management may be able to provide at least a partial solution to this problem.

Thus, only through systematic research and development activities carried out locally is it possible to judge which of the two approaches to apicultural development should be adopted to suit the socio-economic situation, the vegetation pattern and the climatic conditions of each locality.

Contents - **Previous** - **Next**

Chapter 2 Honeybee biology

Contents - Previous - Next

A thorough understanding of basic honeybee biology is one of the most important requisites for success in beekeeping. Notwithstanding the fact that they have been kept by man for thousands of years, A. cerana and A. mellifera still retain all their natural biological characteristics. As compared with the other farm animals, they have not been truly domesticated, in that their life history, social organization, behaviour, physio-ecological characteristics and genetic composition have not been significantly altered by man. The honeybees of today are very much like their predecessors of millions of years ago. They live in a tightly-knit social organization in which each individual member of each caste and sex plays a specific role in the survival of the colony and thus improves the chances of continuity of the species. An individual honeybee cannot long survive when it is separated from its colony.

Anthropomorphically, honeybees may appear to possess social intelligence and a reasoning mind, and such misconceptions often lead to colony mismanagement. The fascinating social behaviour of honeybees is uniquely the result of millions of years of evolution through natural selection. It is not an exhibition of a high level of cleverness. Bees behave, or react to environmental stimuli, in a fairly predictable manner. Most of what they do and how they do it is in essence genetically programmed, and only through proper techniques of manipulation can beekeepers put the colonies to work.

A. Colony members

Every honeybee colony is a family, consisting of a single fertile female, the queen, which is the mother of the colony; a large number (ranging from several thousand to tens of thousands) of infertile females, the workers; and, at certain times of the year, several hundred male drones. Taken together, these three categories are referred to as castes.

(1) The Queen

Being the sole member of the female reproductive caste, the queen is indispensable for the survival of the colony. A mated queen serves the colony in two essential functions: laying fertilized and unfertilized eggs, and secreting substances known as pheromones, required for the stability of the colony's social order.

Within a few days of having mated in mid-air with about ten drones, the queen begins to lay eggs, and continues to do so until she is physiologically exhausted. The larvae of female bees (queens and workers) will hatch from the fertilized eggs, while the unfertilized eggs yield drone larvae. Factors determining whether fertilized or unfertilized eggs are to be laid include the size of the cells in the comb and the mechanism underlying the functioning of the queen's reproductive organs. During the mating process, the queen stores sperm from the drones in a storage organ, the spermatheca, within her abdomen. By controlling the opening and closing of the spermatheca, the queen can allow sperm cells to fertilize her eggs or prevent them from doing so. The fertilized eggs are deposited in small worker cells, while the unfertilized eggs are laid in the larger drone cells: the queen can determine cell size and cleanliness by passing her head into the cell and using her front legs to measure its internal width.

Healthy, sufficiently mated A. mellifera queens can lay as many as 1500 to 2000 eggs a day, provided that the colony is strong, that the queen is sufficiently fed and that there is sufficient empty comb space to accommodate the eggs. The workers partially control the queen's egg-laying by regulating the amount of food fed to the queen and by their preparation of empty cells; they also cannibalize the eggs when a food shortage occurs.

Worker bees recognize their queen not by her physical structure but by her scent, given off by the pheromones she secretes. These pheromones, which consist of about 30 organic compounds, have both direct and indirect effects on the colony's social behaviour. During the nuptial flight, they serve as sex attractants, drawing the drones to the queen. Inside the hive, they assist in stabilizing the colony: the workers are aware of the queen's whereabouts by the presence or absence of pheromones. In A. mellifera colonies, some workers act as "messengers" in distributing the pheromones they obtain from direct contact with the queen to other workers within the hive. Under certain circumstances, the presence within the hive of pheromones will inhibit the untimely construction of queen cells: they also inhibit the development of the workers' ovaries, and during swarming they exercise a direct influence on swarm stabilization.

Pheromone communications within the colony constitute one of the most important components of the social life of all honeybee species. Since older queens secrete less pheromones as well as laying less well - than queens in their prime age, and although a queen can live for several years before being superseded by a younger one, professional beekeepers often requeen their colonies every one or two years, in order always to have queens at their maximum biological efficiency.

(2) The Drones

The drones are the male members of the honeybee society reared by the colony shortly before the swarming season begins. As already stated, several hundred drones may be reared by the colony, emerging from unfertilized eggs the queen lays in larger brood cells. In queenless colonies, workers whose ovaries have developed as a result of the lack of inhibiting action by the queen's pheromones can also lay eggs which, being unfertilized because the worker is unmated, also yield drones.

Drones possess no food-gathering apparatus: their sole biological function is to mate with queens. During the mating season, they are well fed by the workers before taking flight. A drone may make from 4 to 6 flights a day, but a smaller number is not uncommon. Drones from neighbouring colonies all fly to a place known as the "drone congregation area", where mating takes place. To ensure successful mating, several thousands of drones must be in the area, although the queen will mate with only about ten. The drone dies shortly after copulation.

When the mating season is nearing its end, the colony reduces its drone-rearing, and when the season is over, the rearing of drones ceases completely. The drones remaining in the hive gradually die of old age, negligence by the worker bees or starvation, or they may simply be expelled from the hive.

(3) The Workers

The workers are an infertile caste of female bees, developed from fertilized eggs. They are suited by their physiological and anatomical features to perform virtually all kinds of chores except reproduction, to increase the chances of the colony's survival. Factors determining the type of task to be executed by a worker include its physiological and anatomical state of readiness, and environmental stimuli, as well as the requirements of the colony to have a particular job done at a particular time.

Soon after emerging from its cell, a young worker receives food, in the form of either nectar or honey, from mature workers, and also helps herself to honey and pollen she finds in the colony's storage cells. In the first few days after she emerges, she is too weak to do anything except inspect and clean empty cells in preparation for food storage by the colony or egg-laying by the queen. During this period she consumes relatively large amounts of honey and pollen, and this directly affects the development of her hypopharyngeal and wax glands.

The secretion from this "nurse bee"'s hypopharyngeal glands, rich in fat and protein, is fed to the larvae, those of all ages in queen cells receiving large quantities; for this reason it is referred to as "royal jelly". Larvae in worker and drone cells receive this special diet only during the first days after hatching; during their later larval life they are fed on a mixture of honey and pollen.

At about the same time as the hypopharyngeal glands of the nurse bee develop, or shortly afterward, four pairs of wax glands, located below her abdominal segments also develop, under the stimulation of consumption of large amounts of honey. From these glands she secretes flakes of whitish wax, which are manipulated by worker bees, using their mandibles, in the process of comb construction and repair and in capping cells.

Under normal conditions, a worker bee is physiologically exhausted from the tasks of secreting royal jelly and wax when she reaches the age of about 14 to 18 days. A few days after this period are spent packing pollen in storage cells, the mouth-to-mouth retrieval of nectar from returning foragers, and occasionally guarding the hive entrance. When she is about three weeks old she ceases to be a "house bee" and becomes a "field bee". At this stage her flight muscles are sufficiently developed, and after orientation flights which enable her to locate the hive in relation to surrounding landmarks, she collects nectar, pollen, water and propolis and carries them back to the hive until she dies.

As already stated, physiological readiness is not the only factor exerting a direct influence on a worker to perform any specific task: environmental stimuli, the condition of the hive, and the colony's immediate requirements are among other factors regulating the type of work to be carried out and the number of bees to be involved in each task. When a colony is running out of space to accommodate brood and food stores, for example, or when combs have been damaged or destroyed, many workers will undertake the task of comb construction and repair; older workers who have already passed beyond the wax-secretion stage can, by consuming large quantities of honey or sugar syrup, reactivate their wax glands and participate in the construction work. Again, when a colony requires a relatively large population of nurse bees to tend the growing number of brood, the duration of royal jelly secretion by the existing nurse bees can be prolonged, provided that the colony has an ample supply of honey and pollen for them to consume. On the other hand, during a heavy honeyflow season younger workers can easily be recruited for foraging as field bees to increase the colony's food-gathering capacity.

B. Development of the honeybee

The first stage in the development of a worker bee occurs when the queen deposits a single fertilized egg at the bottom of a worker cell. After three days, the egg hatches to become a tiny first-instar larva, lying at the bottom of the cell and fed regularly by nurse bees. After successive stages of growth and moults, the larva completely covers the floor of the cell, and it then changes position, stretching out along the depth of the cell. When the larva is fully grown and no longer needs to be fed, house bees cap its cell with a thin layer of wax; unlike the flat cap of a honey-storage cell, the cap of a brood cell shows a slight protuberance.

At this stage the larva, henceforth called "sealed brood", spins a cocoon around itself and begins to pupate, i.e. to shed its last larval integument and differentiate into a pupa. The pupa has all the adult bee's distinct body parts, but they all adhere tightly to the bee's body, and some appendages are not yet fully expanded. Before emerging, the pupa grows gradually darker in colour. Finally, transformed into an adult, it slowly chews its way out of the cell. The complete metamorphosis from newly-laid egg to emerging adult worker requires a total of 21 days: three as an egg, six as a larva, and 12 as a pupa.

For a drone, life begins when the queen deposits an unfertilized egg in a larger drone-brood cell at the bottom of the comb. Like the eggs of worker brood, drone-brood eggs require three days to hatch, and as for worker larvae, nurse bees feed drone larvae, which uncurl along the depth of the cell when their bodies fill the cell floors. When the larvae are fully grown, the nurse bees cease feeding them, their cells are capped, they spin their cocoons, and pupation takes place. It requires 24 days - three days longer than for worker bees - for a drone to develop, from newly-laid egg to emerging adult. Emerging drones are fed on honey and royal jelly until they are about a week old. Their flight activity begins when they are from 6 to 8 days old, but they are sexually mature only when aged from 12 to 14 days.

A honeybee colony will rear a new queen or queens under two circumstances: in the colony reproduction process known as swarming or in an attempt to replace an old queen with a younger one (supersedure) or to create a new queen in an emergency, when the old one is accidentally lost.

Whereas worker and drone brood are, as will be recalled, reared in hexagonal cells, queen development takes place in cells shaped somewhat like a groundnut. Queen cells are of three types: swarm cells, supersedure cells and emergency cells. Swarm queen cells are built along the lower edge of the comb, often in large numbers: as many as 20 cells of various ages may be seen in a colony. Supersedure queen cells, fewer in number, are generally about the same age and built perpendicular to the comb surface; they are usually formed from old, darker wax than swarm queen cells which, built at times of high food availability, usually consist of whiter, newly-secreted wax. The distinctive feature of emergency queen cells is that they are expanded from ordinary worker cells already containing young larvae, and appear to protrude directly from worker-brood cells on the surface of the comb.

The development period of a queen is significantly more rapid than those of workers and drones: 16 days from egg to adult. The queen larva is well provided by nurse bees with royal jelly for her entire stage of development: it is deposited very frequently in the cell, and the queen larva simply lies on a bed of its food; the remains of uneaten royal jelly is often seen in the cell after the young queen emerges. Although larvae destined to become queens and workers are genetically similar in that both are hatched from fertilized eggs, qualitative and quantitative differences in the diet they receive, particularly in the early stages of their larval lives, determine major differences in their anatomical and physiological development.

C. Colony growth cycle; swarming

If a honeybee colony is relatively safe from damage or destruction by its natural enemies, if it has an ample supply of forage, and if the queen and the workers have been performing their duties in an optimum manner, it will eventually outgrow its hive space. When this occurs, the colony is ready to reproduce itself by swarming.

In temperate regions, natural food is available to honeybee colonies only in spring and summer, when warm ambient temperatures permit flights and active foraging. The colony is most busily engaged in brood-rearing during this period, until hive overcrowding and congestion signal the colony to swarm. During the cold autumn and winter months, however, colonies raise only a small amount of brood, depending for their survival on their stored food.

Such a clearly-defined annual cycle does not exist to the same extent in tropical regions, where colonies of indigenous Apis cerana and introduced temperate races of A. mellifera rear brood whenever their food supply is plentiful. Overcrowding of the hive can thus occur at almost any time, and swarming under tropical conditions occurs not annually, but when the seasonal availability of forage permits. Thus, under normal conditions a temperate-zone colony of A. mellifera casts out a single swarm yearly, while tropical races of A. cerana may cast out several successive swarms, each of such secondary and tertiary swarms being accompanied by an unmated queen.

In preparation for swarming, a colony builds new queen cells and rears young queens. At the same time the old queen receives less food and loses weight, acquiring the capacity to fly. Before the new queens emerge, from 30% to 70% of the colony's worker population fill their stomachs with honey as a food reserve and leave the parent hive in search of a new home site.

Upon leaving the hive, usually accompanied by the old queen, the swarm settles near the parent hive until scout bees have located a new site. If the queen is lost at this stage, the swarm will return to the parent hive, since it cannot function without a queen.

D. Colony defence

Colony defence is a duty of the workers. Bees over two weeks old are frequently involved in guarding the hive, most of them having been relieved from their tasks of brood-rearing and comb construction and repair. Their hypopharyngeal glands no longer function at full efficiency, but their poison glands are in the prime stage of development.

Guard bees recognize members of their own colony by a hive odour specific to each colony. Having the same odour, returning foragers have no difficulty in passing through the hive entrance, but most foreign intruders, including worker bees from other colonies with a different odour, are repelled by the defending guards.

The stings of workers of all species of Apis are anatomically similar, being composed of three shafts and barbed at the tip. When a worker bee stings her enemy, the sting, along with its poison sac and part of the gut adjoining the base of the bee's last abdominal segment, is torn from her body and remains in the enemy's flesh when she pulls away. If the sting is left untouched, the muscles controlling the pumping movement of the poison sac continue to function, injecting the bee's venom into the enemy's body. Her last abdominal segment torn away, the worker soon dies, however, from the loss of blood and body fluid through the open wound.

At the same time as she stings her enemy, the worker releases an alarm pheromone from glands near the base of the sting, to alert other workers and indicate the whereabouts of the enemy. The alarm pheromone, which smells to man like synthetic banana oil, is isopentyl acetate. Easily diffused through the air, it brings a rapid response from the workers in the hive.

E. Foraging

Under normal conditions, worker bees begin to forage when they are about 2 to 3 weeks old. Foraging is the last chore in the life of a worker. Once she has begun foraging, she continues in this activity for the rest of her life. Foragers are sometimes called "field bees".

Part of the colony's stored honey is invested in foraging activity: before taking off on a flight a field bee consumes a certain amount of honey to ensure that she will have a sufficient energy supply for her round-trip journey. To obtain a full load of nectar and/or pollen in a single trip, she may have to visit several hundred flowers. The amount of energy she expends, related to the amount of food she collects, is determined largely by such factors as the species of forage, floral density per unit area, the distance from the hive, and weather conditions. Despite opinions to the contrary, flight productivity does not necessarily depend on the capability of the worker bee or of her race.

In the collection of nectar and pollen there is no specialization or division of labour among foragers. There are, however, both qualitative and quantitative differences among flowering plant species as regards nectar and pollen production: not all plant species possess nectaries (glands secreting nectar), and for a forager to collect nectar, the nectaries must be attainable by the bee's proboscis or tongue. Nectaries may be located on many parts of the blossom: base of the stamen and stigma, petals and sepals. Moreover, some plant species have extrafloral nectaries that may be visited by bees.

A forager may appear to prefer the nectar of one flower species over another. This is because it is to her advantage to visit flowers producing greater quantities of nectar with a higher sugar concentration. Further, the sugar concentration in the nectar of a given plant species may vary from one place to another, or from one time of day to another, or even from one plant to another in the same species. If high-quality nectar is available, a forager of Apis mellifera can carry as much as 70 to 80 mg of nectar per load.

Workers of all honeybee species carry nectar internally, part of their alimentary canal being modified to form a "honey sac" or "honey stomach" to accommodate their nectar load. On returning to the hive, the forager regurgitates the nectar to one or more house bees, by which it will be converted into honey. They add to the nectar the enzyme invertase, through whose action the sucrose sugar in the nectar is split into fructose and glucose, the sugars predominant in honey. Using their proboscises, the house bees expose the nectar as a thin film, thus increasing its surface area and ensuring the more rapid evaporation of the water it contains.

The entire body of a worker bee, particularly her thorax, is densely covered with fine, branched hairs, on which pollen grains are caught when the bee works on a flower. She sometimes uses her mandibles to chew off the anthers, or deliberately rolls over the anthers to acquire the pollen. The tibiae of the bee's hind legs are equipped with rows of short setae, which she uses to scrape the pollen from her body and to form it into pellets, sometimes regurgitating a slight quantity of nectar to provide moisture and adhesiveness for this purpose.

The pellets, attached to "pollen baskets" on the bee's rear tibiae, are carried back to the hive, where the load is deposited by itself in a pollen-storage cell. Whereas cells containing ripe honey are capped, pollen-storage cells are not: the bees tightly pack pollen to about two thirds of the capacity of the cell and coat the top surface of the pollen in each cell with honey, This protects the pollen against spoiling.

In addition to collecting nectar and pollen as the colony's food, field bees collect plant gum (propolis) and also water. Propolis, which is exuded by certain plants, often to protect wounds on their surface, is rich in tannin and displays antibiotic activity. It is an adhesive material, which the bees use in comb construction, to coat the interior of the hive, and to seal cracks. In collecting propolis, a field bee uses her mandibles to bite the substance from the plant surface and carries it back on her rear legs to the hive, where the house bees, in their turn, use their mandibles to remove it from the forager.

The honeybee colony needs water for two purposes only: to cool the hive and to dilute the honey fed to the larvae. Like nectar, water is collected by the field bee through her proboscis and is carried back to the hive in her honey stomach, being regurgitated to the house bees on arrival. During the heat of the day, some foragers may switch from nectar to water collection, or they may prefer to collect nectars with a low sugar concentration, whose water concentration is correspondingly higher.

F. Temperature regulation

Honeybees, like all other insects, are unable to control their body temperature internally according to changes in the ambient temperature; for this reason they are referred to as "cold-blooded animals". However, although the individual bee cannot control its body temperature, a populous honeybee colony can regulate the interior temperature of the hive, particularly within the area surrounding the developing brood. In normal colonies, the brood-nest temperature is maintained at a remarkably constant 32-36 C.

