Part A

Bee Biology

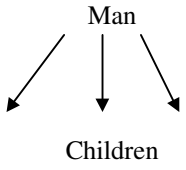
1.0 Origin of Bees and Definition

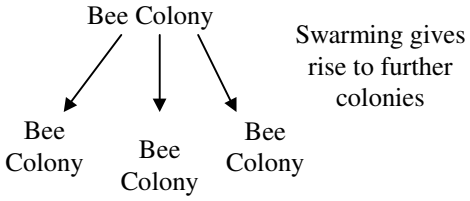
There are upwards of 20,000 species of bees worldwide. They are insects belonging to the Order Hymenoptera - which means *membranous winged*. Honeybees and Bumblebees are just a small proportion of the 20,000species. Others are wasps, ants, sawflies and a host of others.

Honeybees evolved as social insects from flesh eating ancestors. They evolved in tropical climates, and here in N. Scotland are very; close to their northern temperate limit. Even here they need help from Man to survive.

They are depicted on cave paintings of 6,00 years old, as is the act of harvesting from wild bee colonies.

Social insects evolved from colonies of individuals in close proximity in which an element of cooperation developed. In the social system the individual bee is not the unit but the colony.





In the social system the individual will sacrifice itself for the good of the colony.

Honey bee colony	1 queen several hundred males or drones up to 50K workers

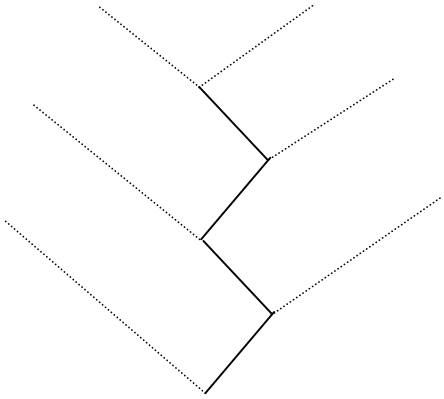
Honeybees are a species of bee kept by man in artificial homes or hives.

Usually brown or brown/yellow, and smaller than bumblebees.

The colony is able to survive from year to year because it stores a surplus of food to live on through the winter months when food is scarce or unavailable. This combined with the bees' ability to generate heat in the close proximity of the hive, allows bees to withstand a degree of cold and survive the winter period.

2.0 The Bees Home/Nest

The basis of the nest is a series of parallel vertical sheets of hexagonal cells of uniform size, made from wax secreted by the (worker) bees and elaborated into the cells either side of a central midrib of wax.



The nest is roughly dome shaped, the lower areas of which are occupied by areas where young bees are growing inside wax cells. Food is stored above and either side of this area, also in wax cells.

The classic nest site in the wild is a hollow tree, with the entrance at the bottom of the hollow area. The hive made from (straw/wicker) wood or plastic is an artificial version of this.

Realise at this stage that the temperature of the bees nest, in particular the area where the young bees are raised, must be kept at a steady temperature of about 34°C year round (c.f. human at 37°C).

It is important to understand that the bees produce the heat as a result of metabolic activity (ie eating and ‘burning’ food) in the same way as humans, and survive the winter by slowly eating their stored food. In the course of this they produce a little heat, and the combined effect of thousands of bees so doing produces a communal source of warmth - coupled with the insulative properties of the hive.

3.0 The Social System

In the case of the honey bee (and many other social insects) there are three distinct types or 'Castes' within the colony or community:

The queen (female) Workers (Female) Drones (Male)

The queen and workers develop from fertilised eggs.
The drones develop from unfertilised eggs.

Fertile egg		Unfertilised egg
Protein rich diet	3 days protein rich diet, then honey/pollen diet	
QUEEN FERTILE FEMALE	WORKER STERILE FEMALE	DRONE MALE

3.1 The Queen (Fertile female)

1 Functions primarily as an egg laying machine.
2 Lives 4-5 years naturally.
3 Will go with a swarm and is essential to the founding of a new colony.
4 Does not forage for food outside the hive. Fed entirely by the workers on 'Royal Jelly' (a glandular secretion).
5 Only a queen can mate and lay eggs which will develop into workers or another queen.
6 Lays up to 1000 eggs per day.
7 Leaves the hive only to mate, or to fly with a swarm.
8 Produces a number of volatile chemical messenger substances (pheromones) which help control colony behaviour.
9 Cannot produce beeswax.
10 Does have a sting, but uses it only on other queen bees. It is curved, smooth and can be withdrawn.
11 Under normal circumstances there is only one queen in the colony at a time.

3.2 The Workers (Sterile females)

1 Function primarily to carry out all the day to day work of the colony such as comb building, food gathering, feeding larvae etc.
2 Live up to 6 weeks in summer, 6 months in winter.
3 Forage for all the food requirements of the colony.
4 Under exceptional circumstances can lay eggs, normally they don't. Their eggs will only ever produce drones.
5 Leave the hive repeatedly.
6 Also produce a number of pheromones, principally for communication of messages rapidly through the colony such as alarm or attack.
7 Structurally adapted for their many functions.
8 Secrete wax and royal jelly from special glands.

9 Sting in defence of the colony - animals, birds, bees from other colonies. Sting is barbed and cannot usually be withdrawn, and the act of stinging usually kills the worker.
10 Up to 50,000 workers in a colony.

3.3 Drones (Males)

1 Sole function is to mate with a young queen. They die in the process of so doing.
2 Do not forage or carry out any domestic functions.
3 Do not sting.
4 Mating takes place only outside the colony, in flight, high up.
5 Several hundred are present in a colony, in summer only.
6 Steal or beg food from workers or open cells of honey.
7 They are thrown out or abandoned in corners to die in the autumn. Occasionally a very small number may survive the winter or be raised in early spring.

4. Bee Structure and Anatomy (Remembering the 3 Castes)

4.1 External Anatomy

4.1.1 External Features

The overall anatomy is typical of your average insect.

The body is in 3 main parts, with a hard cuticle, (its skeleton) on the outside and all the organs inside, including all the muscles to work the joints and so on.

3 Parts: Head
Thorax
Abdomen

The head bears a pair of antennae, (smell, vibration etc); compound eyes (very good vision) and mouthparts for both sucking and biting.
(See Atlas p.122-124)

The thorax is subdivided into 3 parts. Each bears a pair of legs (1 each side) making a total of 6 legs. The second and third parts each bear a pair of wings. In the worker the legs are modified with hairs and spines for collecting and transporting pollen (on the third pair of legs).

The abdomen is subdivided into a number of segments. It bears no appendages, but reproductive apparatus at the tail end and also in the case of the queen and workers, a sting.

Senses

These are well developed. Sensory organs include the eyes and antennae.

Smell-well developed both for location of food and also for detecting pheromones which are emitted by other bees and control behaviour.

Queen present
Attack - sting this
Look out - danger
The door is this way
Follow me
This is the food source - feed here

Each colony also has a distinct and identifiable odour (to other bees) so they recognise their own members as distinct from intruders - defence

Sight
Bees have well developed vision. It is of course important to the queen in terms of locating her home prior to and after her mating flight, and workers in general have a keen sense of orientation which is largely visually based. They orientate very strongly to their home location, using a variety of recognised landmarks. Drones also recognise the queen by sight and smell during mating. the eyes are probably not used inside the colony where it is virtually dark.

Direction
This is more a combination of sight and smell, very keenly developed in the workers. See above. They must navigate accurately to find and re-find sources of food, and must also communicate information regarding food sources to other workers. Workers are able to 'measure' both distance and direction, (the latter based on their ability to recognise the direction of polarisation of light which is dependent on the relative position of the sun), and by a combination of repeated movements on the comb (the 'bee dance') can tell other workers of the distance, direction and type of potential food source. This allows a continuous communal 'appraisal' of the best and most cost-effective sources of forage.

Touch
The antennae and other sensory hairs on the bees' body provide a keen sense of touch which is used, in conjunction with scent, inside the hive.