By fanning their wings, evaporating the water film at the proboscises of the workers, and dispersing drops of water in empty cells, a honeybee colony can reduce its temperature markedly. When water is available, a colony of Apis mellifera can withstand an external heat of 70° C.

When the external temperature is low, on the contrary, the bees reduce heat losses by clustering together, and the lower the temperature, the more compact the cluster. In addition, in order to generate more body heat, the worker bees will consume more food, especially honey: more heat is released as a result of the increased rate of food metabolism.

The survival ability of honeybee colonies during severe winter months depends on whether the colony has enough workers, adequately provisioned with food. Insulating the hive wall and decreasing the volume of the hive can also improve the effectiveness of the colony's thermal regulation. In the temperate regions,, colonies of A. mellifera survive by forming clusters around the brood nest, the bees at the surface of the cluster and those within it changing their respective positions at intervals. In this manner, A. mellifera colonies can survive temperatures as low as -40° C.

The regulation of brood-nest temperature is not confined to the European races of A. mellifera which further do not lose this behaviour characteristic on being transferred to tropical regions. Tropical honeybee species and races can also regulate their brood-nest temperature to a certain extent, but they are able to survive only mildly cold temperatures, generally not below 0° C.

G. Communication and recruitment to crops

Communication among its members is one of the most important biological attributes of the honeybee colony. All species employ two principal modes of social communication: pheromones and dance "language".

Pheromone communication among the members of a colony plays an essential role in regulating its social life. Apart from the queen pheromones and the alarm pheromone mentioned above, scent-gland pheromones, known as Nasomov pheromones, are used by workers of A. mellifera to mark the site of a food that has little or no scent, in order to assist other foragers in locating the site. The same pheromones are also used extensively by workers in indicating the hive location, and during the process of swarming.

In addition to chemical communication through pheromones, workers of all honeybee species are able to attract their nest-mates to a crop by dancing, scouts announcing the discovery of a new home site or, more often, food source in this manner. The distance from the hive and the direction of the food source are conveyed through a dance "language", which has two important basic forms: the round dance and the tail-wagging dance. The round dance indicates that food is near the hive, and therefore does not give a direction, but the tail-wagging dance gives more details. The distance is indicated by the speed with which the dancer completes her dance cycle, while the direction is shown by the angle of deflection from the vertical made by the bee's abdomen while in movement, which is equal to the angle formed by the lines between the food source, the hive entrance and the sun. If the line of movement is upward, it signifies that the foragers should fly toward the sun, and vice versa. Further, if the dance indicates the presence of nectar, the scout will pause and give a small quantity of the nectar to her fellow-workers, while if the source consists of pollen, she will allow the others to inspect or perceive the odour of the pollen. Finally, the intensity of the dance indicates the richness of the food source: a vigorous dance, indicating a rich source, will attract numerous recruits, while a slower dance, indicating a poorer source, will on the contrary attract fewer recruits.

Contents - **Previous** - **Next**

Chapter 3 Bee forage and floral calendars

Contents - Previous - Next

Honey and most other hive products do not originate directly with honeybees: they are natural products which the bees have collected and processed.

The bees visit flowering plants to obtain nectar, which is the source of honey, as well as pollen. As was seen in Chapter 2, many plant species possess, inside their flowers near the base of the petals, glands called nectaries, which secrete nectar. (Some plants have nectaries unconnected with their flowers, called extrafloral nectaries.) It should be recalled, however, that not all plant species have nectaries that secrete enough nectar to attract bees.

The concentration of sugar in nectar depends on several factors: the plant species and variety, the soil type, the time of day of collection, the temperature and relative humidity, etc. As a rule, plants with a higher sugar concentration in their nectar are more attractive to bees than those with weaker nectars, because in the process of making honey the bees are obliged to get rid of excess water in the nectar, so that in treating more highly concentrated nectars, they need to expend less time and energy.

When the excess water has been evaporated from the nectar and the enzymatic reactions in the conversion of nectar to honey have been completed, the honey is ready for storage, to serve as the bees' reserve of carbohydrates to cover the colony's energy requirements. In the broad sense, then, honey is the colony's energy reserve, all or part of which will be expended in the process of foraging.

From the standpoint of the beekeeper, a colony is "productive" when it stores a surplus of honey, i.e. when it can collect and convert into honey more nectar than it consumes. The beekeeper harvests all or most of this "surplus" honey. In some beekeeping systems, he may have to provide the bees with sugar syrup to replace the honey harvested, particularly at times when the colony requires additional food.

In both stationary and migratory beekeeping, the beekeeper seeks to place his colonies in or near areas where a sufficient quantity of honey plants - be they crop or pasture plants, weeds, shrubs, forest trees, roadside planting, etc. exists, in season or throughout the year, within the economical flight range of the foragers. Planting special crops for bees is not likely to yield a good economic return: arable land will provide better returns if it is used for other agricultural purposes. Beekeeping is thus one of the rare forms of agriculture in which the planting of crops is not specifically required.

A. Honey plants and pollen plants

In order to survive, prosper and be productive, honeybee colonies, as has already been observed, must have a supply of both nectar and pollen in adequate quantities. Not all plant species are equally good for beekeeping. Some supply both nectar and pollen abundantly when in bloom, and these are often called honey plants, because they are best suited for honey production. Plants producing nectar but little or no pollen are also considered to be honey plants. Other plants, however, may yield pollen but little or no nectar. These pollen plants are also important in beekeeping, especially at the time of colony build-up, when the bees need large amounts of the protein contained in pollen for their brood-rearing.

Ideally, a good beekeeping area is one in which honey and pollen plants grow abundantly and with a relatively long blooming season. Such areas are however not always available or easy to find. The beekeeper therefore combines his skill in colony management with migratory practices in order to provide his bees with good, productive foraging environments. He must know the time and duration of the blossoming season of every major honey plant, including the environmental factors affecting them, and make a reasonable assessment of the supporting capacity of each area, i.e. the number of colonies that can be put to productive work there.

Since the practice of modern beekeeping is relatively new in Asia, the compilation of economic bee forages and the identification of areas suitable for beekeeping are still far from complete. Asian beekeepers may find useful information in many internationally-published books, pamphlets and technical articles which contain lists of honey and pollen plants, some of which may already be abundant in parts of Asia, waiting to be exploited by beekeepers. A list of some commonly-known honey plants recorded in some Asian countries appears in Table 2/1.

Table 2/1. Some Important Asian Bee Forage Plants

Species	**Family**	**Common Name**
Aesculus turbinata	Hippocastanaceae	Japanese horse-chestnut
Astracalus sinicus	Leguminosae	Chinese milk vetch
Bombax ceira	Bombaceae	silk-cotton tree
Brassica campestris	Cruciferae	rape
Brassica spp.	Cruciferae	mustard
Calliandra calothyrsus	Leguminosse	calliandra
Castanea pubinervis	Fagaceae	sweet chestnut
Ceiba pentandra	Bombaceae	kapok
Cirsium spp.	Compositae	thistle
Citrus spp.	Rutaceae	orange, pomelo
Clethra barbinervis	Clethraceae	
Cocos nucifera	Palmae	coconut
Croton spp.	Euphobiaceae	
Cucumis spp.	Cucurbitaceae	cucumber, melon
Cucurbita moschata	Cucurbitaceae	pumpkin
Diospyros kaki	Ebenaceae	persimmon
Eriobotrya japonica	Rosaceae	loquat
Eucalyptus spp.	Myrtaceae	eucalyptus
Eupatorium odoratum	Compositae	snakeroot

Euphoria longan	Sapindaceae	longan, lam yai
Fagopyrum esculentum	Polygonaceae	buckwheat
Gossypium spp.	Malvaceae	cotton
Helianthus annulus	Compositae	sunflower
Hevea brasiliensis	Euphobiaceae	rubber
Ilex pedunculosa	Aquifoliaceae	gallberry
Ilex rotunda	Aquifoliaceae	
Lespedeza spp.	Leguminosae	bush clover
Ligustrum japonicum	Oleaceae	privet
Litchi chinensis	Sapindaceae	litchi
Malus pumice	Rosaceae	apple
Medicago sativa	Leguminosae	lucerne, alfalfa
Melilotus alba	Leguminosae	sweet clover
Prosopis cineraria	Leguminosae	mesquite
Prunus spp.	Rosaceae	cherry, apricot, peach
Pyrus pyrifolia	Rosaceae	pear
Rhus spp.	Anacardiaceae	sumac
Robinia pseudoacacia	Leguminosae	black locust
Salix spp.	Salicaceae	willows
Sesamum indicum	Pedaliaceae	sesame
Styrax japonica	Styracaceae	snowball
Tilia japonica	Tiliaceae	linden, lime
Tilia maximowicziana	Tiliaceae	linden, lime
Tithonia tagetifolia	Compositae	Mexican sunflower
Trifolium pretense	Leguminosae	red clover
Trifolium repens	Leguminosae	white clover
Tridax procumbens	Compositae	
Ziryphus jujuba	Rhamnaceae	Chinese jujube

B. Floral calendars

A floral calendar for beekeeping is a time-table that indicates to the beekeeper the approximate date and duration of the blossoming periods of the important honey and pollen plants in his area. The experienced beekeeper will have acquired much of this information over the years, but published charts are also available for many areas.

The floral calendar is one of the most useful tools of the apicultural extension worker. It enables him to inform the beekeepers on what to expect in bee-forage availability, and when, so that they can manage their colonies in the most rational manner. Beekeeping in any specific area cannot develop without an understanding of the calendar, and for migratory beekeeping, special calendars for the different foraging zones along the migration route are required.

Assembling a floral calendar for any specific area is simple but time-consuming. It requires complete observation of the seasonal changes in the vegetation patterns and/or agroecosystems of the area, the foraging behaviour of the bees, and the manner in which the honeybee colonies interact with their floral environment. The accuracy of a floral calendar, and hence its practical value, depend solely on the careful recording of the beginning and end of the flowering season of the plants and how they affect the bees. The preparation of an accurate, detailed calendar will therefore often require several years of repeated recording and refinement of the information obtained.

The steps normally taken in building up a floral calendar are as follows:

1. The beekeeper makes a general survey of the area, drawing up a list of flowering plants found, special attention being paid to plants with a high floral population density per unit area or per tree.

2. He places several strong honeybee colonies in the area, inspecting the hives regularly and observing changes in the amount of food stored within the hive to determine whether it is depleted, stable or increasing. Any food gains or losses can be monitored accurately by weighing the hives.

Fig. 3/1. Floral calendar, in the form of a circular chart, indicating the periods of availability of major nectar and pollen sources in northern Thailand

3. At the same time that he monitors the hives' food stores he surveys areas in the vicinity of the apiary and within the flight range of the bees, to record the species of plants that the bees visit.

4. He determines whether the plants are visited for nectar or for pollen. Pollen-foragers will have pollen pellets attached to their hind legs. To determine whether the bees visit flowers for nectar the observer squeezes the abdomen of individual bees to obtain a drop of regurgitated nectar, tasting it for sweetness or measuring the nectar concentration with a hand refractometer.

5. He studies the frequency with which the bees visit each flower species, in relation to changes in the level of the colonies' food stores. If there is a continuous increase in food stores, in direct response to the availability of the plants visited, the plants are good forage sources. When the food stores remain stable, the plants can be depended upon to meet the colonies' daily food requirements, but they cannot be classified as major honey sources.

6. He carefully records all the changes in the blossoming of the plants visited. When the colonies begin to lose weight, the flowering season is finished for all practical purposes.

Once all the data on forage species have been assembled and repeatedly verified, they should be judged as they relate to the actual performance of the honeybee colonies. The calendar can then be drawn up in the form of circular or linear charts, showing the weekly or monthly availability of each plant and their flowering sequence.

C. Assessment of areas for beekeeping

Productive beekeeping depends on good colony management and good beekeeping areas, and in order to promote it as a profitable agricultural occupation, areas with a good potential for beekeeping must be located and evaluated. Asia is rich in places inhabited by feral swarms of native honeybees, and this fact often inspires premature judgements to the effect that beekeeping can be promoted almost anywhere in the continent where native bees are found. The truth, however, is that most feral colonies of Asian honeybees adopt a migratory strategy, moving with the seasons and the availability of forage. Thus, the temporary presence of a few feral swarms of honeybees here and there, for short periods, does not necessarily indicate that there is enough forage in the area to support year-round commercial beekeeping.

As in the assembling of floral calendars, weighing the hive is one of the most accurate ways of assessing the suitability and supporting capacity of an area. One major problem in this respect is how to select sites for assessment. The following guidelines for the exploration and evaluation of potential beekeeping areas may be found useful:

1. Referring to lists of known major honey plants in other countries or regions with similar vegetation patterns, agro-ecosystems, climate and edaphic conditions, determine whether similar plants are to be found in the area under study.

2. The seasonal occurrence, in unusally high numbers, of feral nests of native honeybees can often indicate that there is ample forage in the area, at least during the period in question.

3. The mere presence of flowering trees and shrubs in limited numbers, or of a few hectares of land covered with good honey plants preferred by bees, does not necessarily indicate that the area has potential for commercial beekeeping.

4. Practical, large-scale beekeeping operations call for large areas, usually hundreds or thousands of hectares of nearby land bearing good forage with high population densities. Good honey plants are characterized by relatively long blossoming periods, generally in terms of several weeks or months; high density of nectar-secreting flowers per plant or unit area; good nectar quality with high sugar concentrations; and good accessibility of the nectaries to the bees. The foraging land should be well proportioned, in terms of length and width, so as to promote foraging efficiency.

5. The supporting capacity of an area for honey production is best determined by monitoring weight changes in the bee colonies. Among other factors that affect the economic value of an area for beekeeping are average hive yields, prevailing honey prices in the area, as well as costs of colony-management inputs.

6. The fact that a flower is brightly coloured or that it has a strong scent does not always indicate that it is good for bees, unless the fact is confirmed by the criteria set out above.

7. The large-scale planting of honeybee forages has never been proved to be a profitable approach in terms of net economic return, except in integration with other agricultural activities, such as reafforestation, roadside plantings, animal pasture, etc.

Contents - Previous - Next

Chapter 4 Beekeeping with oriental honeybees (Apis cerana)

Contents - Previous - Next

The history of beekeeping with Apis cerana in Asia is at least as ancient as that of beekeeping with A. mellifera in southern Europe and the Middle East. The nesting habit of both bees, which leads them to prefer enclosed cavities, has made it possible for man to engage in certain aspects of colony management, most importantly the hiving of the bees in man-made vessels.

Several geographical races of the oriental honeybee occupy the vast Asian mainland, and they possess different behavioural characteristics, particularly those contributing to the bees' capacity for survival. Among the major behavioural characteristics exercising a direct influence on colony management are migration and absconding, colony reproduction rate, colony population size, and foraging and food-storage behaviour.

There appear to he marked differences among the tropical, sub-tropical and temperate races of A. cerana with regard to these characteristics. It therefore has been, and continues to be, difficult - if not impossible to design a single colony-management scheme suitable for all A. cerana races throughout the Asian continent. This chapter will however provide some useful information and general guidelines on A. cerana beekeeping, even if certain modifications of the methods proposed may be necessary for practical colony management in specific localities.

A. Hive types

(1) Log-Hive Beekeeping

Keeping A. cerana colonies in log hives doubtless originated in man's observations of the natural nesting habits of the bees. It is the most ancient form of apiculture in Asia and, inefficient as it seems to be, it is still practiced throughout the continent. On being asked, its practitioners explain that it is traditional. It seldom fails to provide the hive-owner with a certain amount of honey and beeswax, helping him to generate additional income. It can also be undertaken as a hobby or off-farm activity, requiring little investment in terms of capital and time.

Essentially, there is not much that can be done in managing log-hive colonies. Since the general design of such hives permits them to be opened only from the top or base, and since lifting the roof of the hive is often impossible without breaking combs attached to the hive walls, the beekeeper cannot conveniently open his hives to inspect them. Attempts to furnish log hives with top bars have had only limited results, because the cylindrical interior of the hive makes it impossible to prevent bees from building their combs adjoining the hive walls. The difficulty of opening the hive for colony inspection thus precludes many useful techniques of colony management.

There is little room for improvement in log-hive beekeeping, or in methods of handling the honey and beeswax obtained from such hives. The following general indications may however be useful to the log-hive beekeeper:

1. The interior volume of the hive should be from 20 to 25 litres.
2. The hive interior should be coated with melted beeswax to improve baiting.
3. All cracks in the hives should be carefully sealed, and only one opening left as the hive entrance.
4. Hives should be kept in the shade, and safe from major predators such AS ants and hornets.
5. In order to avoid competition among foragers from different colonies, only a few hives should be kept in any one place.

(2) Keeping Apis cerana in Lox Hives

Maintaining colonies of oriental honeybees in box hives is an improved and often less expensive version of loghive beekeeping. In view of current wood prices in many parts of Asla, the cost of building hives from good solid logs can be prohibitive. In some coastal areas of tropical Asia, coconut bark is frequently available for log-hive construction. But where such bark is not readily available and good lumber is expensive, box hives can be built of discarded wooden crates and boxes, or even from scrap lumber.

One advantage of box hives is that their design makes it possible for the beekeeper to open them to inspect the colony. Some progressive beekeepers build their hives in such a way that they can be used with frames or top bars, so that the bees can be managed in a manner similar to beekeeping with standard movable-frame hives.

Unfortunately, there has been no standardization in the size and design of wooden box hives for the entire continent of Asia, one major difficulty being the wide differences in colony populations among the various geographical races of A. cerana. In general, the A. cerana box hives most common in tropical Asia are smaller than the full-depth Langstroth hive, whose volume is about 40 litres (465 mm x 365 mm x 238 to 240 mm inner dimensions). An internal volume of about 20 to 25 litres is considered adequate for most tropical colonies of A. cerana; colonies in larger hives have difficulty in defending their nests against the bees' natural enemies and in controlling the hives' microclimate.

In temperate Asia, where the population size of A. cerana colonies is normally larger than in the tropics, traditional beekeepers use larger box hives, which may reach the dimensions of hives used for temperate A. mellifera, i.e. 35 to 45 litres.

Box-hive beekeepers may find the following suggestions useful:

1. In order to better protect the colonies against pests, all cracks in the hive walls should be sealed, and the size of the hive entrance should not exceed 5 cm^2.

2. In order to ensure that the hive is properly insulated, its walls should not be less than 2 cm thick.

3. A box hive should, whenever possible, be placed in the shade, preferably on a stand suitably protected against ants.

(3) Movable-Frame Hives

Keeping A. cerana colonies in movable-frame hives is the most advanced form of beekeeping with native honeybees employed in Asia. The method allows for virtually any manipulation of the colony: brood-nest adjustments, inspection for diseases and pests, verifying food-store levels, queen rearing, supering during the honey-flow season, etc.

Whereas the full-depth Langstroth hive can be used for temperate and sub-tropical races of A. cerana, smaller hives are required for the tropical races, often from half to two thirds of the size of the Langstroth. Some beekeepers prefer hives with 8-frame supers and 10-frame brood boxes.

Keeping oriental honeybees in movable-frame hives appears to meet with varying degrees of success, most of the difficulty lying not so much in questions of hive design and size as in the bees' biological characteristics. Beekeepers in temperate, sub-tropical and tropical Asia agree in finding that absconding by colonies is their main problem, even more prevalent in the tropics than in the other regions. In this particular case, absconding is not caused primarily by colony mismanagement: it is a form of the bees' genetic behaviour which enables them to evade attacking enemies and to migrate to other foraging areas during dearth periods. Although this trait is biologically favorable to the bees, it constantly threatens beekeepers with the loss of their colonies. Thus, the economic success of beekeeping with A. cerana depends essentially on minimizing the rate of absconding of the honeybees.

B. Obtaining colonies

There are three principal manners of obtaining honeybee colonies: baiting swarms or absconding colonies, transferring bees from feral nests, and buying complete hives.

(1) Baiting

When food is abundant and an Apis cerana colony becomes over-populated, it divides into two or more units, the parent colony and the swarm or swarms, which leave the hive and search out a new home site. Absconding colonies must also find new home sites. Such swarms and absconding colonies can be attracted to a well-prepared and suitably placed bait hive.

Many beekeepers use old empty log or box hives to bait the bees. For better results, the hives should he coated internally with melted beeswax. They can be made more attractive to the house-hunting bees by placing in them a piece of old comb about 10 cm square, containing honey-storage cells. Bait hives should be placed in an open shed or securely attached to a tree or post, about 2 to 3 meters above ground level. The best time of year to put out bait hives in temperate Asia is early spring, and in tropical Asia when the mayor forages are in bloom, usually at the end of the monsoon season.

A swarm or absconding colony will not enter a bait hive unless it is safe from attack by the bees' natural enemies. It is therefore essential for the beekeeper to inspect his bait hives frequently and to take all measures necessary to prevent other animals or bee pests from occupying them. Once a swarm or absconding colony has moved in it is best to wait until comb construction and brood-rearing have begun before attempting to relocate the hive or to transfer the bees to another hive. Methods of transferring bees from bait hives to movable-frame hives are identical to those employed in transferring bees from feral nests (see below).

(2) Transferring Bees from Feral Nests

Despite the fact that transferring A. cerana colonies from feral nests to movable-frame hives is time-consuming, its cost is low and it is practical for villagers with spare time.

The beekeeper can learn of the presence of a feral nest in one of several ways: by active search, often in areas already known to have been frequented by bees; by tracking foraging bees back to their nest; or by word of mouth. Some beekeepers pay a small reward to informants, mostly village children, who report the presence of accessible feral colonies.

Once a colony has been located, the operation is quite simple. The equipment required includes a knife, a hive tool or other means of opening the nest, a hive with empty wired frames, a smoker, a roll of twine, a brush, and a litre of 1:1 sugar syrup in a vaporizer. If available, a portable battery-operated comb-embedder is useful. The beginning beekeeper will need good protective clothing and a veil, but as he gains experience and learns to avoid disturbing the bees unnecessarily, he can dispense with some of this protection.

The best time of day to transfer bees is late in the afternoon, when flight activity is minimum. The beekeeper first applies a little smoke at the hive entrance, and then gently opens the nest wall, exposing the combs. After spraying sugar syrup on the bees until most of the workers are coated with it, he cuts all the brood and honey combs from the nest. He embeds the combs in empty wired frames by gently exercising pressure on them until their mid-ribs reach the wire; this operation is facilitated by heating the wire, if the necessary equipment is available. He further secures the combs to the frames by tying them with twine and then places the frames in the hive, brushing as many bees as he can into the hive with them. It is most important that the queen be with the colony in the new hive. It is useful to find her and place her in a queen cage, to ensure that the workers remain in the hive.

When all is done, the transferred colony is moved several kilometres from its original site, to prevent some of the workers from drifting away. If possible, two or three frames of honey should be given to the newly-transferred colony. The queen should remain caged for three or four days (or a week at most) before being released to resume its egg-laying.

C. Colony management

A honeybee colony will provide the beekeeper with substantial amounts of honey on only one condition: that it is placed in a good foraging area. All other colony manipulations can serve only as complementary approaches, designed to enhance the colonies' efficiency. Past unsatisfactory results in Asian beekeeping development have been due primarily to misconceptions regarding colony management.

Whereas the simultaneous blossoming of both cultivated and wild flora during the spring and summer offer great opportunities for temperate-zone colonies to collect and store their food, this situation does not always apply in the tropics. The natural vegetation pattern in tropical Asia is generally irregular, with diversified populations of many floral species. The simultaneous blooming of a single good forage source, or of only a few, covering large land areas, is a rare phenomenon in undisturbed tropical zones; it is mostly found in cultivated or otherwise disturbed lands, where one or a few species become dominant.

The success or failure of colony management with Apis cerana depends largely on the beekeeper's ability to find good bee forage land and to adjust his colonymanipulation techniques accordingly.

(1) Feeding

Seasonal fluctuations in food availability and the ability of the honeybee colonies to store food are the two most important factors determining whether feeding is necessary. For many years, oriental honeybees have been kept in rural areas of Asia without the colonies being fed with sugar syrup or a supplementary diet of pollen, and this technique is still possible in areas where there is a continuous supply of bee forage all year round, such as on land adjoining coconut plantations. Nonetheless, where such regular supplies are not available, supplemental feeding becomes necessary, especially when the beekeeper harvests all or most of the colony's food stores. Methods of colony feeding are similar to those for A. mellifera (see Chapter 5, D.(3) and (4)).

(2) Prevention and Control of Swarming

The oriental honeybee has a high reproduction rate, and it casts multiple swarms over short periods of time. When swarming takes place, the beekeeper loses a substantial part of his colony population, the inevitable result being a poor hive yield. But there is virtually nothing a beekeeper can do to prevent his A. cerana colonies from swarming, except to maintain them in movable-frame hives and to inspect them regularly in order to determine when he must intervene.

One of the major causes of swarming is hive overcrowding. The beekeeper can increase his hive space by providing one or more additional supers with empty combs, if the colony is strong enough, or by replacing one or two frames of older larvae with empty combs. A routine inspection for the presence of queen cells, at weekly intervals, will let him know whether the colony is preparing to swarm. If such queen cells are found, removing them all is an effective swarm-control method; they can be used to form new colonies. Clipping the queen's wings will not necessarily prevent the colony from swarming: if the old queen is unable to fly, newly hatched queens will leave the parent colony with the swarms.

(3) Reducing the Likelihood of Absconding

It will be recalled that absconding is the colony's natural response to such unfavourable hive environments as lack of food or attacks by the bees' enemies. Correcting these situations can to some extent deter the colony from absconding.

In marginal foraging areas, where food is not abundant all year round, supplementary feeding during the dearth period is necessary, especially, as already noted, when all or most of the stored honey has been harvested.

Colonies of A. cerana are highly responsive to threats by the bees' natural enemies, and it is of the utmost importance for the beekeeper to make every effort to protect his colonies against attacks by bee pests. Heavy predation by hornets, ant attacks, wax-moth infestation and parasitism by bee mites are among the major problems to be dealt with. In this regard, the techniques indicated in Chapter 6 A for the protection of A. mellifera colonies apply to A. cerana colonies as well.

It has often been suggested that a mass programme to select A. cerana races for reduced absconding behaviour constitutes a priority sector in an apicultural development programme. From the practical standpoint, however, genetic manipulations of honeybees are usually difficult. The queens' multiple mating with drones in mid-air forms an obstacle to maintaining any particular breed or gene pool. Drones from feral nests are a major hindrance to selective breeding: unless the breeding site can be isolated, it is impossible to ensure that queens of the selected stocks mate with drones of the breeder's choice, so that the genetic quality of the offspring cannot be guaranteed. Apis cerana queens can be artificially inseminated but the technique is difficult even under normal laboratory conditions, and transferring this technology to rural beekeepers would create many problems. Further, should the selection approach be adopted, a special queen-breeding station for large-scale distribution would be required.

It thus appears that the most practical, and therefore the most appropriate, approach thus far available for minimizing the absconding behaviour of A cerana colonies lies in good colony management: good hive construction, suitable apiary sites, supplemental feeding during dearth periods, prevention and control of honeybee pests and diseases, etc.

(4) Honey Harvesting

Honey-harvesting methods are determined by the type of hive in which the honeybees are kept. With log or simple box hives, the beekeeper has no alternative but to open the hive and harvest the crop in a somewhat destructive fashion, because in such hives there is no separation between brood and honey combs. most of the honey-storage cells being either in the upper part of combs also containing brood, or else in outer combs attached to the hive walls. About half the brood combs should be left in the hive; this practice can assist somewhat in limiting absconding by the colony.

In harvesting honey from log or box hives, the beekeeper applies a little smoke and then uses a sharp, thinbladed knife to cut the combs containing honey from the hive walls or ceiling from which they are suspended. The sections of comb containing honeystorage cells are separated from the brood and pollen cells. The honey is squeezed or pressed from the combs and strained through fine wire mesh or a double thickness of cheese-cloth. Some beekeepers prefer to chop the comb into small pieces and allow the honey to drain out; this method is said to be more hygienic and to yield a clearer honey, with less foam. The rest of the comb, with its pollen and brood, is usually consumed, or sold in the market, as a delicacy.

Generally speaking, honey obtained from log hives is not of prime quality: since opening the hives for inspection is difficult, some "unripe" honey with an excessive moisture content, in uncapped storage cells, is harvested along with the ripe honey. A further inconvenience is that the honey obtained from log hives tends to be limited in quantity, not more than a few kilogrammes per harvest. On the other hand, however, log-hive operators in tropical Asia occasionally obtain two or even three harvests per year.

The advantages of movable-frame beekeeping become especially evident at the honey-harvesting stages. Not only can the hives be opened for inspection to determine the availability and ripeness of the honey they contain, but individual Frames containing capped ripe honey can be removed from the hive, leaving the pollen and brood cells intact. Finally, the honey can be extracted mechanically, and a better-quality product obtained.

Automatic or semi-automatic machinery exists for uncapping honey cells, but in most places in Asia, manual uncapping is preferred. Several thin-bladed knives are heated in boiling water for alternate use. The operator removes any excess water from the knife with a clean cloth, and carefully slices off the caps of the honey cells. When the frames have been uncapped on both sides, they are placed in the extractor, where the honey is thrown off by centrifugal force. (Most Asian beekeepers prefer manually-operated extractors.) The extracted honey is strained through fine wire mesh or a double thickness of cheese-cloth; the cappings, which may contain as much as 10 to 20% of honey, are chopped fine and allowed to drain in the same manner. After 24 hours, most of the honey they contain will have drained off; the residue is heated, pressed, filtered and allowed to harden into blocks of beeswax.

D. Colony propagation

Apart from the methods of obtaining colonies outlined in Section B of this chapter, the beekeeper can expand his Apis cerana apiary by colony propagation, although only those who operate movable-frame hives can adopt this technique effectively, The operation depends essentially on obtaining new queens for colony multiplication, either by working with naturally-constructed queen cells or through special queen-rearing methods which will be discussed in Chapter 5.

As has already been seen, populous honeybee colonies construct queen cells as the initial step in swarming, and the beekeeper can select capped queen cells from healthy colonies. Large, capped queen cells built with new, white wax generally indicate that the immature queens within have been adequately fed for their larval stage. Three or four brood frames with honey and pollen in their upper parts are transferred from healthy, populous colonies into an empty hive. A queen cell is gently detached from its comb, maintained upright, and attached to a brood frame in the centre of the new hive. A few thousand adult bees are shaken into the hive and to prevent them from drifting back to their parent colonies, the newly-assembled hive units are moved to a new location several kilometres away, where there are honeybee colonies whose drone population is adequate to ensure mating with the new queen when she undertakes her nuptial flight.

The queen's life cycle in the new hive follows the pattern established for all queens, as described in Chapter 2. Emerging after a few days, she rests within the hive for a few days more, makes her orientation flights, mates and soon begins to lay. The entire process, from transferring the queen cell from the old colony to the commencement of egg-laying in the new hive is usually accomplished in from 10 to 14 days; during this period, frequent inspection of the newly-assembled hive units is necessary to ensure that all is going well.

It should be emphasized that while this procedure is satisfactory for small-scale operations, a more systematic approach is necessary when a largescale expansion is contemplated. For this purpose, the more sophisticated techniques of queen-rearing, originally developed for Apis mellifera and described in Chapter 5, must be adopted.

E. Bee pests and diseases

The oriental honeybee has inhabited the Asian continent for millions of years, and over this long period various microbial diseases, parasites and predators have found ways of exploiting bee colonies. In fact, it is now believed that the bees' high rate of absconding is an inherited behaviour characteristic which has gradually evolved a response to pressure on colonies from heavy predation and parasitism.

Pest control is one of the most important aspects of the management of Apis cerana. While the primitive design of log and box hives does not allow for much choice in the way of pest-control measures, the least the traditional beekeeper can do is to ensure that the environment of his hives is free from major pests, and to make it difficult for pests to invade the hives. All cracks in hive walls should be sealed; the hive entrance should be kept as small as possible, to limit the ability of wasps and wax moths to enter the hive; to protect them from ant attacks, hives should be placed on stands whose legs are coated with grease or spent oil. But colonies in simple hives cannot he manipulated effectively to control infestation of bees and brood within the hive by tree mites and microbial diseases.

(1) Bee Mites

Two mite species are considered to he serious pests of A. cerana in Asia: the tracheal mite Acarapis woodi and the Varroa mite Varroa jacobsoni. For the most part, the other mites found in association with oriental honeybees feed exclusively on pollen, using the bees primarily as carriers. These "phoretic mites", particularly those belonging to the genus Neocypholaelaps, may be present in large numbers in honeybee colonies, but apart from consuming stored pollen, and disturbing foragers when many of them hoard the bees at once, they are essentially harmless. A simple way of distingishing between parasitic and phoretic mites is that the latter are not found within sealed brood cells, nor within the adult bees' tracheal system,

(a) The Tracheal Mite Acarapis woodi

Beekeepers in parts of India and Pakistan have reported heavy losses in commercially-operated colonies of A. cerana as a result of infestation by the tracheal mite. It is not yet clearly established whether the parasite was introduced into Asia via imported colonies of A. mellifera or whether it is indigenous to Asia. Whereas some beekeepers and apiculturists suggest that A. cerana colonies are more susceptible to the tracheal mite than colonies of the European honeybee, others maintain that the reported losses of colonies are due mainly to the spread of Apis iridescent virus (see below) or to a combined attack by the mite and the virus.

Symptoms and Diagnostic Procedure: It is difficult to determine the presence of tracheal mites in honeybee colonies: the parasites are very small, and they infest the host bees internally, in the thoracic trachea. Adult bees infested by A. woodi show no noticeable signs, but their life-span is shorter than that of uninfested bees; as a result, rapid decreases in colony populations in winter and spring can be observed. The only reliable diagnostic method is the microscopic examination of dissected tracheae of sample bees from colonies suspected of being infested. If present, the mites are usually found within the trachea closest to the bees' thoracic spiracles; the infested tracheae display a colour darker than normal.

Control: The tracheal mite can be controlled by hive fumigation according to the methods set out in Chapter 6.

(b) The Ectoparasitic Bee Mite Varroa jacobsoni

The bee mite Varroa jacobsoni is a parasite of Apis cerana indigenous to the entire continent of Asia. Wherever colonies of the oriental honeybees are kept, there is therefore a possibility of mite infestation. Through millions of years of being parasitized by the mite, the bees appear to have developed some degree of resistance to its attacks. Absconding is one of the colony's manners of ridding itself of the mite, or at least of those infesting the brood, which in such cases is abandoned.

Colonies heavily infested by Varroa produce little or no honey, but most often the beekeeper can lose the entire colony when it absconds.

Symptoms and Diagnostic Procedure: See Chapter 6.

Control: See Chapter 6.

(2) Viral Diseases

At least three viral diseases affecting Apis cerana are known: the Thai strain of sacbrood virus (TSBV), the Kashmir bee virus (KBV) and Apis iridescent virus (AIV). While TSBV affects the brood, the latter two diseases affect the adult bees.

TSBV was first reported in A. cerana colonies in Thailand and has since been reported from other Asian countries. Its natural distribution range may cover the entire Asian continent where feral colonies of the bee exist. In Thailand the disease is found in colonies under "stress" conditions: lack of food, excessive humidity, low worker population, poor-laying queens, etc.

Little is known about KBV, except that it has also been reported in A. mellifera colonies in Australia. In its first recorded presence, It was identified together with AIV in bees from Kashmir.

Recent reports state that AIV has been causing serious damage to commercial colonies of A. cerana in northern India and Pakistan, the virus being associated with "clustering disease". The bees are unusually inactive; they frequently form small, detached clusters of bees that do not fly. Many individual bees are observed crawling on the ground and are lost. At first, these symptoms were associated with the presence of the tracheal mite Acarapis woodi on some diseased bees, but it was later shown that AIV is the major causative agent.

Treatment: No chemical treatment that can be used effectively against the viral diseases of honeybees is available. Since it has been observed that the diseases are most frequently found in colonies under stress conditions. it appears that strengthening the colonies and providing better hive environments are among useful preventive measures. It is suggested that among measures to be taken are requeening the colonies with young, healthy queens, supplemental feeding, adding frames of older brood, and protection of hives from cold, humidity, and strong wind.