Hearing
There is some question as to the ability of bees to hear and respond to sounds, but since queens in particular can make some quite specific sounds ('piping' of virgins inside their cells before and just after emergence) it seems logical that these sounds can be heard by other bees, and that they respond to them.

4.1.3 More on the subject of Feeding / Diet / Foraging

Bees evolved alongside flowering plants, and with the plants' need to transfer pollen from flower to flower. By offering the bees a reward in the form of pollen or nectar, and by being 'showy' to attract the bees, this was achieved. The 'cost' to the flower was in having to produce the reward in the first place - sugar solution (nectar) or an excess of protein (pollen) - both quite expensive in metabolic terms for the flower to do.

The worker bees are adapted to collect both the pollen and nectar. Nectar is collected in a pre-stomach or crop, and pollen into compressed pellets carried on the hind legs.

Pollen = protein
Nectar = carbohydrate. Between them they are a complete diet.

By adding enzymes to the nectar from their saliva and other glands, the enzymes chemically alter the sugars, and by evaporating off the excess water content from 90% down to about 20%, the nectar is changed into honey. With a water content of 20% or less the honey will not ferment. Honey is stored in cells made of wax, which is impermeable to water, with a wax covering, and thus remains hermetically sealed against moisture in the air.

Pollen is stored in the wax cells, and preserved by adding some honey to it - the food store is therefore able to last through the winter.

Typical flowers for bees to use as a food source are short-tubed, yellow white or blue in colour, and often fall into one fo a fairly small number of flower families e.g. Liliaceae (Crocus, snowdrop), Crucifera (Cabbage Family - Oilseed Rape, Mustard), Rose Family, Dandelion / Daisy family.

4.2 Internal Anatomy
4.2.1 Digestive System
The gut consists of a single tube, which can store and regurgitate nectar from a pre-stomach or crop, as well as digest and absorb honey and pollen, and excrete the indigestible remains (mostly the outer coat of pollen grains) from the other end of the tube. The mouthparts have been referred to already.

4.2.2 Reproductive System
FEMALE. In the workers the ovaries are atrophied, although in the prolonged absence of a queen in the colony they will sometimes start to develop in a few individuals which can then lay unfertilised eggs, which will develop into drones. The only part of the female sexual apparatus which is fully developed in the workers in the sting, and it is fully functional.
In the queen the female organs are fully developed. The ovaries produce a constant supply of eggs about 0.7mm long. The queen mates on only occasion (probably with several drones on that occasion) during the first three weeks of her life, and stores the sperm from these matings within her reproductive system. if she fails to mate during this time, she will eventually start to lay eggs but these being unfertilised will only ever produce drones.
So long as the supply of sperm lasts she can lay fertilised or unfertilised eggs, depending on whether she lays into a drone sell (more of this later).

If she fails to mate with sufficient drones, or her supply of sperm runs out, she will also become a drone layer. However queens can successfully lay fertilised and unfertilised eggs for up to four or even five years in some cases.

MALE. The drone is designed only to produce sperm and mate with the queen - in flight. He dies in the process. Once a colony has given up queen rearing for the year, few drones are tolerated in the hive and they are first denied access to food, then thrown out of the hive to die.

4.2.3 Respiratory System

Bees like all living creatures need a supply of oxygen to the body. They extract this from the air around them. Bees denied access to a supply of air will suffocate and die.

Each segment of the body has an opening in the side called a spiracle, which leads into a branching tube, the trachea. Oxygen and the metabolic by product, carbon dioxide, are exchanged with body fluids across the walls of the tracheae, which permeate the body tissues. Movement of the body helps push air in and out of the spiracles, which in turn facilitates efficient exchange of gases.

4.2.4 Circulatory system.

The bees circulatory system is somewhat complicated, with a long tubular ‘heart’ lying along the length of its body dorsally. The blood is not like ours in that it does not contain red cells for carrying oxygen, but it does carry sugars and amino acids and other metabolites. The blood is not pumped through vessels but around the body cavity in a manner controlled by flaps and valves.

4.2.5 The Glandular System

SALIVARY GLANDS occur in the head and thorax of the workers, and discharge at the mouth. The saliva is a slightly alkaline water. It is used to dissolve sugary foods, and to wash surfaces free of them, and to soften substances being chewed.

HYPOPHARYNGEAL GLAND occurs in the workers' head, produces brood food or 'royal jelly', a thick white milky substance, rich in sugars, proteins and other nutrients which is fed to young larvae, queen larvae and the queen.

In older workers the gland produces an enzyme which acts on the sugars in nectar changing it into honey.

MANDIBULAR GLANDS In the queen they produce mainly the so called queen substance - a pheromone produced only by the queen and which, as it is passed around the colony during mutual feeding and grooming, informs the colony that the queen is there. Her absence will be noticed within about ten minutes of her removal. It also helps the drones locate the queen during the mating flight.

In addition it suppresses the development of ovaries in the workers, it suppresses the building of queen cells, and promotes the building of worker as opposed to drone comb.

NASONOV GLAND is present only in workers, at the dorsal posterior end of the abdomen. When exposed by the worker it emits a pheromone which advertises the location of the colony entrance or settling position for a swarm, and says 'come here'.

STING SCENT is a substance smelling like pear drops emitted from glands in the sting apparatus, and says to other bees 'sting this'.

WAX SECRETING GLANDS on the worker only, on the last four ventral abdominal segments, secrete scales of wax which are picked up by the legs, passed to the mandibles (jaws) where they are chewed and mixed with saliva before being sculpted into honeycomb.
The secretion of wax requires the consumption of a lot of honey - about 2-4 lb of honey per lb of wax produced - and requires the nest to be warm. A lot of heat is also generated in the process.

5.1 Comparative life cycles
Times in days from laying of egg

	WORKER	QUEEN	DRONE
HATCHING OF EGG	3	3	3
CELL SEALED	8-9	8	10
PUPA PRODUCED IN CELL	11	10	14
PUPA MOULTS TO MATURE FORM	20	15	22.5
MATURE FORM EMERGES FROM CELL	21	16	24

The basic life cycle is the same as that of a butterfly

EGG	LARVA	PUPA	ADULT FORM
EGG	CATERPILLAR	CHRYSALIS	ADULT FORM

LARVAE GROW BY SHEDDING THEIR SKIN - MOULTING - FIVE TIMES

All larvae are fed for the first 3 days on royal jelly. Then all except queen larvae are switched to a mixture of honey and pollen until the cell is sealed over with wax by the workers. The egg is upright at first, about 1mm long, white like a tiny grain of rice glued to the bottom of the cell. As it nears hatching it gradually topples over sideways.
Larvae at first lie curled up on their side in the base of the cell floating in a pool of royal jelly, but turn head up to the opening as they grow bigger.

Queen larvae hang upside down from special cells built downwards.

5.2 Different types of brood area in the colony.

Brood = eggs, larvae and pupae in all stages of development occupying specific areas of brood comb within the colony.

Worker Brood. This is found in the ‘normal’ size of hexagonal wax cell described earlier, of the same diameter as is also normally used for the storage of honey. When capped , worker brood is slightly raised but not markedly so. the young bees chew their way out.

Drone Brood. Also hexagonal, but wax cells of a slightly larger diameter which is quite clear to the eye when observed. The act of laying eggs in drone cells somehow triggers a mechanism in the queen whereby the egg is not fertilised. When capped by the workers for pupation,, the cappings are very convex and raised above the surface of the surrounding wax, so the comb has a very ‘bubbled’ or ‘puffy’ appearance.
Note that in all brood the cappings are porous (not impermeable as in capped honey0) and this allows the grub and pupa within the cell to breather, as air is exchanged through the porous capping.