(3) Microbial Diseases

Colonies of A. cerana are occasionally found infested with bacterial diseases such as American foul-brood and European foul-brood; other microbial diseases have also been reported. Since much of the technical information concerning the microbial diseases of A. cerana is based on that obtained from experience with A. mellifera. recommendations for their prevention and control with respect to the latter species (see Chapter 6) are also applicable to beekeeping with A. cerana.

Contents - **Previous** - **Next**

Chapter 5 beekeeping with the common (european) honeybee (Apis mellifera)

Contents - Previous - Next

A. Beekeeping equipment

A period of over a century of widespread movable-frame beekeeping with the common honeybee Apis mellifera in many parts of the world has resulted in the development and marketing of virtually all types and sizes of beekeeping equipment. Many innovations in design, and the use of different materials, enable beekeepers to select their equipment according to their own needs and preferences, but certain standard appliances and items of equipment are required in almost any type of beekeeping operation.

It is of great importance that the hive equipment used in any one apiary be of standard size under the Anglo-American or metric system 1/ not only because standardization of equipment offers beekeepers operating convenience and high resale value, but also because most of the supplies and appliances available commercially are tailored to fit standard size designs.

(1) Hive Bodies and Supers

Properly speaking, the expression "hive body" refers to the box containing brood frames, whereas a "super" is a box placed above the hive body to accommodate frames containing combs of honey. The standard hive body is 9 1/2" (238-240 mm) high. Many beekeepers often use hive bodies as full-depth supers, but the height of supers can vary from full-depth (= standard hive body) through "honey supers"(3/4depth = 7 1/2" or 185 mm) to "section supers" (1/2-depth = 4 3/4" or 133 mm).

1/ Since the dimensions of the Langstroth hive were originally established in the Anglo-American system. whereas a number of countries in Asia currently use the metric system, the sizes of equipment discussed in this chapter are presented in both systems. It should be borne in mind however that the metric-system figures are not derived directly from the Anglo-American, but refer to similar (but not identical) measurements in general use in countries where the metric system has been adopted.

The width and length of standard 10-frame hive bodies and supers are 16 1/4" x 19 314" (405 x 505 mm) outer measurements and 14 3/4" x 18 1/2" (365 x 465 mm) inner measurements. Running along the upper inner rim of the width of the box, a recess of 3/8" x 5/8" (10 x 13 mm), known as the "rabbet" or "rebate", serves to hold the top-bars of the free-hanging frames inside. (See Fig. 5/1.)

Fig. 5/1. Langstroth hive bodies, showing different corner constructions and details of the rabbet (Redrawn from Miller, 1976)

Wood is the material most generally preferred for hive construction, offering durability, flexibility and convenience, as well as improving the colony's efficiency in regulating hive interior temperature and humidity. Bodies and supers painted externally will last longer than those without paint; white is the colour generally preferred for its action in radiating direct heat from the sun.

Wooden hive bodies and supers should he built to be as strong as possible. The weakest points in the hive's architecture are the corners of the boxes. The three basic ways of making corner joints (box corner, special box corner and dove-tail joints) are illustrated in Fig. 512.

Fig. 5/2. Major types of corner joints for the construction of hive bodies and supers Upper left: Box corner Upper right: Special box corner Below: Dove-tail loins (Redrawn from Miller, 1976)

(2) Hive Cover

The outer cover is essentially the roof of the hive. It should be long-lasting and provide good insulation for the bees. Most beekeepers prefer telescoping covers fitted with sheet metal or aluminium (see Fig. 5/3).

In some areas, an inner lid or cover is used in addition to the outer cover. In severe weather, it assists in insulating the interior of the hive. Inner covers are commonly made of boards, plywood or masonite in a wooden frame.

Fig. 5/3. Telescoping hive cover (Redrawn from Miller, 1976)

(3) Bottom Board

The bottom board (see Fig. 5/4), the floor of the hive, is built to fit the hive body. In order to provide a landing board for the bees, the length is extended past the front of the hive body for about 2" (50 mm), so that the total length of the bottom board is 22" (555-560 mm). The board consists of a flat floor mounted on side-rails. An entrance reducer is generally used at the front of the hive to permit alteration of the size of the hive entrance.

Fig. 5/4. Bottom board (Redrawn from Miller, 1976)

(4) Frames

The concept of movable frames in box hives is the noblest innovation in beekeeping. The basic function of such frames is to hold individual combs firmly in place, so that the entire comb can be moved while remaining intact.

Fig. 5/5. Details of frame construction

Left: Top-bar end
Right: Bottom-bar and frame end
(Redrawn from Miller, 1976)

A frame consists basically of a top-bar, two end-bars and a bottom-bar, nailed together. Since the frames must fit the supers, and these are of uniform length, the top-bars of all frames must be 19" (482 mm) long; they are 3/4" (16 mm) thick and I 1/16" (25 mm) wide. The height of the end-her reflects the depth of the super: 9 1/8" (230 mm), 7 1/4" (175 mm) and 4 1/2" (125 mm) for full-depth, three-quarter depth and half-depth respectively. End-bars are 1 3/8" (33 mm) wide and 3/8" (10 mm) thick. The bottom-her is 17 5/8" (450 mm) long, 3/4" (25 mm) wide and 3/8" (10 mm) thick. When these elements are assembled, both ends of the top-bar protrude so that the frame can rest on the rabbet.

Fig. 5/6. Full-depth (9 1/8" = 230 mm) end-bars (Redrawn from Miller, 1976)

(5) Comb Foundation

The invention of comb foundation for use with movable frames marks another milestone In the history of beekeeping. Comb foundation is a thin sheet of beeswax stamped with a pattern of hexagons of a size equal to the base of natural brood cells. Providing beeswax foundation accelerates comb construction, thus making better honey harvests possible. It also leads the bees to construct comb whose cells are of a uniform size.

The overall dimensions of comb foundations available on the market are calculated to fit standard frame sizes: full-depth, three-quarter depth or half-depth. While foundation types vary, medium-brood plain foundation offers reasonably good performance under normal conditions. As a rule, foundation is fixed to the frames by being mounted on four fine but strong wires, threaded through holes in the end-bars and stretched tight (see Fig. 5/7). A spur embedder or an electrical heating device is used to embed the wires into the comb foundation.

Making comb foundation is a complicated task, requiring not only skill and experience but also a costly foundation mill, preferably of the type composed of two precision-engraved rollers, used by manufacturers. While a few large-scale beekeeping operators and cooperatives may be in a position to own such a mill, most beekeepers find it more convenient to buy their foundation ready-made.

(6) Other Hive Equipment

Pollen Trap. As its name implies, the pollen trap is used to scrape pollen pellets from the legs of foragers as they return to the hive; it is convenient for beekeepers who wish to obtain surplus pollen for sale or for feeding bees during the dearth period. When a pollen trap is set at the hive entrance (see Fig. 5/8), returning foragers have no way of entering the hive but to pass through the trap. As they do so, the pollen pellets attached to their hind legs are scraped off and fall into a receiving tray.

Queen Excluder. The purpose of the queen excluder (see Fig. 5/9) is to confine the queen to the brood box while allowing the workers to have access to the super, in order to ensure that the honey combs contain no brood. It is also used in producing royal jelly, in queen-rearing and in forming multi-queen colonies. Based on the fact that the bodies of workers are much smaller than that of the queen, it consists of a single sheet with openings large enough to allow the former to pass through, but too narrow for the queen. The conventional excluder is designed to be inserted horizontally between the super and the brood box of a multi-storey hive, but vertical models also exist that can be placed between frames of brood and honeycomb in single-storey hives.

Feeder. At certain times of the year the beekeeper may wish to feed his colonies with sugar syrup as a food supplement, or to medicate them using syrup as a carrier. Among various types of feeders existing, two simple models can be recommended: the division-board feeder and the feeding pail or ,jar.

In the broad sense, the division-board feeder is a rectangular syrup container (see Fig. 5/10) whose length is the same as that of a frame; it is designed to be placed within the hive in the same manner as a frame. To prevent the bees from drowning, chips of wood or Styrofoam are placed in the feeder as floats.

Alternatively, plastic or glass pails or jars holding from 2 to 4 litres of liquid can be used as feeders, provided that they have relatively large and tight-fitting lids in which small holes can be pierced. When in use, the pail containing the sugar syrup is turned upside down and placed on the frames, allowing the syrup to seep through the holes. An empty super is installed between the hive cover and the honey chamber, in order to close the hive.

Hive Tool. Honeybees use propolis to seal frames and covers to hive bodies and supers. In order to separate these various pieces (e.g. to open the hive or remove a frame for inspection) the beekeeper prizes them apart with a hive tool, which is also useful in scraping excess propolis or wax from hive parts. It is such a convenient piece of equipment that virtually all beekeepers carry one in their hand when working with their hives (see Fig. 5/11). It consists basically of a length of iron or steel, flattened at one end. A good commercial hive tool may be made of spring steel, but the sawn-off end of a crowbar can furnish equally satisfactory leverage.

Smoker. The bee smoker, used to calm bees, consists of two principal units: a metal fire-pot with a funnel-shaped cover, and a bellows (see Figs. 5/11 and 5/12). Some good models are equipped with a shield for protection against the heat generated. A smoke-releasing fuel (e.g. dried leaves. grasses, wood shavings, rice hulls, etc.) is burned in the fire-pot, and air is injected into the pot by operating the bellows; the smoke is then directed at the bees through the funnel.

Bee Brush. A soft camel-hair brush, used to brush the bees off combs and supers being manipulated, is considered one of the most necessary tools for harvesting frames of honey comb, particularly in small-scale beekeeping. In less sophisticated operations, a handful of grass or leaves may be used.

(7) Protective Equipment

Bee Veil. Every beekeeper accepts that he will be stung many times during a season. However, no one likes being stung on the face, especially near such sensitive parts as the nose and eyes, and therefore wearing a bee veil is essential when honeybees are being handled. (See Fig. 5/11.) Such veils should be made to fit snugly around the hat or to cover the head, and to fit tightly to the shoulder, leaving enough space between the veil and the face. Black screen is preferred for the veil, since it provides the best visibility; 12-mesh screen wire or fabric are the preferred materials. Apart from the black screen, all parts of the veil, including the hat if one is worn, should be light in colour, to avoid antagonizing the trees and because such colours are cooler. When a hat is worn, it should have a wide brim.

Protective Clothing. No specific design of protective clothing for beekeepers exists, but white overalls are occasionally worn. Most clothing suitable for field work is also suitable for beekeeping, although light-coloured, smooth materials such as cotton are preferable because they are cooler and create less risk of antagonizing the bees. Beginning beekeepers may feel more secure in handling bees if they are wearing gloves, although experienced ones wear gloves only under extreme conditions. Bee gloves are made of tightly-knit cloth and/or soft leather; they cover the forearms up to the elbows.

(8) Uncapping and Extracting Equipment

The basic equipment required for extracting honey from the comb consists of an uncapping knife, a honey extractor, a honey strainer, a wax melter and storage containers. The beekeeper should of course select equipment whose type and capacity are best suited to his needs.

Uncapping Knife. Worker bees seal honey-storage cells with a thin layer of wax, known as cappings, which must be removed from the combs as a first step in honey extraction. Although normal long-bladed kitchen knives can be used for this purpose (see Fig. 5/13), the operation can be carried out with greater ease if heated knives are used. The beekeeper may use two knives and plunge them alternately in hot (preferably boiling) water, or he may decide to obtain a specially designed electrically heated knife (see Fig. 5/14) or steam knife.

Honey Extractor. It has been estimated that in making 1 kg of wax for building comb, the bees consume 8 kg of honey. The honey extractor makes it possible for the beekeeper to save the comb for re-use by the bees and to increase his honey crop accordingly.

Basically, the honey extractor is a device that spins the combs so rapidly (up to 300 rpm) that the honey is flung out of them by centrifugal force. Different types and sizes are available, ranging from the motor-operated extractor accommodating hundreds of frames (see Fig. 5/15) to the manually-operated two-frame extractor. Normally, the beekeeper working with several hundred hives will find a hand-operated extractor adequate for his needs (see Fig. 5/16); stainless steel models (see Fig. 5/12), although somewhat more costly than those built of other materials, seem to offer enough advantages in their operation to justify the higher price.

Honey Strainer. After its extraction from the combs, honey is passed through a strainer to remove impurities. A large funnel lined with layers of cheese-cloth or fine wire mesh can serve the purpose in small apiaries, but larger operators may find it preferable to own a compact honey strainer, consisting of two or three "baskets" of different mesh sizes, fitted one within the other. Honey passes through the innermost, 12-mesh, basket and then through one or two others with finer meshes. Such strainers work well for most beekeeping operations.

Storage Container. Honey is a delicate, perishable product, and after it has been extracted and strained it must be properly stored. The beekeeper should be aware of some of its special properties: it can absorb moisture from the air, it reacts with metals, it changes colour if exposed to light over long periods, and its taste changes on heating, so that it must be neither heated nor stored in an excessively warm room.

If it is not bottled for sale immediately after extraction, honey should he stored in clean, noncorroding, tightly-sealed containers strong enough to withstand its weight (honey is about 1 1/2 times the weight of water). Glass-lined steel drums, off-white opaque heavy-duty polyethylene cans, and lacquer-coated or galvanized-iron cans are among the popular containers used.

Wax Melter. Beeswax is a valuable hive product, and it should be melted down with care. The equipment used in rendering it from cappings and broken combs, after all surplus honey has been extracted from them, includes solar wax melters, steam chests and presses. Since the first two of these can only recover from a third to half of the wax contained in the residue, a press is needed to obtain as much of the remaining wax as possible; steam-heated, underwater, screw-type or hydraulic presses are used for this purpose.

B. Obtaining colonies of Apis mellifera

Several methods exist of obtaining colonies for initiating beekeeping with Apis mellifera. Two, mentioned briefly in Chapter 4 in connection with A. cerana, are of little or no practical use in most parts of Asia, where large populations of the common honeybee have not yet been established: capturing swarms and transferring colonies from feral nests.

(1) Buying Complete Hives

The easiest way to obtain honeybee colonies is obviously to buy complete hives from an established beekeeper. It must be recognized, however, that in countries or areas in which modern beekeeping with A. mellifera has not yet taken root, such local purchase is rarely possible, and it is necessary to import such complete hives from abroad, not a realistic approach in many circumstances.

Given the right price and the good condition of both the bees and the equipment, buying complete hives has often proved to be the most economical approach for beginners, who may in addition be able to obtain valuable suggestions and guidance from the seller. Other advantages are that an apiary can be established immediately, and that the beekeeper can often divide colonies in the populous hives acquired.

Considerations which the prospective purchaser should hear in mind in buying hives include the condition of the hive equipment, the population of adult workers and brood in each hive, the age and egg-laying performance of the queens, and the amount of honey and pollen stored, as well as the price.

(2) Buying Nucleus Colonies

A nucleus colony (see Fig. 5/17) is a small hive unit, normally consisting of 2 to 5 frames of brood, a small quantity of food reserves, several thousand workers and a laying queen. Nucleus colonies are cheaper than complete hives and are lighter in weight, so that they can be transported more easily at less cost.

The guidelines set out above for the purchase of complete hives apply equally to the purchase of nucleus colonies. They should if possible be bought in the spring, or at another time when natural Forage is abundant. Under these conditions, they will soon outgrow their small hive bodies and must be transferred to standard hives properly equipped with frames and foundation.

(3) Package Bees

Package bees are not normally available in most Asian countries, but in some areas the private sector of beekeeping development projects may wish to purchase packages from abroad. The handling of package trees is discussed here in some detail because of the likelihood that this technique will take on greater importance in the medium term, if not sooner.

Basically, a package of bees consists of several thousands of workers, a mated queen, and a can of sugar syrup provided as food during shipment. The trees are packed in a wooden box, two ends of which are screened to provide ventilation. A package contains from 2 to 5 pounds (900 to 2250 g) of bees, one pound (450 g) consisting of 2500-3000 workers. The price of a package, net of shipping costs, is determines by the weight of trees it contains, but as a general rule package trees are cheaper than complete or nucleus colonies.

When ordering packages, the beekeeper specifies a delivery date, in order to be prepared in time to receive them. As soon as they arrive, the bees are fed on a 1:1 sugar syrup, which is brushed over the wire screen of the package. To ensure adequate feeding, from 300 to 500 cc of syrup should be allowed per package, depending on the number of bees it contains.

The bees are best transferred from the package to the hive in late afternoon, one or two hours before dark. Hives should contain five frames, provided with foundation. The feeder can is removed from the package, and any bees it contains are shaken into the hive. The queen cage is removed from the package and the condition of the queen is observed. If any "queen candy" 1/ remains in the hive, at least half of it is removed, so that the workers can release the queen from her cage within a day; the queen cage is then placed between two frames in the middle of the hive. The remaining bees are shaken from the package into the hive (see Fig. 5/18) and provided with about two litres of sugar syrup.

One or two days after installation the hive is inspected to ensure that the queen has been released and that the hive contains enough syrup to stimulate comb construction. The colony should normally begin rearing brood within a week of being installed. The beekeeper should inspect the hive frequently for signs of disease or abnormalities and to ascertain whether the colony needs additional frames.

The greatest difficulty involved in obtaining package bees from abroad lies in the transportation problem. Starvation and suffocation from heat at airport warehouses while the packages are in transit are perhaps the two most important limiting factors in the importation of package bees. These risks can however be minimized by reducing the duration of the travel, and

Establishing honeybee colonies from packages thus involves complex arrangements, care during installation, and a certain amount of time and attention, but since only adult trees are shipped in this manner, the risk of importing brood diseases is minimized.

C. Colony location

A good apiary site must suit both the needs of the bees and the convenience of the beekeeper. As far as the bees are concerned, a good location is one in which forage is abundant throughout the year or during a period long enough to permit the bees to hoard food. It should be secluded, well drained, safe from flash floods, and protected against strong winds and heavy rains; a source of clean water must be available nearby. In temperate regions the site should receive plenty of sun, but in the tropics it should be partially shaded, to protect the bees against hive overheating in the hot sunlight (see Fig. 5/20). If possible, the site should also be safe from destructive enemies of honeybees and from toxic farm chemicals.