Queen Cells. The axis of a queen cell is vertical, not horizontal. as in the case of worker and drone. Queens are raised in special cells which are used only ever for this purpose. Honey can pollen care both stored in worker and sometimes in drone cells, but never in queen cells.
Queen cells start off like inverted acorn cups, against the face of the main brood comb. They are lengthened downwards as the grub inside them grows, as the workers add more wax. They finish up just over an inch in length, and are then capped over. The eggs is probably not laid directly in the cell, but carried there by a worker. Sometimes workers make a mistake and transfer a drone egg to a queen cell, and this is destined only to produce a large drone, not a queen.
Queen cells can also be made by modifying a pre existing worker cell., as long as it contains a n egg or a grub less than three days old.. More royal jelly is added to the cell to float the grub out, the neck of the cell is extended outwards and turned downwards through 90 degrees, to produce a so-called emergency queen cell.
Normally produced queen cells are usually found at the periphery of the brood nest, and emergency ones among areas of brood anywhere.
Queens are raised either
a) To replace an old or failing queen - supersedure
b) To replace a queen which has dies or disappeared
c) As a prelude to swarming, in which the colony divides into two or more separate colony units.

The mature queen does not chew her way out of her cell. the cell is opened by the workers for her, and they may physically prevent her from emerging until they are ‘ready’ for her, for example if they plan to swarm but bad weather delays the emergence of the swarm.

5.3 The life and ‘division of labour’ of bee castes.
Queen. Once the queen has emerged from her cell, she immediately does one of two things either
a) Kills any remaining young queens in the colony, including any still inside their cells, by stinging them. This is the only occasion when a queen be uses her sting.
b) Flies off with a swarm.

She settles down for about a week to ten days in the colony doing very little, except begging food from workers from time to time. Apart from feeding her they more or less totally ignore her, but her presence is already enough to suppress them from raising any further queens.

During this time, or soon afterwards she makes a few short flights to ‘get her bearings’ and learn the position of her home hive in relation to the landmarks. At about 2and a half to three weeks after emergence she chooses a day which is warm and not too windy, for her mating flight. This is usually in the afternoon and lasts an hour or more. Drones are attracted to her by sight and scent at the point of her leaving the hive.

She mates with several drones on this one flight, and this supply of sperm must last her whole lifetime, She will only ever fly again with a swarm, and will not mate again. On return from her mating flight she is much more attractive to the workers, which immediately begin to feed her with royal jelly, a protein/amino acid/carbohydrate rich complete food, secreted by the workers. On this rich diet she begins to produce eggs and to lay within a few days after mating.

Workers
Workers are produced from fertilised eggs which have been fed on royal jelly for the first three days, then on honey and pollen for the remainder of their larval life.

They live on average six weeks in summer, and six months in winter. the length of life is more or less in direct proportion to the amount of work they have done.

the division of labour among workers is one of the major developments in social insect communities. Each bee has a specific task or set of tasks to do depending on its age through its entire life. As they age they undertake set tasks in a more or less set sequence.

1 Cleaning cells for egg laying
2 Ventilation of the colony
3 Attending the queen
4 Capping cells
5 Tending young brood
6 Building com
7 Tending older brood
8 Orientation flights

9 Packing pollen
10 Secreting wax
11 Following dancing bees
12 Foraging
13 Die when worn out.

From4 to 8 they will also be eating pollen, and throughout their whole life they will spend periods patrolling at the entrance of the nest on guard duty, and also resting (sleeping?).

In the winter this sequence is much more protracted, and long periods are spent in the winter cluster completely dormant.

Drones
The total life-span of a drone is about 60 days, unless they mate, when their life ends immediately. They are ready to mate 10 - 14 days after emergence from the cell. They do little else except eat honey and pollen, and contribute a little to the warmth of the nest. They are mostly killed or forced to leave the hive by the workers in late summer or autumn, although a few may survive into the winter, and it is usual to see a few drones at any time in the colony. The maximum number of drones is seen in late spring and early summer.

6 Bee health and Disease.

Note - no bee diseases can be transmitted to humans

6.1 Diseases of the Brood

AFB and EFB
American Foulbrood and European Foulbrood are bot bacterial diseases, which kill the larvae in their cells. They are both legally notifiable to the Agriculture and Fisheries Department. Although EFB is treatable, both usually require the destruction of the bees and frames. Legally they must be notified and the instructions of the SOAFD MUST be followed. ONLY SOAFD can legally treat for EFB, and destruction is the usual treatment to be instructed. Destruction will include the honey, bees and frames, and often the hive as well. These diseases are usually fatal to the colony and highly contagious to other bees, and extremely resistant to destruction.

Chalkbrood.
This is a fungal disease of the larvae which kills a proportion of the grubs after they are capped in the cells. The mummified corpses turn white and fluffy, then black. Requeening helps, but the best treatment is the regular renewal of brood combs by the beekeeper. Chilled or otherwise stressed colonies are more susceptible.

6.2 Diseases of the adult bees.
Nosema

The disease is caused by a protozoan -a microscopic single celled organism related to that which causes malaria in humans - which infects the bees' gut. The bees develop a distended abdomen and are unable to fly. The disease is commonest in spring and is best controlled by making sure bees entering the winter are well fed and sheltered and not exposed to chilling winds. It also helps to make sure they have constant access to clean drinking water which cannot become contaminated. A drug called Fumidil-b is available to treat affected bees, and empty combs can also be fumigated with acetic acid to kill any residual organisms.

Acarine disease.
This is caused by a parasitic mite which lives in the tracheae of adult bees. It weakens and disables bees, and colonies. The treatment recommended for Varroasis may help. There is no other effective treatment, and older treatments such as FROW mixture must not be used.

6.3 Diseases affecting both larvae and adults

Varroasis
Caused by the a parasitic mite Varroa jacobsonii, a mite which has over the course of the past 50-60 years successfully transferred from its natural host the Asian Honey bee (to which it is not fatal) onto a new host, the European honey bee (on which it is a serious threat and often fatal to colonies).
The mite has a complex life cycle, and is ultimately usually fatal to colonies, even often in spite of the best treatment we have to offer. The mites suck blood from both larvae and pupae and adults, weakening, disabling and malforming the bees. It is now probably present throughout the British Isles, but is so far not detected in the North of Scotland.
there are two types of chemical treatments)
a) Hard chemicals. Bayvarol and Apistan are acaricides (Toxic to mites), and can also be used to detect as well as to kill infesting mites.
b) Soft chemicals. Some 'natural' chemicals such as formic acid, and some essential oils, are effective as acaricides.

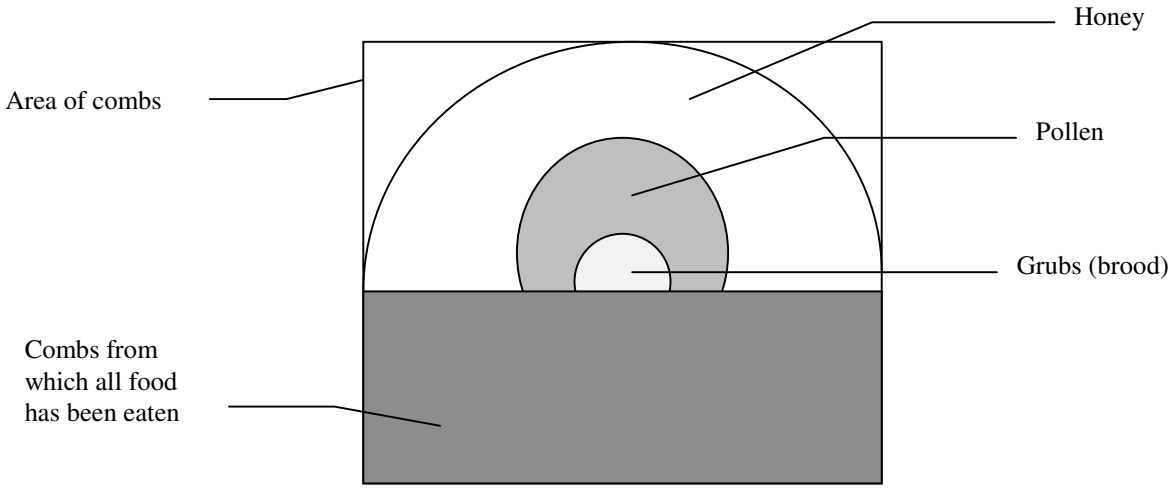
Treatment normally includes a mixture of both types of chemical, but the mites have demonstrated a capacity to develop resistance to the chemicals. Bees affected are much more susceptible to other diseases, including non defined viruses, Acarine etc.

7 A year in the life of a 'wild' colony

This sequence is given to indicate the *natural* processes which the colony goes through, and which the beekeeper has to be aware of and try to capitalise on. The section on seasonal management will come later, but this sequence is given here as a means of introducing many aspects of life in the colony in their proper context.

7.1 SPRING

At this time, late February or early March, the colony is small, maybe only one tenth of the size of a summer colony. The bees spend much time huddled into a dense ball or cluster to conserve heat, each bee spending a little time at the centre where it is warmest. Here at the centre there will probably be a small patch of brood.



Vertical section through colony in early spring

During milder days the cluster will break up somewhat, bees will fly out to excrete waste, collect water or early pollen. If the air temperature falls below ten centigrade, the bee cannot maintain its body at a temperature high enough for activity or flight, and this is the point at which the cluster forms. The bee must, within the cluster, at some point keep its body temperature above eight degrees centigrade, in order to feed. If its body falls below this temperature it will die if it is not warmed by the bees at the centre. Warmth is generated by exercising the flight muscles without flying.

As long as the ambient temperature is below about 13 degrees centigrade, the bees stay in the nest (although this critical temperature lowers as spring advances and brood is ever more present.) Water is needed to dilute stored honey to feed larvae. The days lengthen, temperature rises, crocuses snowdrops and then hazel trees begin to produce pollen, and more food is coming into the nest. This stimulates the workers to feed the queen more, and this stimulates more egg laying.

Willow Blackthorn and Gean begin to flower, providing more pollen and nectar. By late March or early April a rapid increase in bee numbers should be under way. The size of the brood area increases rapidly now, expanding downwards into the empty combs, and also upwards as more stored food is

consumed. This is still a dangerous time for the bees as a sudden change in weather, or a late spring, can bring about sudden starvation.

By May food sources include apple. plum, oilseed rape, wild raspberry, gorse broom and all sorts of spring flowers. Combs begin to fill up with pollen and honey, the rate of accumulation exceeds the rate of consumption, and this is what we call a 'honey flow'. Every space available for new comb is occupied and full of honey or bee larvae. Soon drone comb is built and drone rearing begins.

7.2 SUMMER

Consider for a moment the activity of foraging bees. As they return to the hive they pass their load of honey directly to the other younger 'house' bees which then ripen it (evaporate the water) and store it in cells (Pollen loads are dumped directly into storage cells). If there is nowhere for these house bees to store the ripened nectar, because all cells are full of honey or larvae, these bees just sit around full of nectar, torpid and 'replete'. The degree of inter - bee communication in the colony is thus reduced, and this, coupled with the ever increasing number of bees, leads to a gradual partial breakdown in the passage of queen substance around the colony, especially to the 'repletes'. A sort of queenlessness exists, and some of the replete bees begin to build queen cells in response to this. Up to 3, or as many as 20 or more, may be started. This is preparation for swarming, and usually begins around the end of May or beginning of June. May, June and July are the swarming season.

As soon as the first queen cell has a grub sealed into it, the primary swarm will depart.

1 It usually flies out of the hive around the middle of the day.
2 The weather must be warm, dry and not too windy
3 It is led out by the workers, NOT the queen
4 It takes about 5 minutes for the whole swarm to emerge.
5 It may include as much as half the total bees in the colony, including bees of all ages but predominantly young ones of wax secreting age.
6 The queen usually emerges near the end of the swarm emergence.
7 The remaining bees carry on as if nothing is happening.

A primary settling point will already have been selected by 'scout' bees some days before, and they guide the swarm to it, about 20 - 30 feet from the parent nest. This is to ensure that the queen has safely accompanied the swarm. If she has not, within an hour the swarm returns home. Assuming that the queen is with the swarm, then a new nest site is chosen (which may be several miles away) and the swarm gradually migrates to it, over a period of days, a mile or two at a time, settling in a bush or tree in between moves. Eventually it settles, the bees begin to build comb and the first new eggs are laid.

Meanwhile the old colony is temporarily queenless. About 6 - 8 days after the primary swarm left (but sooner if its departure was delayed by bad weather) the first young virgin queen emerges from her cell. This queen may well fly off at once with a secondary swarm or 'cast'. Several casts may leave over the next few days, each one accompanying the most recently emerged virgin queen, but eventually one of the virgins is allowed by the workers to kill all the remaining queen cells, and swarming stops. This queen is allowed to mate and starts to lay.

Meanwhile honey gathering has continued, although if many swarms leave the number of remaining bees is severely depleted and they will live largely off the surplus accumulated before swarming started.

By the end of July or early August, swarming is usually over unless there has been another large buildup of bees and honey following the first swarms in May. Swarms as late as July or August will never build up into a good sized colony able to survive the following winter.

7.3 AUTUMN

By August the size of the brood area is much smaller, although it may undergo a short, lesser increase in size to boost the number of bees going into the autumn. There are still plenty of workers, but by now they are an aging population. Their job now is to fill every available space with honey and pollen to see the colony through the winter. Brood rearing now continues on 3 - 4 frames instead of the 8 - 10 frames of spring and early summer.

By late September or early October, foraging has just about stopped as there are few sources of food as late as this. Most of the summer bees have died, and the drones have been thrown out or left to die. The nights are colder, the first frosts come and the bees start to cluster at the bottom of their combs, with all their honey and pollen above them. They may fly occasionally for water, and to excrete, otherwise they stay in the nest.

7.4 WINTER

Cast you mind back to early spring. The cluster is in a similar state as then. The cluster breaks up very little, and from about November until sometime in January brood rearing is intermittent or stops completely. The queen stays at the centre of the cluster in the warmth. Brood rearing is probably triggered again by a combination of increase in day length and rise in temperature, but the number of bees continues to decrease until April or May.

The food supply is consumed relatively slowly during the early part of winter, but the rate of consumption increases once brood is being reared.

Part B – Bees, Equipment and basic techniques

1 Bees and beehives

The bee kept by beekeepers is identical in every way to the wild *Apis mellifera* which lives in hollow trees and similar places. It is simply persuaded to occupy an artificial home by providing the right conditions.

The sheets of comb in a wild colony are evenly and consistently spaced, with the centre to centre distance constant, and the gap between adjacent combs also constant.

In an artificial bee nest or hive, it is essential to have sheets of comb which can be lifted out one at a time to be inspected, or placed at a different position within the hive, or even in a different hive altogether. To be able to do this the comb must be supported in a wooded frame, which can itself be lifted free from the hive. This is the concept of the moveable frame hive. The requisites are:

1 A regular sized wooden frame

2 Sheets of beeswax foundation to fit into them - these are thin sheets of pure beeswax embossed with the hexagonal cell pattern, to promote the workers to build or 'draw out' even sheets of comb.

3 Evenly spaced frames, set at the correct centre to centre spacing

4 Accurate dimensions such that all empty spaces are an exact bee space of 3/8 to 5/8 inch. This space is too large to be blocked off but too small to be filled with comb. This prevents all the frames being glued together by the bees.

Sheets of wax foundation, usually wired to give additional support, are fixed into the wooden frames before they are put into the hive for the first time.

Typically a hive to contain these frames consists of a series of rectangular boxes (ie 4sided crates with no top or bottom) placed on top of a floor and with a watertight roof placed over them, and an entrance at the bottom for the bees to come and go. The overall size of these boxes, depending on the exact design, is usually about 18 x 18 inches internally, and the height depending on whether the box is to contain 'deep' or 'shallow' frames. The depths are usually about 9-10 and 5-6 inches respectively,.