It is to the beekeeper's advantage that there exist a good access road or path to the apiary. The site should be relatively flat, and spacious enough for the colonies to be manipulated easily. To avoid foraging competition with bees from neighbouring apiaries, and also to minimize robbing and the spread of bee diseases, apiaries should be located at least two kilometres apart; if the apiaries are large, this distance should be increased, since workers can fly farther than 10 km.

Commercial beekeepers generally own many colonies of honeybees, and the question arises of how many colonies should be placed in a single apiary, since if the number is excessive, the foraging competition among colonies will have a direct and negative effect on hive yield. For all practical purposes, an apiary should normally consist of 30 to 80 colonies, the two most important factors determining the optimum number being the worker population in the hives and the amount of forage available in the area. Where nectar and pollen sources are abundant, an apiary can consist of 50 or more hives with relatively large worker populations without endangering satisfactory yields.

Contents - **Previous** - **Next**

D. Colony management

Contents - Previous - Next

Although all the colonies of Apis mellifera in Asia belong to the same racial group, no unified colony-management scheme exists which is suitable for the entire continent. How a beekeeper handles his colonies at a given time of year depends on the bees, their environment and how they react to changes in it. Beekeepers in temperate Asia, like their counterparts in Europe, Australia and North America, enjoy the advantage of clearly-defined seasonal changes to which the annual biological cycle of their bees is well adapted. But when colonies of the European races of the common honeybee are kept in tropical Asia, their normal annual cycle is disrupted, the warm temperatures and flourishing vegetation enabling them to be active virtually all year round. Under these circumstances, overall colonymanagement schemes for A. mellifera in tropical Asia are bound to differ from those for the temperate regions of the continent.

The following basic manipulation techniques are offered here as guidelines equally applicable in temperate and tropical areas. They are particularly useful in the production of liquid honey.

(1) Examining the Colony

The best time to examine a colony is when most of the foragers of the colony are out of the hive: the older field bees being most apt to sting, the beekeeper has less chance of being stung when they are away. Working with colonies on cloudy or rainy days is to be avoided, because at such times most of the older workers are within the hive.

On entering the apiary, the beekeeper should he fully prepared: he should he wearing his veil, his trouser-legs should be well attached around his ankles, and he should he carrying his hive tool in one hand and a well-lit smoker in the other. He should always work at the side of the hive, not in front of it (see Fig, 5/11); he thus avoids blocking the hive entrance and reduces his chances of being stung by returning or departing foragers .

All his movements when working with or near a colony must he slow and deliberate. In handling the hive, he directs a small puff of smoke into the hive entrance, waits for 30 to 60 seconds, lifts the hive cover slightly, puffs a little smoke within, and only then he gently removes the cover, placing it on the ground in front of the hive. Again he puffs a little smoke, while using his hive tool to prize free the inner lid, which he places upside down in front of the hive. With his hive tool he prizes all the frames apart; he may find it necessary at this stage, and throughout the further manipulations, to administer a little smoke occasionally, to calm the bees. The first frame to he removed is the second one on the beekeeper's side; after inspecting both sides of it carefully, he gently leans it against the front corner of the hive. The remaining frames he removes one at a time, inspects, and replaces. When all the frames have been inspected, he replaces the frame that was set aside and restores the inner lid and cover to their original position.

In inspecting the Frames, the beekeeper pays particular attention to the presence and number of brood cells, honey-storage cells, pollen cells, and egg cells; the pattern of the brood comb; the presence or absence of queen cups and cells; the appearance of the adult workers; and especially signs of disease and other abnormalities. In a relatively large colony, it is not essential for the queen to be seen at every inspection: the mere presence of eggs laid uniformly in a relatively large worker-comb area indicates the presence of a good-laying queen.

(2) Combining Colonies

The productivity of a colony depends largely on the number of workers it contains. Occasions arise when the beekeeper must combine two weak colonies to form a single, stronger hive unit, or a queenless colony or a colony with a failing queen with a "queenright" colony.

Several methods can he adopted to combine colonies. In dearth periods, the most reliable technique is to place a sheet of newspaper over the frames of the stronger colony, make a few slashes in the paper with a hive tool, and then remove the floor of the other hive and place it above the first. Within a day or two, the bees will have gnawed the paper away; they will then gradually mingle, and the scents of the two hives will mix. In time, one of the queens will be lost naturally; if the beekeeper specifically wishes to preserve one of the queens, he removes the other before the operation.

A more rapid method is to install all the brood combs from both hives in one hive, with a pre-selected queen. The bees from both colonies are shaken out in front of the new hive entrance and are sprayed with sugar syrup, at the same time as the hive is being smoked. The bees in the two colonies will combine in such confusion that there will be little or no Fighting among them.

Another rapid method is to place the better queenright colony over a queen excluder which has been placed above the weak, queenless colony. Then, while smoke is applied into the hives, sugar syrup is sprayed on the bees.

During the nectar flow, some experienced beekeepers who have little time to spare unite their colonies by simply installing the weaker above the stronger; there will be little or no fighting among the bees. For the average beekeeper, however, combining colonies by using a sheet of newspaper often proves to be the most reliable method, in that it reduces to a minimum the risk of losing bees by fighting.

(3) Feeding Sugar

Since honey usually commands a high price in Asian markets, many beekeepers harvest most of their colonies' honey stores and replace them with a cheaper source of energy: sugar syrup. Notwithstanding a common belief that feeding bees on sugar is not necessarily required in the tropics, there is in fact a relatively long nectar-dearth period in the evergreen vegetation of many tropical areas. Moreover, bees kept in the tropics consume more energy per year, in the form of honey or sugar, than bees in the temperate regions, because they remain active and take flights throughout the year. Where no nectar is available in the field, a populous colony of A. mellifera may consume as much as several hundred grammes of food in a day.

The syrup used consists of sugar dissolved in an equal weight of hot water; the solution is allowed to cool before being given to the bees. Where unrefined cane sugar (brown sugar) is available, it may be found to be less expensive than refined (white) sugar, particularly if it can be bought in quantity directly from a sugar mill. It may however he necessary to strain brown-sugar syrup through a double layer of cheese-cloth before feeding it to the bees. The feeding methods most generally preferred are the use of a division-board feeder or a feeding pail.

The amount of sugar required by the colony depends on where it is kept and the time of year. In temperate regions, the beekeeper may have to give a colony 15-20 kg of sugar or more to ensure that it will survive the winter. In the tropics, the colony should be inspected frequently to ensure that at least 5 kg of honey or sugar are available in the storage comb whenever there is no honey flow: especially under tropical conditions, a food shortage causes the colony to dwindle rapidly.

When feeding sugar syrup to a honeybee colony, the beekeeper should bear in mind that if unused syrup remains in the storage combs at the time of the honey flow it will result in contamination of the pure honey. As soon as the honey flow begins, therefore, any comb containing sugar must he removed from the hive, and feeding should stop immediately

Another problem that can arise as a result of overfeeding is a condition in which the combs are "honey-bound". It occurs when the workers have used so much comb for storing sugar that the queen no longer has enough space in which to lay eggs (see Fig. 5/22). The difficulty can he remedied, at least in part, by stopping feeding and by providing extra space between the frames.

(4) Feeding Pollen, Pollen Supplement and Pollen Substitute

Brood-rearing requires a substantial amount of pollen as a source of protein, fat and vitamins: it is estimated that one cell of pollen is needed by the trees to rear a larva until it reaches the pupa stage. A shortage of pollen is therefore most critical to a colony, particularly before the honey-flow season arrives, and the beekeeper often has to provide a pollen supplement or substitute as an alternative source of protein to stimulate brood-rearing.

A pollen supplement is composed of the pollen collected by the bees, mixed with other protein compounds such as soybean flour, dried brewer's yeast or dry skim milk; honey or sugar is also added to make the mixture more palatable to the trees. While Formulas for pollen supplement vary, it should contain at least one third of fresh or dried pollen: the general rule is that the more pollen is contained in the mixture, the better.

Bees' pollen must be stored properly; otherwise, much of its nutritive value is lost. The simplest way of storing pollen, unless it is too moist, is to mix two parts of fresh pollen with one part of granulated sugar and pack the mixture tightly in a sealed container. Pollen can also be dried at room temperature, or by direct sunlight, and stored in a refrigerator until needed for feeding, either directly or in a supplement mix.

A pollen substitute is a proteinaceous mixture of bee diets with no added pollen. The most popular formula for a substitute is one part each by weight of soybean flour, dried brewer's yeast and dry skim milk, with honey or sugar added to form it into pellets.

While under some circumstances provisioning honeybee colonies with pollen supplement or substitute is beneficial in increasing the number of brood reared, no mixture can replace fresh pollen. Moving the bees to places where pollen is naturally available, whenever this is possible, is always the best remedy for a pollen shortage. If moving the bees is difficult, the beekeeper's next best solution is to trap pollen during the high season and save it for the dearth period.

During severe shortages of natural pollen, bees have been known to collect various kinds of materials in the form of fine particles. Rice bran, fishmeal, animal feeds and even sawdust are sometimes collected and carried back to the hive in the same manner as pollen. Although some of these materials are edible and have some nutritive value they cannot be used as replacements for natural pollen.

(5) Moving Rees

Practical beekeeping does not depend on growing nectar and pollen plants for bees. For many commercial beekeepers, moving colonies several times a year to places where bee forage is available - be they agricultural lands, forests, roadside plantings or waste lands - is a common practice.

Honeybees recognize the position of their hives by using surrounding landmarks as references, but they have a relatively short memory, lasting only for several days. If they are moved over short distances, within the flight range of their original apiary site, a number of foragers will return to their former location and be lost to the beekeeper. For this reason, bees should be moved at least 4-5 km beyond their former flight range. If they are to be moved for short distances, the slow but reliable method, to avoid confusion among returning foragers, is to change the position of the hives a little each day.

For long-distance moving, it is important that the colonies be moved when the foragers are in the hives, i.e. in the very early morning or late afternoon. To avoid unnecessary damage to the trees and the hive parts, the hive entrances and all cracks in the hive walls must be sealed before moving, and all movable pieces of the hives should be fastened securely.

In the heat of the tropics, it is advisable for long-distance moving of honeybee colonies to be carried out at night. The outer and inner hive covers are often replaced with movable screens placed over the top supers. It has been found useful to have the Lorry engine running while the hives are being loaded, because the vibrations of the engine inhibit the activity of the bees, making the operation much easier.

(6) Preparing Colonies for the Honey Flow

The honey-flow season is the busiest time of the beekeeper's year. Before it arrives, therefore, he should take a number of measures in order to be prepared for it. He must have all his necessary equipment, appliances and supplies ready; his colonies must have enough space for brood-rearing and honey storage; empty drawn combs, Frames fitted with comb foundation, and supers must be readily available to be given to the trees as and when they are needed.

This period is in particular the time when the beekeeper must bring his colonies to a state of readiness. While colonies in temperate regions can be built up gradually in early spring, before the arrival of the major honey flow, in areas of tropical Asia where the honey-flow season is short the beekeeper must manage his colonies in such a way that their strength reaches its peak at the start of the Flow, and not later in the season. In order to do this, he will have to envisage any necessary requeening and combining of colonies, supplemental Feeding to increase brood-rearing, and controlling tree pests and diseases.

For migratory beekeeping, all prospective apiary sites should be visited and surveyed before the colonies are moved to them. This enables the beekeeper to collect a great deal of needed information: the general outlook for forage availability in the sector, the estimated time of blossoming of the honey plants, when to move the colonies, the extent of the risk of bee poisoning by insecticides, other risk Factors, etc.

(7) Determining the Honey Flow

The best means the beekeeper has to determine the arrival and end of the honey flow is to monitor changes in the weight of his hives. When there is no food in the area, the hives lose weight because food stores are being consumed; a gradual increase in hive weight indicates that the flow period has arrived. It is not uncommon for a strong colony to gain as much as 3 kg or more in a day in good nectar areas, such as the longan orchards of northern Thailand. When the weight gain ceases - that is to say, when the food consumed is equal in amount to the food collected - this indicates that the honey-flow season is ending.

During the honey flow, inclement weather may prevent the bees from flying for a few days, and this may cause a sudden drop in the rate of the colonies' weight gain. The beekeeper must judge the situation properly, and not misinterpret this decrease as a sign of the end of the honey flow.

(8) Colony Management during the Honey Flow

If all has been well prepared before the arrival of the honey-flow season, colony management during the season itself usually involves routine apiary inspection, management of brood areas, supering and adding frames, and swarm prevention and control.

Every hive must be inspected frequently to ensure that all is going well. The colony must be provided with enough comb space for food-hoarding and brood-rearing. If the apiary is located near farmland, the beekeeper must he certain that his bees are safe from pesticide poisoning, and he must ward off other potential bee enemies and intruders.

The management of colony's brood area is critical during this season. Brood combs and honey combs must be separated carefully; a queen excluder is often used for this purpose. Another method is based on the fact that the queen starts laying eggs at the bottom of the hive and gradually works upward. When bees are kept in multi-storey hives, with at least two brood chambers, the beekeeper can reverse the position of these boxes and so confine the egg-laying activity of the queen to the lower part of the hive, while the supers are spared for honey storage.

Research has demonstrated that the amount of food collected and stored by a colony depends on the amount of empty comb space available to it. The beekeeper will therefore find it profitable to provide his colonies with more empty frames than they actually need. This practice also ensures that the colony will not lack storage space when the season is exceptionally good. With strong colonies, super containing empty frames with drawn combs or comb foundation can he simply placed over the brood chamber, while for a less populous colony, a few frames may be given at a time. The beekeeper should however have enough drawn combs in stock to be able to use them as the situation requires.

For the honey supers, placing nine frames in a 10-frame standard body is generally a good practice. Not only can the combs be harvested more easily, but the expansion of the top of the combs, resulting from the fact that more bee space is available, simplifies not only the harvesting but also the uncapping process.

(9) Swarm Prevention and Control

Swarming, as has been seen in Chapter 2 C., is a reproductive phenomenon of honeybee colonies. With an understanding of the bees' basic biology the beekeeper can either prevent or control swarming. In the strict sense, swarm prevention consists of the steps taken by the beekeeper to deter or prevent the colony from constructing queen cells, while swarm control consists of the steps he takes once the cells have been found.

One of the major causes of swarming is congestion of bees in the hive, and especially in the brood nest. If the colony is managed in such a manner that this congestion is avoided, the bees are less likely to swarm. Among methods generally adopted for swarm prevention, then, are reversing the position of brood boxes, placing brood frames in a chamber above the existing brood nest, and adding frames and supers.

Removing queen cells is the easiest method of swarm control, but it requires frequent and thorough inspection of the hives to eliminate all cells as they appear: when queen cells are cut, the colony will often build new ones shortly thereafter. In order to deter or prevent the construction of such new cells, it is possible, after the queen cells are removed, to replace a few brood frames with empty combs; the brood frames are then given to weaker colonies.

In some tropical Asian beekeeping areas, such as northern Thailand, swarming occurs in the early monsoon months, after the major honey-flow period but at a time when plenty of pollen is still available. At such times, new colonies can be formed, using queen cells removed from existing colonies, together with brood frames and some bees from populous colonies. With proper management, the natural availability of pollen and heavy sugar feeding during the monsoon months will allow both the new and the old colonies to build up to full strength before the onset of the next honey-flow season.

(10) Queen-Rearing

Good laying queens are important to productive beekeeping. Although queens may be able to live for several years, it is to the beekeepers' advantage that their colonies possess good young queens, and to ensure that they will have an ample supply of queens, many of them rear their own.

The best time of year to rear queens is when pollen and nectar are abundant and there are enough drones present to ensure successful mating. In temperate Asia, this is the period between mid-spring and mid-summer, while in tropical zones the best season is often between June and late October or early November.

Basic queen-rearing supplies and equipment include a grafting tool, wax or plastic queen cups, a queen excluder, queen cages, and mating nuclei. The grafting tool can be anything small enough to be conveniently used in the safe transfer of young larvae from worker cells to queen cups; metal tools are commercially available, but many Asian beekeepers prefer to make their own from a bamboo sliver not much larger than a toothpick, sandpapering its tip finely to shape it into a tiny flat spoon or an angled spatula. Wax and plastic bee cups can also be obtained from bee-supply firms, but wax cups can easily be made by dipping a wooden mould, soaked in soapy water, into melted wax.

The first step in grafting is to fasten not more than 20 queen cups to each cell bar of a wooden frame, and to prime each cup with a drop of fresh royal jelly removed from queen cells. Using a grafting tool, the beekeeper gently transfers worker larvae about 24 hours old from the cells of the selected colony into the queen cups (see Fig. 5/24), taking extreme care that the delicate larvae are not injured and that they do not roll over.

The frame, bearing 20-40 grafted queen cups, is then placed in a nursing colony, prepared in advance. This is a healthy colony, intentionally crowded with the greatest possible number of young adult workers that have emerged from brood combs given to the colony shortly before, and copiously fed with pollen and sugar syrup. The colony may be queenright or queenless; in the former case, a queen excluder is used to prevent the queen from destroying the developing queen cells. If the grafting has been well executed and the larvae are uninjured, the nurse bees will accept them and feed them lavishly with royal jelly. As the larvae develop, the adult bees will add wax to the queen cups and expand them into queen cells, which will he sealed when the larvae are being transformed into pupae.

To ensure that the larvae are lavishly fed with royal jelly, many beekeepers use two nursery hives instead of one. The developing queen larvae are first placed in a "starter colony" for 24-48 hours and then transferred to a "finishing colony". 80th colonies, often made queenless, are crowded with heavily-fed young adult bees. Workers in the starter colony are not allowed to fly, while those in the finishing colony have free flight.

On the ninth or tenth day after grafting, part of the wax on the tips of the queen cells will have been eaten away by the workers. At this stage, the cells are gently removed from the colony and transferred to a "mating nucleus", which is a small hive unit usually consisting of one frame of honey, one of pollen, and one or two of empty combs. Each mating nucleus accommodates one capped queen cell, which is attached to the side of an empty comb placed in the middle of the hive. A few thousand workers are shaken into the hive. Within a day or two, the new queen will emerge from her cell and be fed by the workers. After several days she will have gained enough strength to make orientation flights, and soon thereafter she will mate with drones in her nuptial flights.

Within a period of 7-14 days, the queens in the mating nuclei should he mated and begin to lay eggs. They are now ready for sale or to be used for requeening or to increase the number of colonies. The entire process of queen-rearing and mating takes from 21 to 30 days, given good weather and a sufficient number of drones for mating.

When laying queens are removed from the mating nuclei, it is best to put them in wooden cages called "queen cages", together with some worker bees from the nucleus hive. The entrance of the cage is plugged with queen candy, care being taken that the candy is not too moist, lest it run into the cage.

More queens must be reared than the number the beekeeper actually needs. In the process of grafting, some larvae may be injured, and these will not be accepted by the nurse bees. A rate of success in grafting of 70% is normally considered good, although it is not uncommon for experienced queen-breeders to attain rates above 90%. A 75-85% rate of success in mating is accepted as good.

An apiary consisting of many mating nuclei is called a "mating yard". It must be situated in or near a place where drones are abundant. (Commercial queen-breeders often intentionally prepare colonies to rear large numbers of drones, by simply crowding the colonies and providing them with empty drone combs.) The site should also he protected against such predators as Insectivorous birds and insects.

(11) Requeening Colonies

Many commercial beekeepers requeen all their colonies annually. While there are different methods of introducing a new queen to a colony, it is unfortunately true that none of them is foolproof.

One practical method of queen introduction is to use a wooden queen cage, one side of which is made of wire screen. The old queen is killed before the new one is introduced. Some of the queen candy blocking the cage entrance is removed, and the cage is placed in the hive of her new colony. (It is not necessary to release the workers from the queen cage.) By the time the trees have consumed all the candy, releasing the queen, she is no longer foreign to the colony.

(12) Harvesting the Honey Crop

For the most part, keeping honeybees in Asia is labour-intensive. Harvesting methods vary widely according to the beekeeping area, from collecting individual frames to removing entire supers filled with honeycombs. Since honey is in strong demand in many parts of the continent, and prices are correspondingly high, it is not uncommon for beekeepers to harvest all the extractable honey from their hives, including honey from frames also containing brood.

In secondary beekeeping areas, where there is no major honey-flow season but where some bee forage is available for periods of many months, beekeepers harvest their honey crop by taking only a few frames at a time but repeating the operation several times during the season. By adopting such intensive practices, they are able to obtain annual hive yields of between 10 and 20 kg of honey.

It is important that only ripe honey be collected from the colonies. If the beekeeper fails to watt until at least one half to two thirds - but preferably all - the honeystorage cells are capped before harvesting, too much water will remain in the honey. Operators of large apiaries should possess and use a honey refractometer (see Fig. 5/26) to measure the water content of their honey. A water content not exceeding 20% is acceptable to most buyers, but some prefer honey with a water content less than 18.6%, because at this moisture level it is not susceptible to fermentation.

Some large honey firms have hot rooms or equipment enabling them to get rid of excess water from "unripe", or "green", honey (see Fig. 5127), but tints is justified only in very large-scale operations.

Thus far in Asia, removing honey frames and supers from the colonies does not involve much use of equipment and chemicals such as bee blowers and bee repellents: brushing trees off the honey comb is by far the most popular method used by many beekeepers, including some whose operations cover several hundred to more than a thousand hives. Where labour costs are low, and? the beekeeper can spend enough time on intensive, frame-by-frame honey collecting, the brushing method seems suitable, while in large operations the use of a bee blower may be found more convenient and economical in terms of worker time.

Contents - **Previous** - **Next**

Chapter 6 Bee pests and diseases

Contents - **Previous** - **Next**

In many parts of Asia, the success or failure of beekeeping with the common honeybee A. mellifera depends largely on the ability of the beekeeper to take suitable measures to control diseases and pests affecting bees. Apis mellifera being the only introduced honeybee species in a continent possessing several native species of Apis, colonies of this bee are subject to infestation and attack by all the natural enemies of the native bees in addition to their own. Perhaps the most important are bee mites, hornets and microbial diseases, although passing mention must also be made here of the danger to bees from wax moths on the one hand, and from birds and mammals on the other.

A. Bee mites

Two species of bee mites are of economic importance: Varroa jacobsoni and Tropilaelaps clareae. Whereas the natural range of distribution of the Varroa mite covers the entire Asian continent, T. clareae is found only in or near the distribution range of its native host, Apis dorsata, in tropical and sub-tropical Asia.

The mode of parasitism of both mites is roughly similar. Fecunded adult female mites enter bee-brood cells before the latter are capped, and deposit eggs which hatch rapidly. The developing mites use their feeding apparatus to pierce the skin of the developing brood, and feed on their haemolymph ("blood"), which flows from the open wounds. The development cycles of the mites coincide with those of the host bees. When the hosts emerge from their cells, the mites also emerge, mate, and seek for other bee-brood cells. Some mated adult female mites attach themselves to the bodies of workers or drones; drifting of bees thus infested accounts for the spread of the mites to other colonies. Infestation is also spread by mites attached to foragers dropping off the bees when they are visiting flowers, and later clinging to another bee which subsequently visits the same flower.

(1) Symptoms and Diagnostic Procedure

For some beekeepers, the appearance of adult bees with deformed wings, shortened abdomens or missing legs is the first noticeable symptom of mite infestation. In fact, such symptoms indicate a late stage of severe infestation, which may lead to the loss of the forthcoming honey crop or even the entire colony.

While it is of course possible for beekeepers to make random inspection of brood cells for mite infestation and to assess its level, a more practical approach is to study the pattern of brood combs, which can give an early warning. A scattered pattern of sealed and unsealed brood cells normally taken as a sign of poor egg-laying queens, is often an indication of mite infestation. When this is the case, the housecleaning bees have eliminated the parasitized brood, leaving an irregular pattern of capped and uncapped cells.

(2) Control

There is no one best way to control bee mites. Many beekeepers resort to chemotherapeutic measures, although this approach requires that the risk of contaminating the honey and other hive products be restricted to a minimum.

Hive fumigation can control not only V. jacobsoni and T. clareae but also the tracheal mite Acarapis woodi (see page 53). The simplest fumigation method involves placing fumigating strips into the hives, setting them alight, and letting them smoulder. Commercially available strips include Folbex and Folbex VA, whose active ingredients are the acaricides chlorobenzilate and bromopropylate respectively; the strips are impregnated with other compounds that make them smoulder when lit. Beekeepers can make similar strips themselves, by soaking 2.5 x 9 cm strips of filtre paper in a saturated solution of sodium or potassium nitrate also containing an acaricide relatively non-toxic to bees (e.g. chlorobenzilate, bromopropylate, dicofol, tedion, amitraz, etc,) and allowing them to dry. Bromopropylate and amitraz are especially popular for this use.

Fumigation is best administered when all the bees are inside the hive, usually in late afternoon, and when the temperature is not below 10° C. All cracks and openings of the hive must be sealed with masking tape, rags or wet cloths. The strip is attached securely to an empty frame or placed on a sheet of flat metal that can be introduced into the hive through the entrance. The beekeeper lights the strip, and when it is smouldering well he introduces it into the hive, where the bees will he fumigated with acaricidal smoke for about 30 minutes.

Since the fumigant cannot penetrate the cappings of the brood cells, it can reach only the mites on the bees present in the hive. It should therefore be applied for a total of three or four times, at intervals of four days, in order to reach the mites which at the time of the first fumigation were still sealed within the capped cells.

Some beekeepers prefer spraying to fumigation. The acaricide is diluted with water and sprayed over the bees, the brood combs and the hive walls; three or four applications at four-day intervals usually yield good results.

In tropical Asia, where T. clareae is often a more serious danger than V. jacobsoni, beekeepers who do not wish to use acaricides turn to a biological control method which involves brood management. Since adults of T. clareae can survive without bee brood as food for only two days, most of the mite population of the hive will starve to death if deprived of the brood for three days. Taking advantage of this fact, the beekeeper confines the queen in a small egg-laying area and removes the brood combs to an empty hive box or forms new colonies with them. Some beekeepers combine this approach with a single fumigation.

B. Hornets

In many parts of Asia, hornets (genus Vespa) are serious pests of honeybees, whose colonies can be significantly weakened by hornet predation. If the insects' nests can be found, destroying them is the best way to control hornets, but since they have a long flight range, finding their nests is usually difficult.

Where hornet predation is not too intense, reducing the hive entrance and making efforts to catch hornets that come to forage in the vicinity can often prevent serious destruction. Where predation is particularly intense, however, the surest way of dealing with the problem is to move the trees out of the area completely until the hornet population is much reduced.

C. Microbial diseases

(1) American Foulbrood (AFB)

AFB is the most serious disease affecting bee brood. It is caused by a bacterium, Bacillus larvae, whose spores can remain in the hive and on contaminated equipment for long periods of time. Under favourable conditions (e.g. when the colony is under stress From other factors), the spores germinate sod infect the older honeybee larvae.

(a) Symptoms and Diagnostic Procedure

The presence in the comb of dead older Larvae or pupae lying flat in their cells is the first noticeable symptom of AFB. The cappings of the cells concerned are discoloured, slightly sunken, and punctured. The dead brood's colour is initially dull white, eventually turning dark brown.

When bee brood is found dead with these symptoms, a rapid way of determining whether the death was caused by AFB is the "stretch test". A small stick, about the size of a match-stick, Is inserted into the mass of the decayed larva or pupa, and gently withdrawn. If the dead brood adheres to the tip of the stick and can he stretched as much as 2.5 cm before it breaks and returns to its original position, this "ropiness" typifies the presence of AFB. The stretch test cannot be used when the dead brood has dried, hut dead brood that Is brittle and adheres closely to the lower cell wall suggets the presence of AFB.

(b) Control

Since only by burning can the beekeeper be certain that the spores of the pathogen are destroyed, the trees in colonies infected with American foulbrood should be killed and burned, along with the brood chambers, supers, frames and honey of the colonies.

Some beekeepers use antibiotics to control or prevent AFB, generally preferring Terramycin (oxytetracycline) or sodium sulfathiazole, fed to the colonies mixed with powdered sugar.

(2) European Foulbrood (EFB)

Generally speaking, EFB is not as serious a threat to honeybee colonies as AFB. The pathogenic bacterium is Streptococcus pluton, which does not form spores and cannot remain dormant for long periods. The disease is often found in colonies that are under stress conditions.

(a) Symptoms and Diagnostic Procedure

EFB affects only young honeybee larvae, about 4-5 days old, usually at the coiled stage. When the stretch test is used, the dead larvae cannot be pulled out in a thread, nor do they adhere to the cell walls. Their texture is rubbery rather than brittle, as in AFB.

(b) Control

Improving the colony's strength by requeening, supplemental feeding, and adding frames of emerging brood is often a sufficient control measure. In severe attacks, the beekeeper may wish to feed the colonies with an antibiotic such as Terramycin (oxytetracycline) or sodium sulfathiazole. The recommended dosages are 1 part Terramycin TM 50 (oxytetracycline) mixed with 20 parts of powdered sugar, or 0.2-0.6 g of the active ingredient of sodium sulfathiazole dissolved in 4 litres of sugar syrup.

(3) Sacbrood Disease

Sacbrood is the most common viral disease of the common honeybee; it is found in association with colonies under stress. The spread of the disease in the apiary can cause severe losses.

(a) Symptoms and Diagnostic Procedure

The most evident symptom of sacbrood is the presence in the comb of dead larvae which have failed to pupate. Affected larvae are sac-like in apearance, with relatively tough skins and a watery interior; their colour changes from white to pale yellow and finally turns dark brown and black, the first parts to blacken being the head and thorax.

(b) Control

No chemotherapeutic method of control of sacbrood disease is known; infected colonies can often recover by themselves. Requeening colonies, coupled with the manipulations necessary for increasing colony strength (e.g. adding frames of emerging brood and supplemental feeding) are often adequate as control measures.

(4) Nosema Disease

Nosema is a disease of adult trees, caused by the protozoon Nosema apis. Like most other bee diseases. it usually effects colonies under stress (poor laying queens, unhygienic hive conditions, inclement weather, etc.). Severe attacks can significantly weaken colonies.

(a) Symptoms and Diagnostic Procedure

There is no reliable method of identifying the disease by the naked eye. The laboratory method involves crushing the abdomens of suspected bees and examining the fluid obtained through a field microscope. The large bacilliform spores of Nosema apis, if present, can be easily identified by their fluorescent edges.

(b) Control

The disease is controlled by requeening, usually combined with feeding the bees on fumagillin (25 mg to 1 litre of sugar syrup). The drug must not be fed to the bees when there is danger of contaminating hive products.

Contents - **Previous** - **Next**

Chapter 7 Pesticides and beekeeping

Contents - Previous - Next

For its essential role in crop pollination, beekeeping is an essential component of agriculture today. Pesticides are evidently another. Without either of the two, global food production would be seriously impaired. Yet beekeeping has been sustaining heavy losses through pesticide use since the advent of synthetic pesticides several decades ago. Pesticides, and especially herbicides, reduce the foraging areas available to the bees; the application of toxic pesticides on farmlands and in forests often makes it impossible for the bees to utilize potential forages; and, worst of all, the pesticides frequently kill bees, reduce colony strength and contaminate hive products.

While beekeepers have no direct way of controlling the application of pesticides near their apiaries or within the flight range of their bees, some lines of action are still available to them to prevent damage: they can ask for help from extension agents, for understanding and cooperation on the part of the growers (whose crops often in fact depend on the bees' work), and finally for legal protection. At the same time, they must be fully alert to the potential damage that certain toxic pesticides can inflict on their colonies.

When bees are kept in or near areas where such pesticides are occasionally used, the beekeeper must be in a position to know in advance the pesticides used and their residual effect, what damage they can cause to the bees, and the time of application. Moving the colonies out of range of pesticide application temporarily is often one approach available to the beekeeper; in some circumstances he can prevent the bees from flying for several days, until the residual effect of the pesticide has subsided.

The recent development of new "micro-encapsulated" insecticide formulations, specifically designed for the controlled release of the product over time, has created a new tree-poisoning problem. When such pesticides have been dusted on blooming crops, worker bees collect the particles, return them to the hive and store them in pollen cells. The consequence is the poisoning of the entire colony.

A. Bee-poisoning symptoms

Honeybees react differently to different pesticides, and most herbicides and fungicides are less toxic to bees than are insecticides. To the beekeeper, the most obvious sign of pesticide poisoning is the presence of an exceptional number of dead bees in front of the hives. The following figures have been established as guidelines for assessing the extent of pesticide poisoning: 100 dead bees per day is the colony's normal death rate; 200-400 dead bees indicate a low level of pesticide poisoning; 500-1000 dead bees indicate a medium level of pesticide poisoning; over 1000 dead bees indicate a high level of pesticide poisoning.

B. Relative toxicity of pesticides

As indicated above, pesticide application is one of the most important inputs to agriculture. Understanding and cooperation among growers and beekeepers are essential to prevent, or at least to minimize, the loss of honeybees due to the toxic effects of pesticides. The following table lists the most common pesticides, indicating their relative toxicity to honeybees.

Table 7/1. Relative Toxicity of Pesticides to the Common Honeybee

Group 1 - Highly Toxic

The application of these pesticides to foraging areas when bees are active may cause severe damage. Beekeepers must know in advance when they are to be used and take special precautions; moving colonies out of the area temporarily is perhaps the safest approach.

aldrin	Dimecron (phosphamidon)	methyl parathion
arsenicals		Methyl Trithion
Azodrin	Ethyl Guthion (azinphosethyl)	Mobam
Baygon		Monitor
BHC	Famothos(famphor)	parathion
Bidrin	Furadan	Phosdrin (mevinphos)
Chlothion	Guthion	Sevin (carbaryl)
dimethoate	heptachlor	Sumithion
fensulfothion	Imidan	Temik (aldacarb)
DDVP (dichlophos)	Lannate (methomyl)	TEPP
diazinon	lindane	Zectran
Dibrom	malathion	Zinophos dieldrln

Group 2 - Moderately Toxic

These products should not he applied directly on fields when bees are actively foraging or when hives are exposed. Dose, timing and application methods are among factors determining whether the pesticides can he used with minimum risk to bees.

Abate	endothion	Perthane
Agritox	endrin	Phosalone
Banol	Korlan (ronnel)	Phosvel, Abor
Carzol (formetanate)	MetaSystox	Pyramat
	(methyl demeton)	Systox (demeton)
chlordane	MetaSystox R (oxy-demeton-methyl)	Thinet (phorate)

DDT		Thiodan (endosulfan)
Di-Syston (disulfoton)	mirex	Trithion
		(carhophenothton)

Table 7/1. Relative Toxicity of Pesticides to the Common Honeybee (contd.)

Group 3 - Relatively Non-Toxic

These products can be used on fields or near hives with minimum damage to bees; in fact, a few of the listed acaricides can he used to control bee mites within the hive.

A. INSECTICIDES AND ACARICIDES

acaraben (chloro-benzilate)	Ethodan	Omite
	Fundal	OMPA (schradan)
Allethrin	Galecron (chlorophenamidine)	Ovotran (ovey)
Aramite		Phostex
Bacillus thuringiensis	Heliothis virus	phrethrin
	Kelthane (dicofol)	Rhothane (TDC)
cryolite	Kepone	rotenone
Delnav (dioxathion)	methoxychlor	ryania
Dessin	Mitox (chlorbenside)	sabadilla
Dilan	Morestan	Sulphenone
Dylox (trichlorfon)	Nemagon	Tedion (tetradifon)
Eradex	Neotran nicotine	toxaphene

B. FUNGICIDES

Arasan (thiram)	Cyprex (dodine)	Manzate (maneb)
Benlate (benomyl)	Dexon	Mylone
bordeaux mixture	dichlone	Parzate (nabam)
copper oxychloride sulfate	Difolatan	Phaltan (folpet)
	Dithane M-45	Polyram
copper sulfate (monahydrate)	(folcid)	sulfur
	Glyoxide (glyodin)	Thynon (dithianon)
cuprous oxide	Karathane (dinocap)	Zerlate (ziram)

C. HERBICIDES

amitrol	Eptam (EPTC)	picloram
Ammate (ammonium sulfamate)	Folex (merphos)	Planavin
	Herbisan (EXD)	Princep (simazine)
atrazine	Hyvar (bromacil)	Randox (CDAA)
Banvel (dicamba)	Igran (terbutryne)	Sinbar (terbacil)
Betanal (phenmedipham)	IPC	Stem F-34 (propanil)
	Karmex (diuron)	
Caparol (promytryne)	MCPA	TOK (nitrofen)
Casoron (dichlobenil)	Milogard (propazine)	Trysben (2,3,6-TBA)
	monuron	Vegedex (CDEX)
dalapon	NPA	2,4-D
DEF	paraquat	2,4-DB
diquat		2,4,5-T

Contents - **Previous** - **Next**

Chapter 8 Honeybees and crop pollination

Contents - **Previous** - **Next**

Honeybees of the genus Apis are excellent pollinators. On a single trip, a worker bee may visit as many as several hundred flowers of the same species, a flower fidelity very useful in cross-pollination. Moreover, since a honeybee colony consists of several thousands to several tens of thousands of workers, the number of pollinators readily available is great indeed. The final and most important factor contributing to the usefulness of honeybees as pollinators lies in the fact that A. cerana and A. mellifera being kept for the most part in man-made hives, the beekeeper can move them at any time to areas in need of pollinating insects.