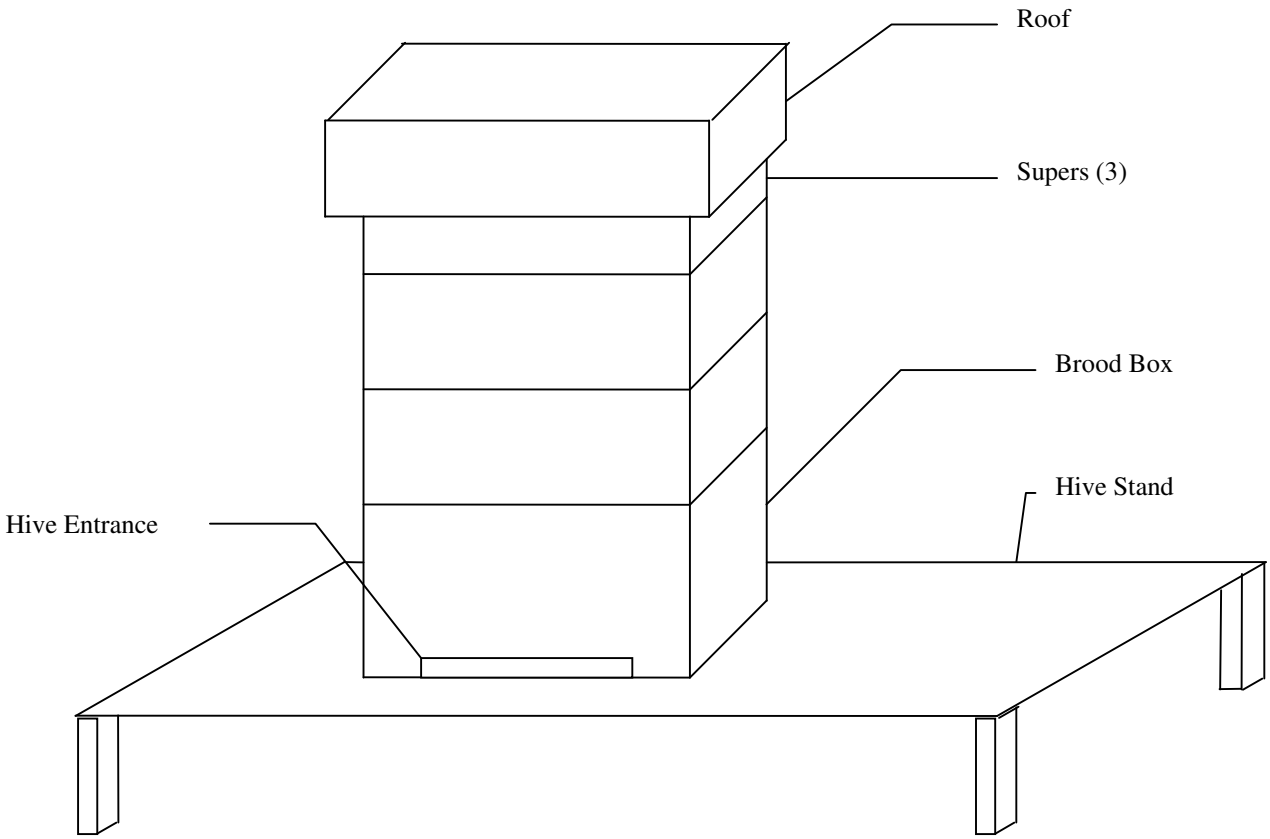
Usually one deep box at the bottom contains the brood frames, and several shallow boxes or 'supers' are placed on top to receive the honey crop.

There are a number of 'standard' frame and hive sizes. Most British beekeepers use British Standard frames, 14 x 8 ½ inches with a 17 inch top bar and 1 ½ inch lugs. The shallow frames are 5 ½ inches deep.. These frames will fit a National, Modified National, WBC and Smith hive (the Smith requires shortened lugs on the top bar).

American frames, particularly Langstroth and Modified Dadant (MD) are also used by some British beekeepers.

Conventionally 10 - 12 frames are used across the width of the brood box (or 15 in the case of the Glen hive), but if fewer frames are used the extra space is taken up with 'dummies' or 'division boards' (solid boards the size and shape of a frame and supported on lugs in the same way.

Above the deep box (or boxes) at the bottom of the stack, to which there is an entrance and within which the queen is normally to be found along with the brood, is placed a wire or plastic perforated sheet or screen, called a queen excluder. This has holes in it too small for the queen to pass through but large enough for the workers, and prevents the queen from passing into the upper boxes. By this method the upper boxes are kept free from brood, and contain only the honey crop. This is how we get a honey crop without grubs in it.



Double walled hives like the WBC keep the bees warmer (or at least, prevent them from losing so much heat) and may be more weather-tight. On the other hand they are heavier, and have more parts to handle, maintain and replace when they rot!

The DIY enthusiast can make their own hives, but:
1 Obtain first a copy of the standard dimensions, and keep to them.
2 Use good quality seasoned timber with the minimum of knots and shakes.
3 Don't use preservatives containing insecticides.
4 Do glue and nail the hives together properly. They will then give many years of satisfactory service.

2 Other Essential Appliances and Equipment

FRAMES AND SPACERS
WAX FOUNDATION
QUEEN EXCLUDERS
CLEARER BOARD
SMOKER
HIVE TOOL
FEEDERS AND FEEDS
PROTECTIVE CLOTHING

FRAMES AND SPACERS
The basic frame has already been described, and the various standards referred to. The frame as purchased is not 'made up' but consists of four or five separate pieces:
top bar
two ends
bottom spars

It must be nailed together squarely and the wax foundation fitted into the grooves. The foundation retaining strip is usually still attached to a new frame by a sliver of wood. It must be removed and the sliver peeled off before fitting the foundation, then lightly nailed back into place.

Plastic or metal spacers (see below) are needed unless Hoffman type self spacing frames are used. These incorporate a spacing element into the wooden ends of the frames.

Frames remain serviceable for throughout perhaps 2 or 3 changes of foundation at two-year intervals. After 5 - 6 years consideration should be given to replacing frames, for sake of cleanliness and hygiene in the hives if nothing else.

Spacers are of metal or plastic and slip over the end lugs of the top bar, one on each end of a frame. They have to be removed from shallow frames before putting these into a honey extractor. Wide spacers are only used in supers, not on brood frames or 'brace' comb (in between the regular sheets) will be built in the additional space.

Sections are individual square or round 'frames' used in special supers called section racks, to produce packs of honey comb in handy size units of about 2

- 3 pounds each in weight.

WAX FOUNDATION

This must contain nothing but pure beeswax. A version with a plastic base is now available, but very expensive. Wired foundation should always be used in brood frames and in any other frames which are going to be placed in the honey extractor. A thinner unwired foundation is available for shallow frames being used for the production of cut comb honey, and in sections. The wiring is either straight or diagonal, and a matter of personal preference.

QUEEN EXCLUDER

There are various designs of these, basically either a perforated sheet of zinc or plastic, or a wire framework, which is placed above the brood boxes to prevent the queen getting into the supers, laying eggs and thus getting larvae mixed up in the honey. Be sure to get an excluder of the correct size for your type of hive, otherwise it will not fit snugly. Do NOT leave excluders on over winter if supers full of honey have been left on top of the brood boxes as winter food supply.

It is helpful to frame up the excluder on one face with edge pieces of wood a bee space thick, so that there remains a bee space on either side of the excluder. This makes it easier for the bees to move around over the tops of the frames.

CLEARER BOARD

This is a board with a one-way port for bees, placed below a full super. The bees gradually make their way through the one way escape to rejoin the queen below, and cannot get back. Over the course of a day or two all the bees leave the super, which can then be removed from the hive with ease.

The commonest type is the 'Porter' escape, which contains two metal leaf springs which allow passage of bees in only one direction. The other type much in use is the so-called Canadian type, which has a hole in the board and a series of wooden battens and guides on one face to channel the bees through from the top. They find it difficult or impossible to find the hole again from below.

SMOKERS

Smoke is used to subdue the bees and make them less prone to sting. The smoker consists of a metal canister burner on top of a set of bellows. The burner contains smouldering fuel, and the bellows direct a jet of air in at the base and out through the nozzle, carrying a jet of cool smoke.