The value of A. mellifera as the most valuable pollinating insect has long been recognized throughout the temperate zone, including parts of temperate Asia. In tropical Asia, however, where the staple diet consists of grains from self- or wind-pollinated plants, the value of honeybees as crop pollinators has received little attention. This is regrettable since many species of tropical fruit trees, vegetables, oilseed crops, and nuts of economic importance can benefit from cross-pollination, and yields may he much improved both quantitatively and qualitatively by pollination services from beekeeping. It is essential that agriculturists in Asia explore these possibilities without further delay.

Migrating honeybee colonies for crop pollination calls for a basic understanding of several points by both beekeepers and growers. Firstly, not all crops require or can benefit by honeybee visits: thus, as already mentioned, most cereal crops are self- or wind-pollinated. Growers must therefore be well aware of the pollination requirements of their crops before making arrangements to obtain bees for pollination services.

Secondly, growers must recognize that it is not always to the advantage of beekeepers to migrate their bees' since not all flowering crop plants secrete enough nectar for bees to collect and convert into extractable quantities of honey, and the honeys obtained from some flowers are not acceptable to consumers. Where one or both of these objections arise, the grower may have to rent bees from the beekeeper for pollination services; only when the beekeeper is assured of a satisfactory honey yield can his services be free of charge.

The effectiveness of honeybees in crop pollination depends on many factors, such as the location of the hives, the attractiveness of the flowers to the bees, and the bees' behaviour in approaching the flowers. Only strong colonies should be used in open-field pollination. Two-storey Langstroth hives are popular for pollinator colonies; the hives should be placed on stands. It is important that the number of colonies needed per unit area be established in advance, for maximum efficiency. This number varies considerably according to the crop: many fruit crops require several strong hives per hectare. To ensure that a large proportion of the flowers are visited, the bees should be moved to the area as soon as blossoming begins or, preferably, just before.

A number of factors can to some extent limit the efficiency of bees as pollinators: competition from nearby flowering plants, such as weeds; colony weaknesses brought about by the effects of pesticides, bee diseases and mismanagement during the pollen flow; and the effects of poor weather, which may prevent the trees from flying. Special emphasis should be placed on the danger of pesticides: while colonies of bees are in the field for pollination, toxic pesticides must not be used in the area, and in this regard, cooperation between growers and beekeepers is of the utmost importance.

Contents - **Previous** - **Next**

Bibliography

Contents - **Previous**

BAILEY, L. Honeybee pathology. London: Academic Press. 1981

COGGSHALL, W.L. & R.A. MORSE, Beeswax: production, harvesting, 1984 processing and products. Ithaca, NY: Wicwas Press.

CRANE, E. (Ed.) Honey: a comprehensive survey. London: Heinemann. 1975

CRANE, E. Bibliography of tropical apiculture. London: IBRA. 1978

CRANE, E. & P. WALKER. Pollination directory for world crops. 1984 London: IBRA.

CRANE, E.; P. WALKER; & R. DAY. Directory of important world 1984 honey sources. London: IBRA

DADANT AND SONS (Eds.) The hive and the honey bee. (Revised ea.) 1975 Hamilton, IL: Dadant & Sons.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. 1984 Proceedings of the Expert Consultation on beekeeping with Apis mellifera in tropical and sub-tropical Asia. Rome: FAO

FREE, J.B. Insect pollination of crops. London: Academic Press. 1970

INTERNATIONAL BEE RESEARCH ASSOCIATION. Source materials for 1985 apiculture. (2d ea.) London: IBRA.

LAIDLAW, H.H., .Jr., & J.E. ECKERT. Queen rearing. Berkeley and 1962 Los Angeles, CA: Univ. of California Press.

McGREGOR, S.E. Insect pollination of cultivated crop plants. 1976 Washington, DC: USDA/ARS Agric. Hdbk 496.

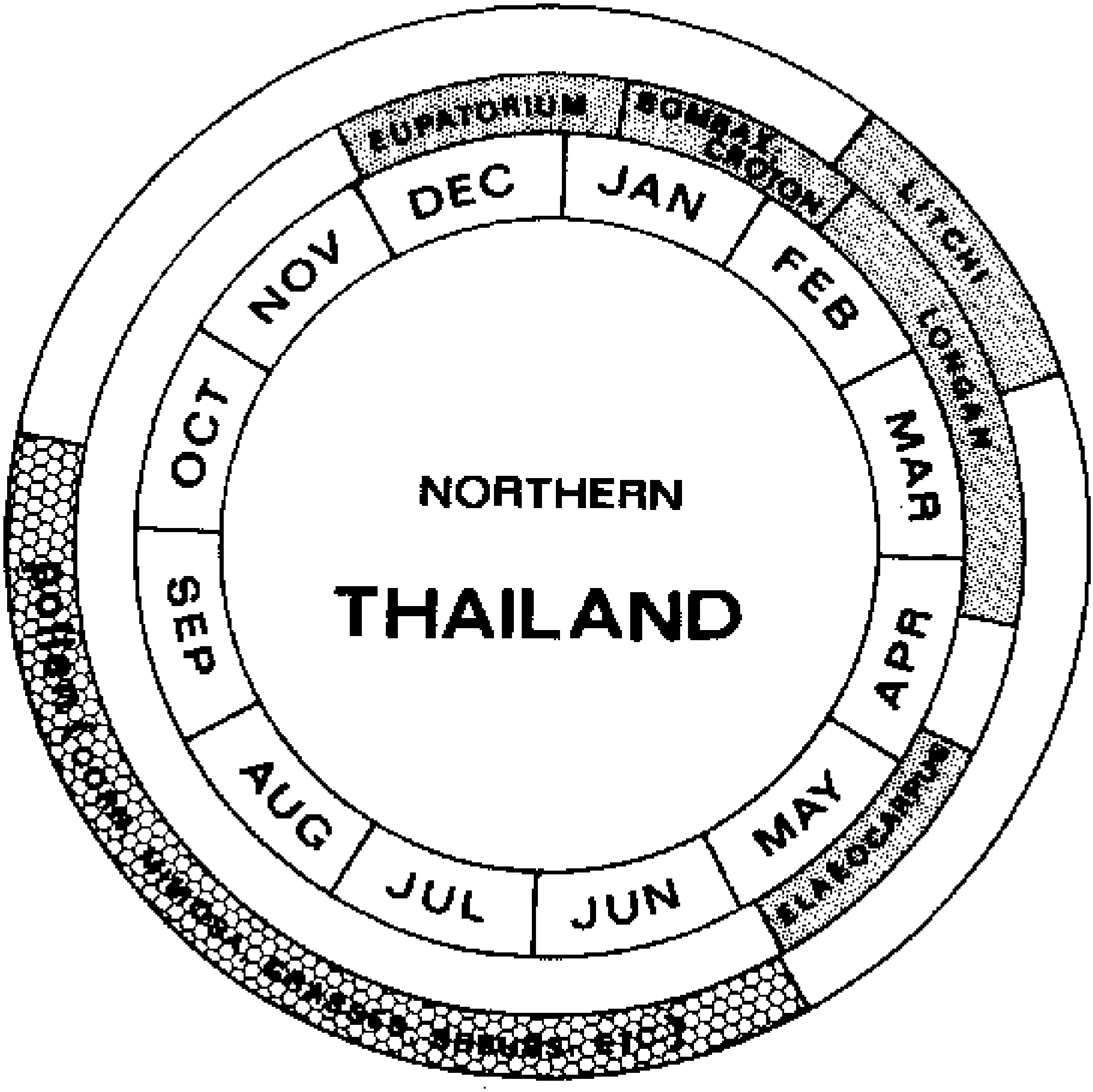
MILLER, W.R. Let's build a tree hive. Phoenix, AR: W.R. Miller, 1976 2028 W. Sherman St., 85009.

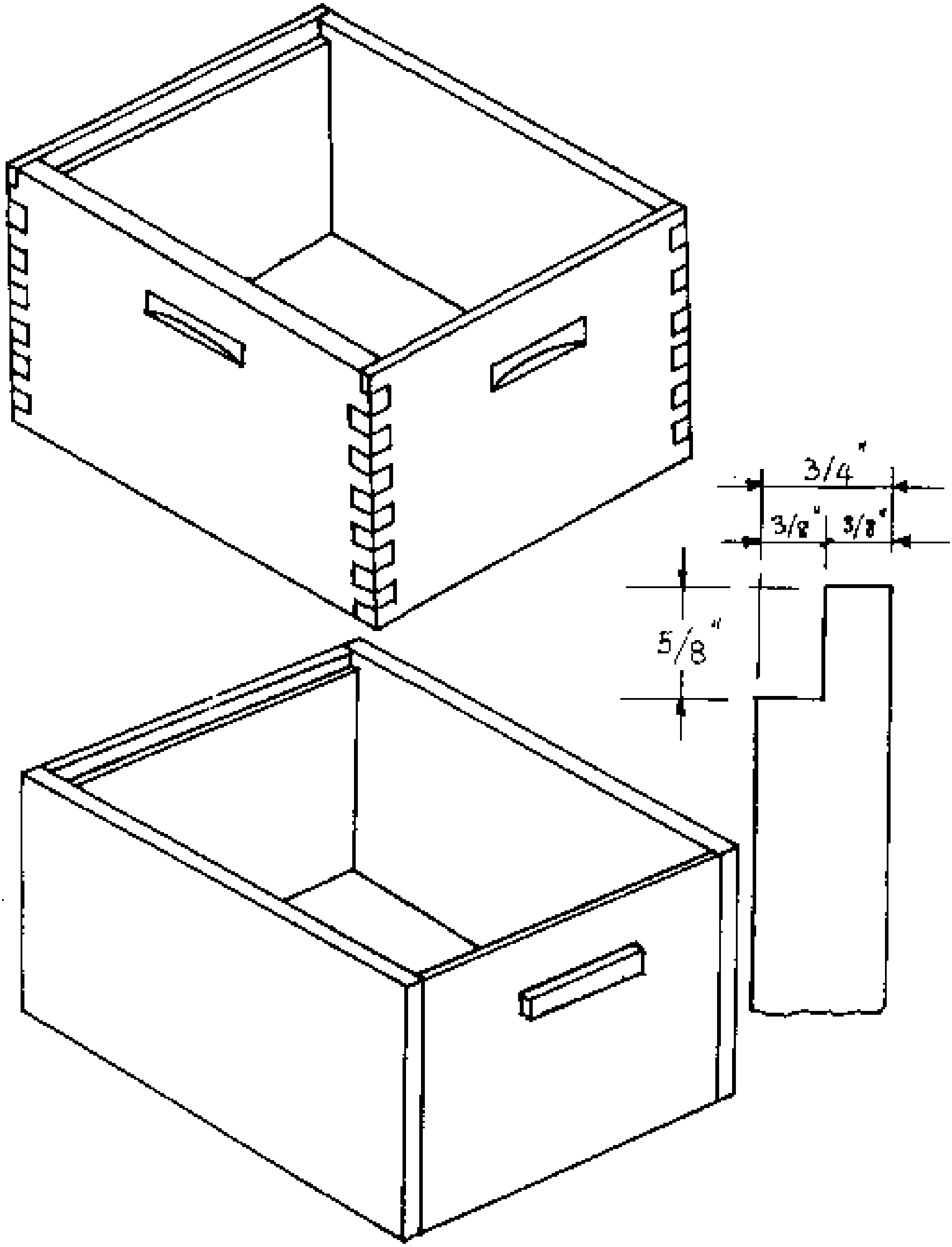
MORSE, R.A. (Ed.) Honey bee pests, predators, and diseases. 1978 Ithaca, NY, and London: Cornell Univ. Press.

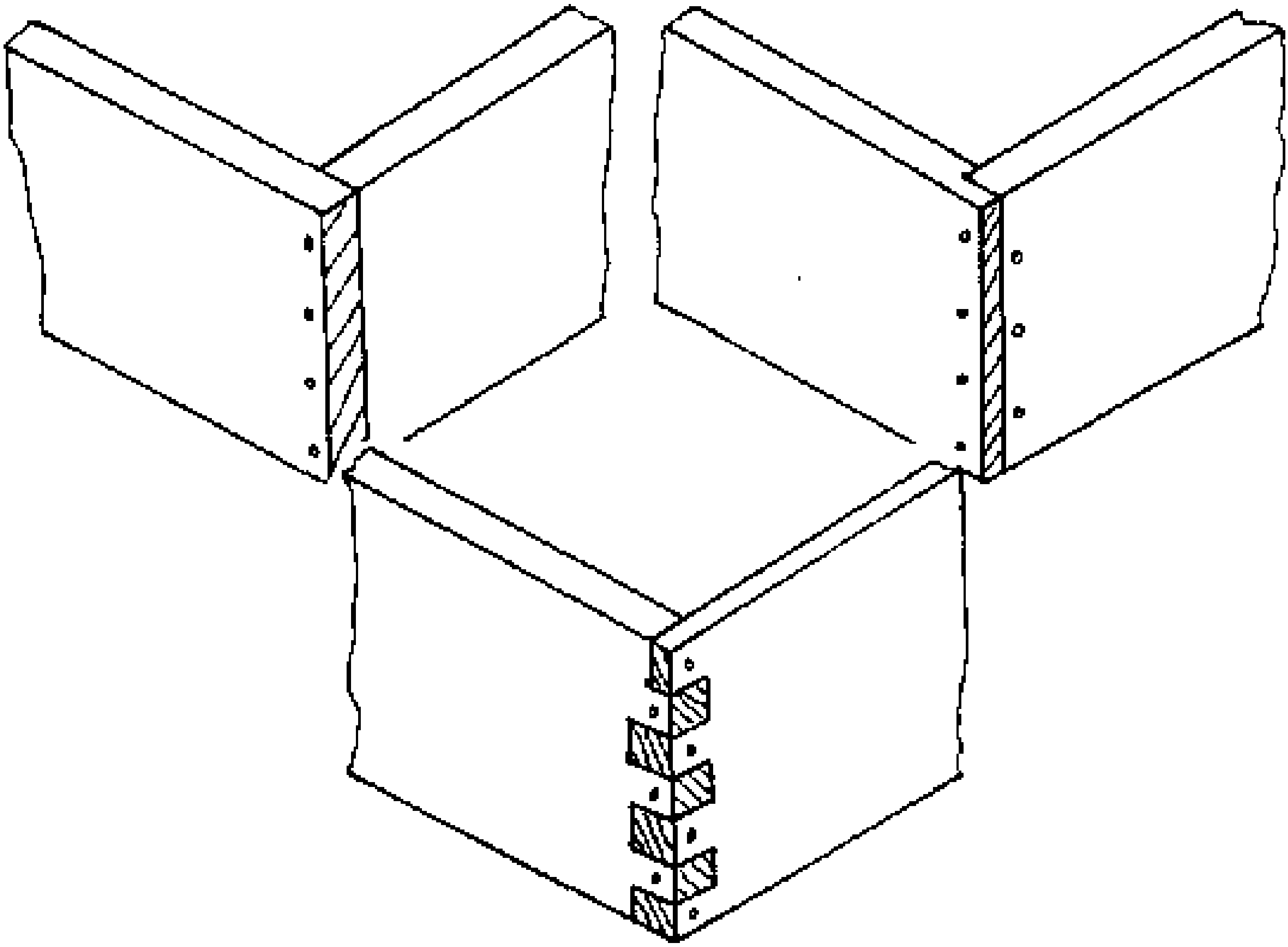
MORSE, R.A. Rearing queen honey bees. Ithaca, NY: Wicwas Press. 1979