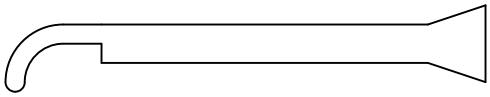
There is no need to purchase a smoker of massive size unless you have a very large number of hives. An average size one, well alight and with a good dense fuel, will easily burn for an hour.

The smoke does not work by stupefying the bees. It fools them into thinking that there is a forest fire, and they immediately fill up with honey in readiness for abandoning their 'hollow tree', and once full of honey are much less prone to sting.

If there is no open honey in the colony then smoke is unlikely to work. Try instead a spray or jet of sugar syrup squirted from a squeezy bottle, along the top bars and between them. Agitated bees will soon stop to lick up the goodies!

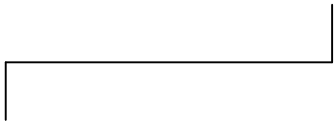
HIVE TOOL

The hive tool is an all purpose metal lever and scraper. There are two main types, the 'double-L' and 'J-type'. One of each type is useful.



J - Type (face view)

Double L Type (Side view)

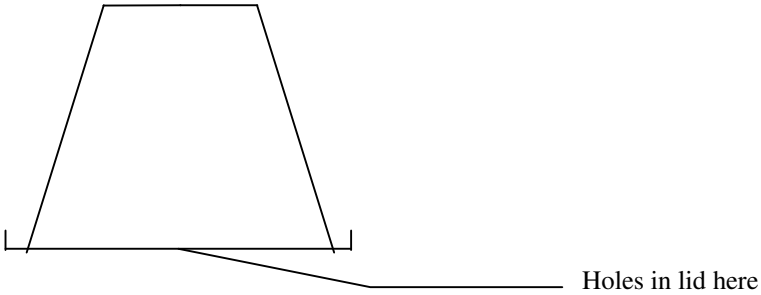


Frames and hive parts are glued together by the bees with propolis - a sticky resinous substance collected from trees and buds. It is used to waterproof the nest, to smooth surfaces, fill up cracks and as a disinfectant (it has strong antibiotic properties), but sticks things together very hard. Thus the need for the hive tool.

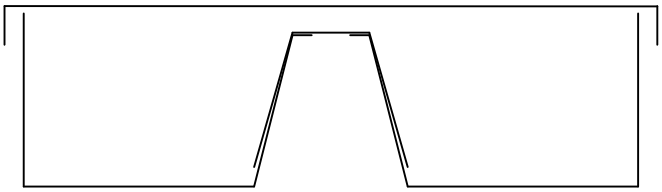
FEEDERS

There will be times when bees have to be fed artificially. This feed usually consists of white granulated sugar dissolved in water to make a syrup (do not use brown sugar). There are many designs of feeder, and I recommend rapid feeders of two types:

The upturned plastic pail with snap on lid, and small holes punched in the lid.



The up and over contact feeder:



Up and Over contact feeder

Both these types are placed directly on the top of the hive, over a feed hole in the crown board covering the top of the frames. Feeders such as frame feeders, Miller feeders etc are good enough, but often do not hold as much feed, or cause more disturbance when replacing them. The up and over contact feeder can be refilled without exposing the frames and bees at all.

Feeds:

Sugar syrup 1Kg bag granulated sugar (2.2lb) dissolved (not boiled) in 1 pint water.

Candy 2 x 1Kg bags (4.4lb) boiled in 1 pint of water to a temp of 117º Centigrade.

Beat with a spoon as it cools and thickens, then pour into a tray mould lined with oiled paper (vegetable oil ONLY please!).

Bakers fondant - as purchased (expensive form of sugar)

Honey and wax washings as available.

An outdoor open air feeder is useful, especially in Spring. This consists of a shallow plastic tray containing a layer of pebbles, moss or peat to stop the bees drowning. This can then be filled with syrup or diluted honey to just below the level of the pebbles etc., and a shelter put over to keep out rain. Do not place directly next to any one hive, or this will encourage robbing from that hive.

DRINKING FOUNTAIN

If there is no source of clean running water nearby (quarter of a mile at most) which DOES NOT DRY UP IN SUMMER, you will need to provide water for your bees. You cannot rely on dew and rain. On a hot day one colony may collect several pints to evaporate inside the hive to keep it cool.

Examples of supply

1 A water butt from a shed or house roof, with a trickle feed to a tray of gravel.
2 An upturned bottle of water with its neck submerged, in a tray of gravel.
3 Tray of peat or moss filled up daily.

You have to use your imagination to solve this problem.

PROTECTIVE CLOTHING

Bees sting. The stings can be quite painful., and although most people develop a degree of resistance to the stings, a very small number become over sensitised. For this minority, a sting can be dangerous. Any sting around the eyes, nose or mouth can also be dangerous on account of the local swelling produced. It is therefore obviously better to avoid stings if possible. You will not be thought a lesser beekeeper for protecting yourself. There is nothing 'macho' about wading into a beehive with bare hands and face. Unless you are very competent and SURE OF THE MOOD OF THE BEES, such action is downright foolish, or even dangerous. The effects of multiple bee stings, even in someone who is not hyper-allergic, will be painful and may require medical attention.

Head. This should be protected by a veil and hat - the two are usually combined. The dark crevices of ears eyes and nose are especially attractive to attacking bees. Ideally the veil should be rigid, or supported away from the face and neck to avoid it being blown into contact and thus allowing bees to sting through it. It should be joined all around onto, or tucked into, the protecting clothing of the upper torso.

Torso. An overjacket (zip or Velcro in place of buttons if front opening is needed) protects the upper body and arms. It should be loose fitting and light in colour, preferable white or cream. The cuffs should be elasticated.

Legs. Overtrousers of the same material as the overjacket. A boiler suit covering both is ideal if the opening is rendered bee proof (bees can crawl into surprisingly small spaces). If separate, the jacket should be tucked into the trousers, and the trouser cuffs elasticated.

Feet and Ankles. Ankles are very vulnerable. Ordinary shoes are not sufficient protection. Wellington boots must be worn, and the overtrousers taken over the outside of the boots.

Hands. These are probably most at risk as the bees are handled. Gloves vary from differing weights and thicknesses of leather and canvas, supplied for the purpose by beekeeping suppliers, to domestic rubber gloves. Most incorporate gauntlets to help protect the lower arms as well, but make sure the elasticated jacket cuffs cover the top of the gloves tightly, and that bees cannot crawl up the gap.

STINGS The sting is usually left behind by the bee, along with the poison sac which continues to pump into the skin. It should be scraped off sideways. Antihistamine cream or spray will relieve the pain and itching. Any serious reaction, if it is going to occur, begins almost immediately, and is usually in people who have been stung before but not for some time. Dizziness, tingling, nausea, pallor and weakness will become evident very quickly, followed by a

state of collapse and difficulty in breathing. Although such a reaction is very rare, beekeepers and their families must be aware of its possibility. Anyone suffering such a reaction requires immediate emergency treatment, as anaphylactic shock (the medical name for this condition) can be fatal if not treated promptly.

Incidentally, family pets such as cats and dogs can also be stung by bees which may accidentally enter the house, if they try to chase or eat them. Be prepared, under these circumstances, to take an affected cat or dog to the vet immediately if an adverse reaction occurs, as it may do.

2 Basic Techniques

3.1 Siting an Apiary and Hives
Requirements of an apiary.
1 Access to suitable forage the year round, OR be prepared to move your hives around. This is time consuming and can be expensive.
2 Level ground, or some means of making level hive stands.
3 Shelter - especially good windbreaks are necessary, but not an excessively shaded site. Shelter from the North and East is especially important in this area. Directly under trees is no good as the air remains damp and stagnant.
4 The front of the hives must not face directly onto a nearby path or road, as people walking by will be directly in the bees' flight path and get stung.
5 A supply of drinking water must be nearby, natural or provided by you.

Positioning hives.
1 Face them SE to SW, NOT NE or NW.
2 Place them up on some sort of stand, not with the floor directly on the ground. Some hives come with a wooden stand with legs - even so, it is best to stand these on four bricks or concrete blocks so the legs don't rot or sink into the ground under the weight of the hive. The best type of stand is a slatted 'trestle' about 18" off the ground. This saves a lot of bending for tall beekeepers.
3 Slope the hives forwards VERY SLIGHTLY, as this will prevent rainwater settling on the alighting board (if there is one) from running in the doorway.

It is also useful to have somewhere to store extra equipment nearby - a shed or corner of the garage is useful. It is also useful to have easy access for a vehicle if you intend moving hives onto clover or oilseed rape or heather.

Neighbours, safety and the Law
Remember that your enthusiasm for your hobby may not be shared by your neighbours or passing members of the public. If your apiary is in the countryside, well away from other buildings and roads, then your problems may be few, other than the risk of hives being blown over or vandalised. If, on the other hand, you are proposing to keep bees in your garden in a built-up area, then there are the needs of others to be considered, and you may have to look for another site. It is not a matter of - "I can do what I like in my own garden." That is true only so long as you do not cause a nuisance to others.

Some guidelines:

1 Tell your neighbours what you are proposing to do, and ask if they have any objections.
2 Site the hives as far as possible from shared boundaries (that includes boundaries against a footpath or pavement, or road. Remember that someone on horseback or a bike may be in danger under these circumstances.)
3 Make sure your bees are not of a strain prone to attack passers-by on sight from a distance. If they are, you will be regularly attacked yourself as well.
4 Go to every length to prevent swarming.
5 Watch out for bee health. Your bees will probably be accused (probably rightly as well!) of soiling windows, and even laundry. It helps top reassure any complainers that the bees are healthy, and be prepared to offer a gift of honey by way of appeasement if this is likely to be accepted. If it is not, move the hives.
6 Do place a high screening of wall or thick hedging around the hives. This will force the bees to keep their flight path high.
7 Keep your neighbours well supplied with honey at all times.
8 Keep your neighbours informed at all times.
9 Be prepared to move your bees if you have to. It is as well to have an emergency alternative site available if possible. Neighbours can move away and be replaced by less bee-friendly ones!

3.2 Choosing a hive type.
The main hive types and frame sizes and so on have already been described to you. The important thing once you have decided on a hive and frame size is to stick to it. It is essential for the proper management of colonies to be able to exchange hive components and frames with each other quickly and easily and you will never be able to do this with three or four different sorts of hive and different frame sizes.

Most small scale hobby beekeepers in the UK use National hives (Single wall) or WBC (Double wall) hives, with British Standard frames. Decide if you only want to produce extracted honey, or if you want to produce whole honeycomb to give away or sell, as cut comb or sections. If the latter, you will need section racks and all the extra dividers (metal sheets) and so on which they require, or else circular sections. Watch out for Smith hives which, although they take BS frames, use short lugs on them. These are also rather difficult for beginners to handle. A lot of secondhand Smiths are around in this area.

Decide if you want to work with a single deep brood box, or a deep plus a shallow brood box. The latter gives more space for a queen to lay (though I have never seen this arrangement fully utilised by a queen), and the shallow box if left on top over winter acts as a winter food supply and less autumn feeding MAY be needed. However it leaves you with twice the frames to search each time the brood is examined, which can be exhausting.

Always start beekeeping with a spare hive, and always try to keep at least one spare hive in the apiary. It will rarely be spare for long.

It is very difficult to manage a single hive of bees successfully if you do not have a friendly beekeeping neighbour, and I recommend a minimum of two colonies. You will find it much easier then to get yourself out of any difficulties.

3.3 A Source of Bees

There are various ways of getting some bees, some better than others. Don't just look for the cheapest way!

1 Stick an empty hive (no bees) with frames of foundation or fully drawn combs, into the site and hope for a roaming swarm to find it and take up residence. Not foolproof, you may have a long wait and end up with bees which are diseased, starving, and prone to swarming.

2 Buy a 'nucleus' (a small colony of queen plus 4 - 5 frames of brood and bees) from a beekeeper who produces such units for sale. This is a good way to get started in early summer. Expect to pay about £9-10 per frame. Such a unit will build up steadily, is unlikely to swarm in the first year, and MAY produce a late crop of honey for you.

3 Buy a full size colony from a beekeeper (see bee press and farming section ads in paper) or from an auction. Price about £9-10 per frame, or whatever the auctioneer will accept! If buying at an auction, do observe the warning 'buyer beware', and be mindful of the possible state of the colony (try to examine it first if possible) and also the state of the hive if it is also for sale. This can be a quick way to get started, but also a quick way to problems such as disease or swarming. Don't pay a high price for a colony in autumn as you will have nothing to do then but feed it up for the winter.

4 Prepare your hive and equipment, and keep your ears open for someone with a swarm looking for a home, preferably another beekeeper who may know something of the swarm and advise you accordingly. This is best in late May or early June. A swarm then will work hard and can give you honey the same year, but don't go for swarms after June as they will be too late to establish well for the coming winter.

3.4 Costs of Setting Up.

This is what you all want to know, and it is very hard to arrive at a precise figure. This is given as the barest guide only, but beware, beekeeping is not a cheap hobby to get started on. The capital outlay for basic equipment is high, but if well looked after will last for a great many years. Start small and build up gradually.

Major items such as a honey extractor can be borrowed from the local association if you become a member. Please don't embarrass other beekeepers by asking to borrow their equipment. Even if they do lend it (and I never do) their need is probably as much, if not greater, than yours.

For a very rough guide to setting-up costs, price the following list of equipment in an up-to-date beekeeping supplier's catalogue:

A complete National Hive without bees (floor, brood box, super and roof)

Frames (per ten)
Foundation wired, per ten
(A National brood box holds ten plus dummy board, or eleven frames)
Queen excluder and clearer board
Smoker
Hive tool
Coverall suit/veil
Gloves

3.5 Hive Records

It is essential to keep a written record of what is happening in each hive week by week, over the whole year. DO NOT RELY ON YOUR MEMORY even if you have only one hive. Keep a written record of what you find after each inspection. Use either a log book, or record cards kept inside the roof of the hive. I prefer a book as cards in the roof rot or get eaten by mice. You also have to take off the roof to read them, and if you are telephoning another beekeeper for advice, this is inconvenient. Please don't consider telephoning me for advice on your bees if you have no written record. I will not be able to help you.

Number your hives, or give them names, so you know which notes go with each colony.

Your record must be able to tell you at all times:
1 When the queen and/or eggs were last seen
2 The date of the last inspection
3 Whether the bees were healthy, or showing signs of any distress.
4 The age of the present queen, and preferably also the source (ie which previous queen she came from)
5 Whether the queen is clipped
6 If the queen is marked, and what colour.
7 The temper of the bees
8 The size of the brood nest (no.of frames)
9 The state of the reserve food supply in the colony.

3.6 The Routine Hive Inspection - Handling Bees

Before opening a hive:
1 Know why you are opening the hive, what you are going to look for, and how you will do it. The importance of those three cannot be stressed too highly, as many beekeepers, not just beginners, open a hive with little or no idea of why they are doing it.
2 Have a plan for what you will do depending on what you do find, e.g. if the colony is about to swarm, how will you respond.
3 Have to hand all equipment which you will or might need.
4 Light the smoker and make sure it is going well.
5 Put on protective clothing.
6 Check that the smoker is still alight.
7 Now you can approach the first hive.

Lighting a smoker.
This is not rocket science, but there are a few hints. Suitable fuels are:
Rolled up corrugated cardboard (beware this may be fire-retardant treated.)
Sacking (may also be treated, but this is a bit of a waste of good sacking)
Dry rotten wood - an excellent long-lasting fuel
Dry peat - even longer lasting than wood but with a characteristic smell (not the horticultural kind - use blocks or pieces of commercial burning peat.)
Dry pine cones - good mixed with other fuels as they get a bit hot on their own
Wood shavings or straw are excellent for getting the smoker started before switching to another fuel.

Fuels NOT to use are plastics, fire lighters or flammable liquids of any kind.