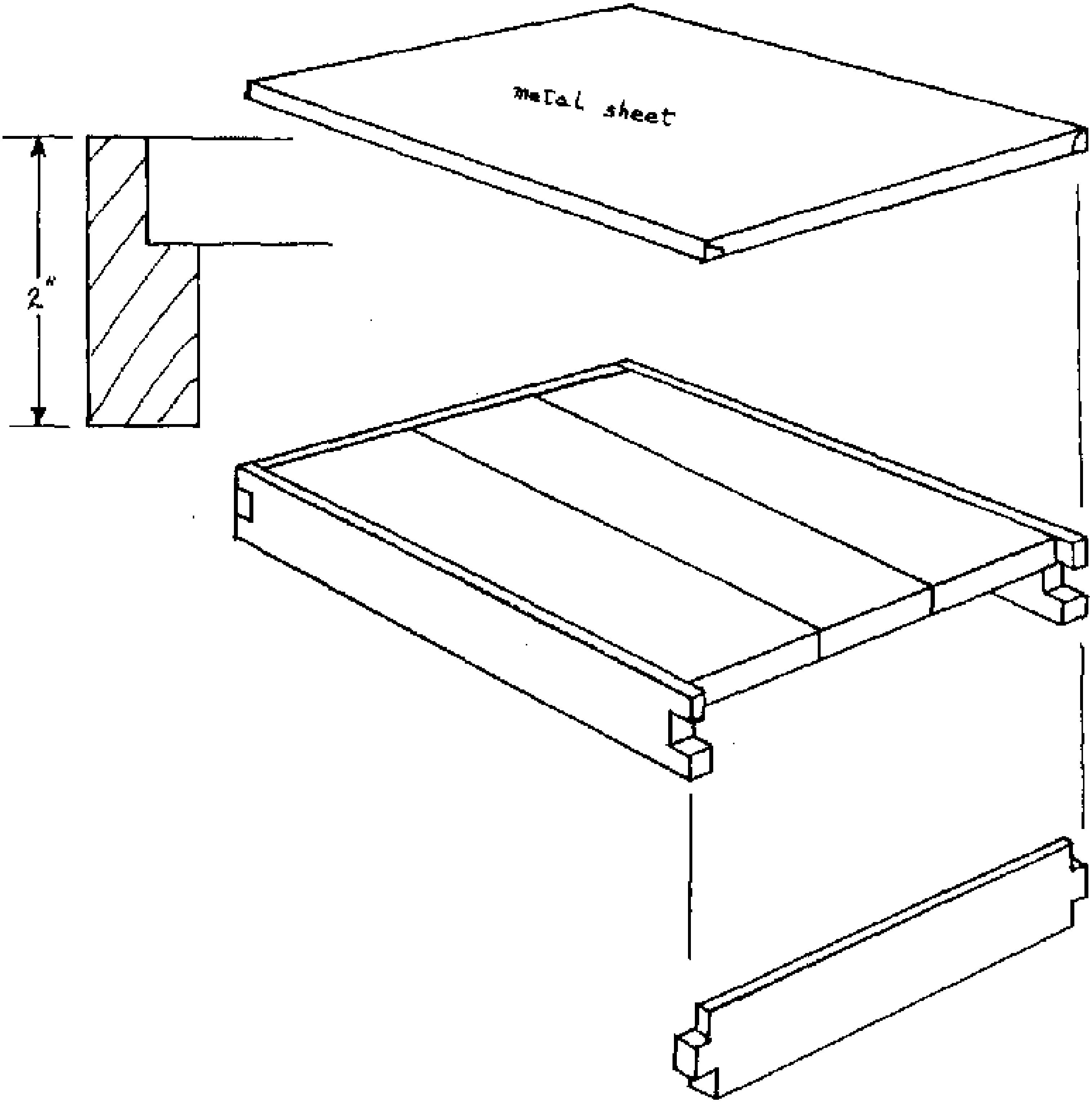
SMITH, F.G. Beekeeping in the tropics. London: Longmans, Green. 1960

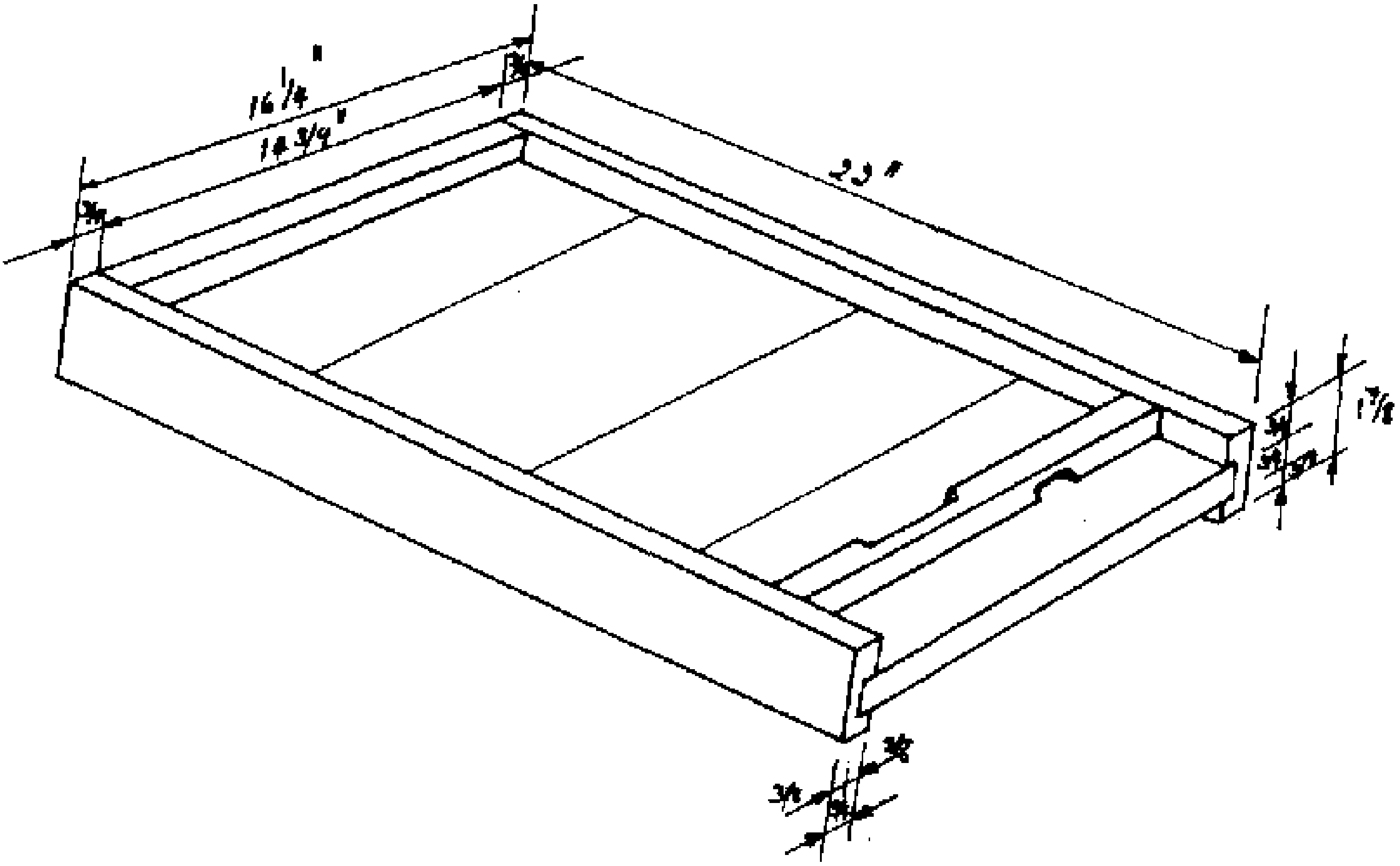
Contents - **Previous**

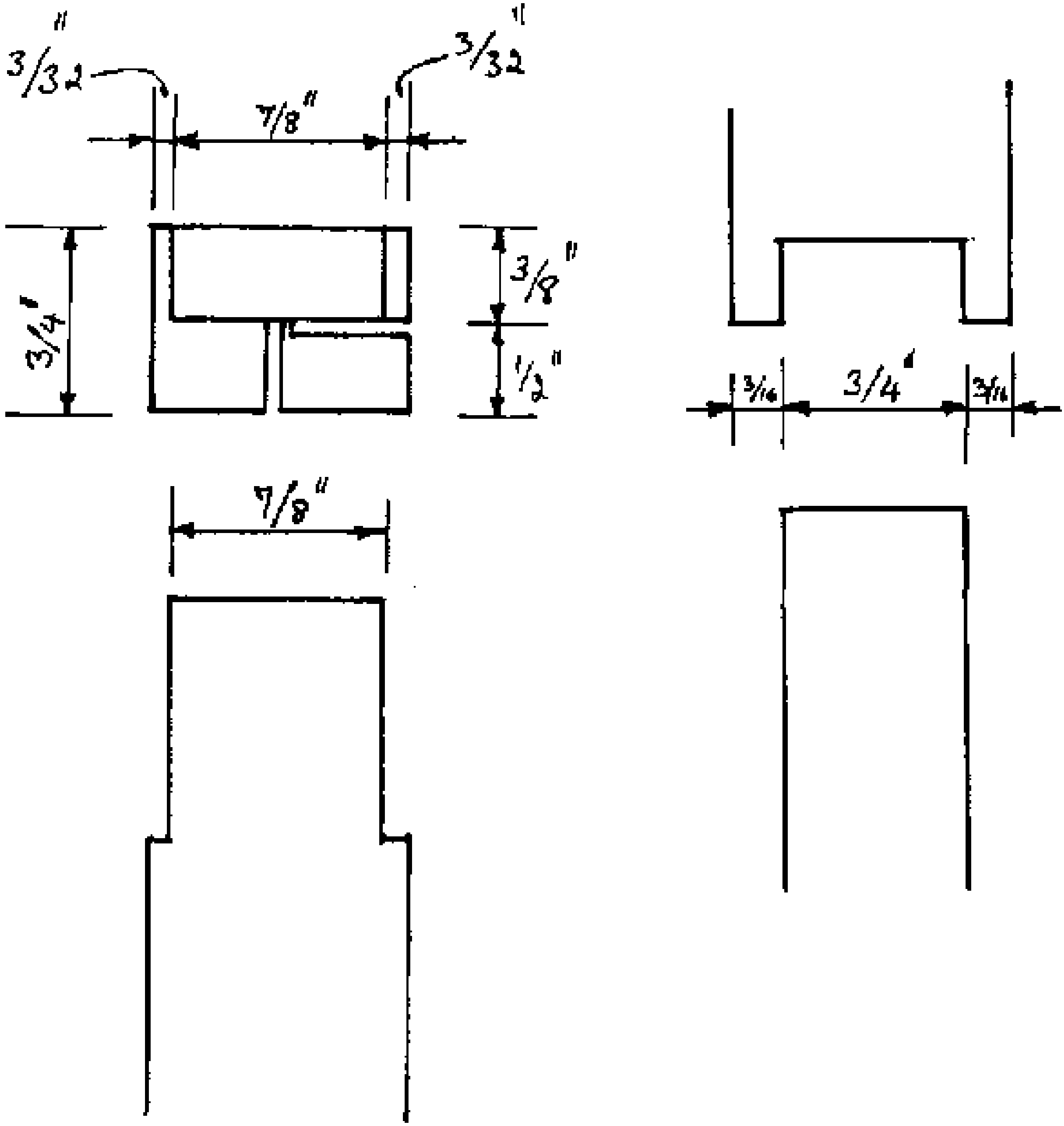

NORTHERN
THAILAND
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
EUPATORIUM
BOMBAX
CROTON
LITCHI
LONGAN
ELAEOCARPUS

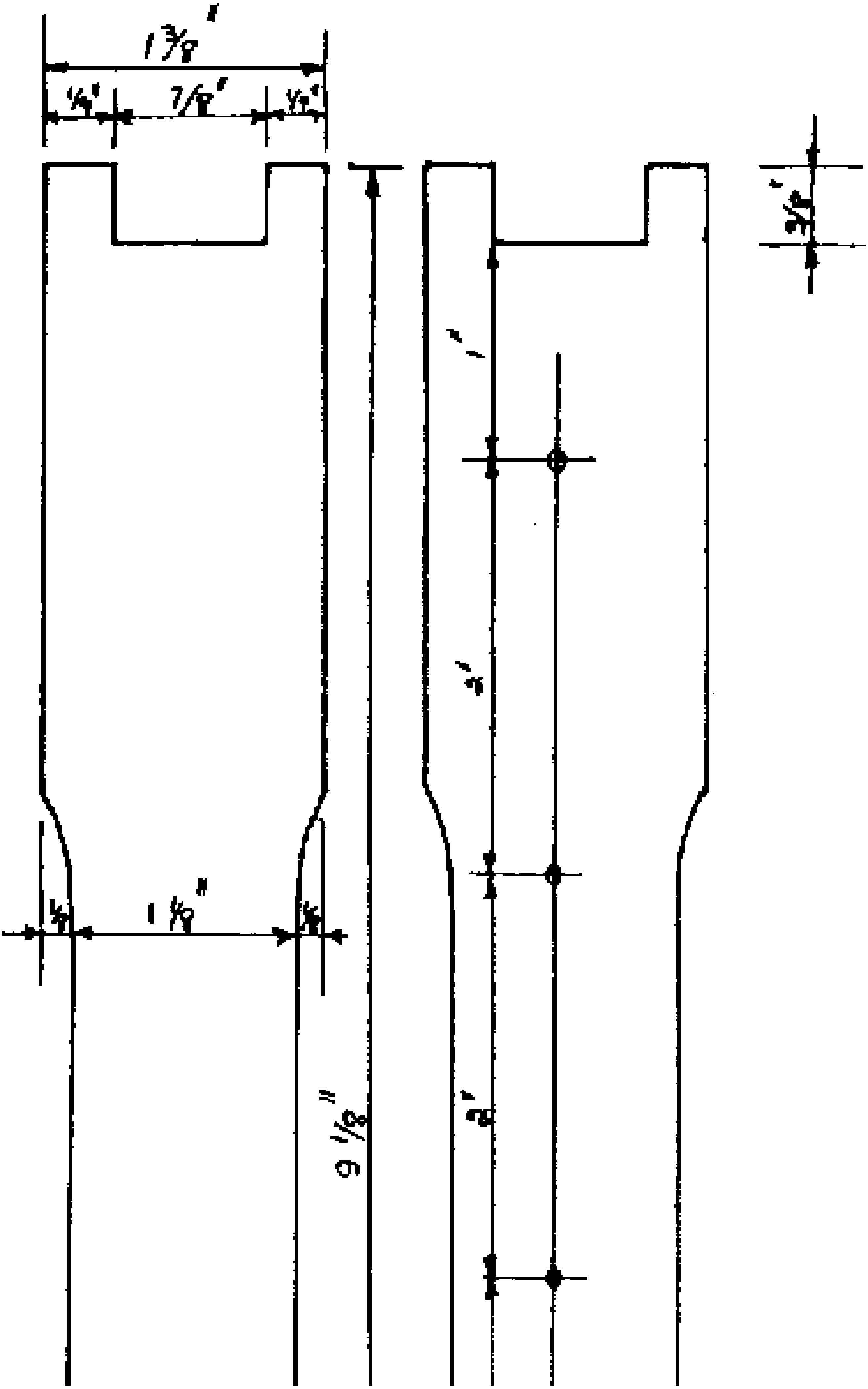

3/4"
3/8"
3/8"
5/8"

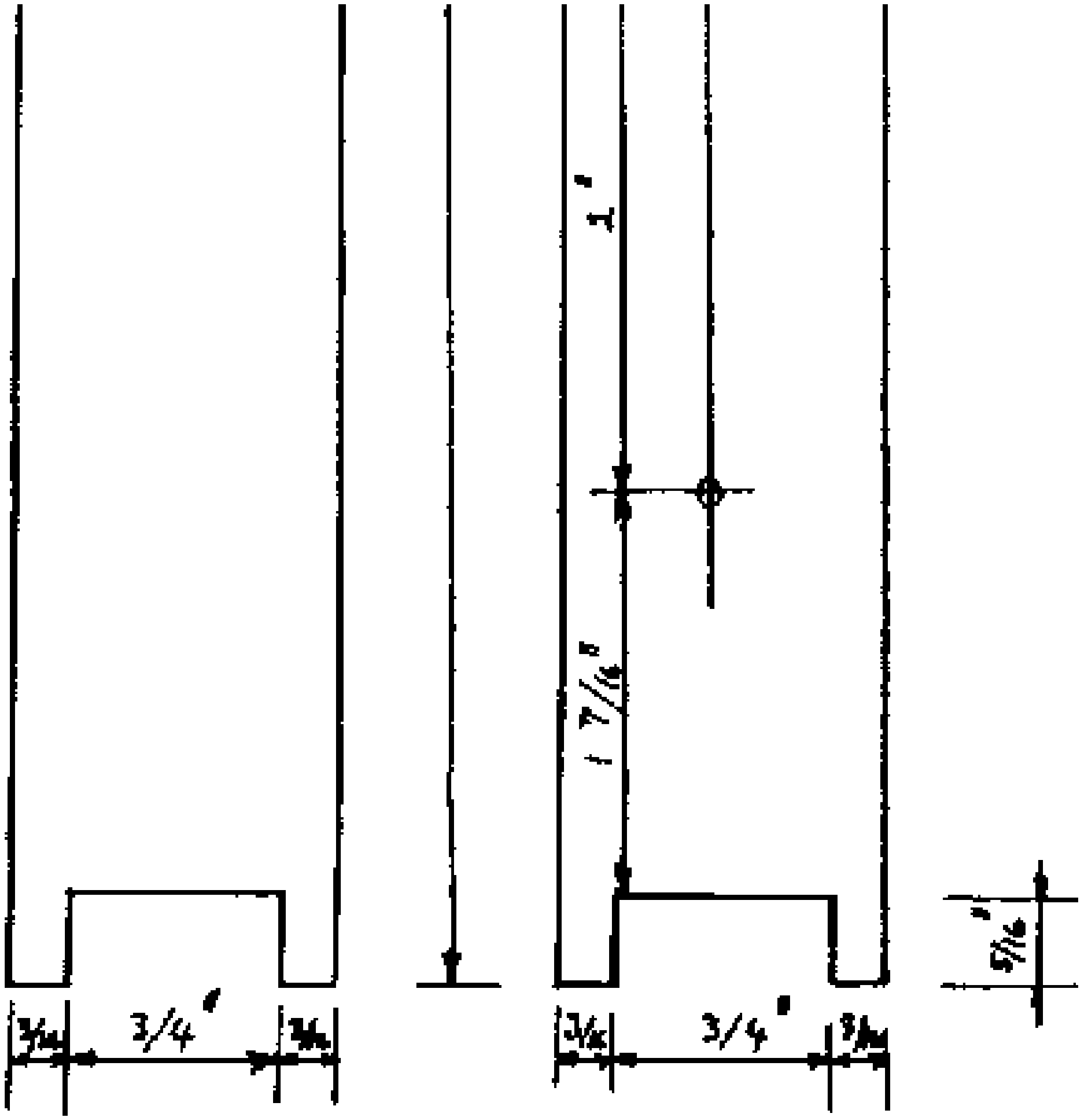



metal sheet
2"


16 1/4"
14 3/4"
3/4
23"
1 7/8
3/4
3/4
3/4
3/4


3/32"
3/32"
7/8"
3/4"
3/8"
1/2"
7/8"
3/16
3/4"
3/16


1 3/8"
1/4"
7/8"
1/4"
3/8"
1 1/8"
1/4
1/4
9 1/8"


3/16
3/4"
3/16
1"
1 7/16"
3/16
3/4"
3/16
5/16"