Start with a loosely screwed up ball of newspaper or straw / shavings in the bottom of the smoker, light them, and pump the bellows. Only when this material is well alight, and maybe you have added more of the same, should you add more of the preferred fuel. Pump the bellows well to get the seat of the fire hot and well alight, then add enough fuel to fill the smoker. Don't pack it tightly or you will snuff out the fire with its own smoke.
By the time you have put on protective clothing the fire should be still alight but cooler, with a fine plume of cool smoke coming from the top. Now close the lid, pump a few more times to make sure, and the smoker is ready to use.

Things not to wear.
Dark clothing - bees are more inclined to attack dark clothing.
Fleecy fabrics - bees treat these as animal fur and attack them
Bright colours - bees tend to settle in large numbers, especially on yellow.
Hair lacquer, strong perfume, cologne, aftershave etc. Some of these scents mean different things to bees than they do to us, and they attack the wearer.
Clothing treated with fabric conditioner. This also has a scent which can cause bees to attack.

Bees also dislike the following:
Sudden or swift movements of the hands or body
Jarring, bumping or jerking of the hive or frames
Human breath
Being sprayed with water.

Opening and examining the hive
1 Approach from the back, or at least the side, not the face on which the door is positioned, and always stand at the back or side when working the hive.
2 Reach over or round a puff 2-3 good puffs of smoke in the door of the hive
3 Wait 2-3 minutes for the smoke to have its effect
4 Remove the roof and place it upside down on the ground behind or beside you and in easy reach.
5 Remove the crown board or quilt (which covers the frames of the top box) and check that the queen is not sitting on it. You need not check for this is there is a queen excluder below the top box. Place it at an angle leaning up to the door so that the bees can walk up it and back in their door. More

experienced beekeepers will hold it above the bees and with one sharp jolt, knock all the bees back onto the top of the frames. It is OK to do this!
6 If this is not the box or level of frames that you need to examine, loosen all four edges of the box by gently inserting the hive tool. The grasp the box and lift it gently away with a twisting motion. This will break gently any remaining wax connections between the two boxes. Place the box you have just removed on the inverted roof, slightly offset to all four sides are supported. Now place the crownboard back over it, unless there are more boxes to be removed.
7 When you reach the desired level within the hive, loosen the end frame or dummy board. Lift it out by levering the ends up with the hive tool, then grasping the lugs. Keep the comb vertical at all times, and examine both faces and the ends / edges too if you are looking for a queen. If this is a dummy, or if there is no brood on it, the bees may be brushed or shaken off the frame before placing it up against the door for safe keeping. The next frame can then be removed. If the first frame does contain brood, it should not be shaken but placed instead in a spare brood box or cardboard box, and covered. This is especially important in cold weather as the brood will be otherwise easily chilled. Us the smoker if necessary to subdue the bees a little more. Hold frames over the rest of the hive while being examined so that any bees that fall of do so into their hive, not the ground, and any nectar which slops out will also fall back into the hive.
8 With a frame out there is a little more space to work in., and the remaining frames can be lifted out one at a time to be examined. They must then be replaced in the same position and orientation as before, unless a specific manipulation is being done which requires a change to this.
9 When finished, replace the last frame or dummy.
10 Rebuild the hive taking care not to crush bees, replacing the boxes in the same orientation and position as before, unless circumstances require differently. Finish off with the crownboard and roof.

At Inspection time
When inspecting a hive make sure you can recognise the following:
Workers
Drones
Queen
Eggs
Grubs
Queen cells
Worker brood, capped and open
Drone brood, capped and open
Royal jelly
Honey - open and sealed
Pollen stores
Healthy / unhealthy brood

3.7 Moving hives
Hives should be moved at any one time a maximum of three feet, or a minimum of three miles. This is because the bees are so strongly orientated to their home, a move of more than three feet will result in homecoming bees

entering the wrong hive or getting lost in the grass. Anything less than three miles and they will still try to fly home to their old apiary. The memory of their old home will last for about four to five weeks in summer, and two or three months over the winter.

If hives must be moved a short distance within the apiary then move them three feet every day or every second day, and they will adjust every 48 hours to the new position. Be patient, and take as many days as it needs to move them without loss.

If transporting bees by vehicle, secure the frames inside with dummies so that there is no room for the frames to flap and swing around, as this will crush bees. Close up the door tightly the night before and replace the crownboard with a metal mesh screen which allows air to pass in and out, not bees. If the weather is warm, put a feeder of WATER on the mesh travelling screen. Bees get very hot, suffocating easily. The heat produced can soften the combs so they collapse, and the bees all drown in their honey. They will drink the water and by evaporating it inside the hive, be able to lower the temperature somewhat.

Part C - Seasonal Management Strategies

1 Spring Management.

Spring management, especially in the early part of spring, consists mostly of observation and making sure the bees don't go hungry.

1.1 Observe:

- Bees flying - they're alive!
- Doors not blacked by a natural buildup of dead bees from over the winter
- Lots of wax shreds - this indicates bees uncapping honey to eat it in large quantity, and could indicate they might be going short of food
- Pollen being taken in - this is a good indication of active brood rearing
- Hives still weather-tight
- Watch out for any nearby crop spraying

1.2 Tasks

- Feed if necessary - an open air feeder is useful at this time of year
- Spring clean the hives - remove and scrape debris from the floor, or replace with a clean one, and send samples of the debris for checking for Varroa.
- Spring is the build-up phase of the colony. Provide more space as it is needed, but do not over stretch the colony by splitting the brood nest widely with added combs, or other wise work the bees too hard or they may be chilled or otherwise stressed.
- Prepare for the first nectar flow and put the supers on early enough
- Watch closely for any early signs of swarming - drone rearing followed by queen cells. Do not remove a single queen cell too hastily however as this may be a natural supersedure.
- Mark and clip the queen if you adopt this practice. Remember it is easier to find the queen when the total number of bees in the hive is quite low.
- Be ready to respond to crop spraying. You will have established where the nearby crops are, who owns them, and will have advised them that you own bees and must be informed prior to any spraying.

Late March and April are especially dangerous times for bees with the possibility of late winter starvation. Any leftover sugar candy feed from winter will have to be removed at this time to prevent untidy buildup of burr comb around it, and any quilt replaced by a solid cover board. Supers will often be added soon after this if there is an early flow, but if it turns cold or the flow stops be prepared to feed again. Do not feed however when supers are being filled as they will be filled with sugar syrup.

The first inspection of the hive should be carried out in late March or early April, and should be mainly to ascertain if there is enough food, and if there is a fertile queen still laying normal brood. If it is still cool - below about 15 centigrade - only look quickly at the tops of the frames, or lift the hive gently

by the floor to gauge its weight and likely food supply. If in doubt, feed. If in real doubt, a very quick inspection is better than leaving things to chance, no matter how low the temperature. If the bees are starving, intervention with food, even if it is freezing, may save them. If they are left, they will die.

The first real inspection should include a check for all the things on the list, but especially for a healthy queen, brood and eggs. Remember though that if eggs and normal brood is present there is no real need to go looking for the queen unless she needs t o be found to be marked or clipped. A warmer day is really needed for such a search. The queen is most likely to be found on a frame with eggs or young brood present.

Queen marking - this is the best time of year. Use a special cage for the purpose, which has a slatted top. The circular press-in type of cage is best. Use proper queen marking paint and if preferred the correct colour for the year, as this will aid identification and aging of queens later. Mark the centre of the thorax only. A damaged queen is likely to be killed or neglected so she dies. Allow the paint on the queen to dry in the open before releasing her back into the hive.

Clipping can also done using the same cage, a pair of fine forceps to prise a wing up through the mesh or slats, and a fine pair of scissors to cut the end off the wing. Do not cut off legs or antennae, only the end ½ of the wing. This will stop the queen flying with a swarm. More of this topic later.

During April it may happen that expansion of the brood nest is restricted by a barrier of pollen or honey, and as the colony starts to go 'into credit', this barrier will not be eaten. The brood nest may therefore be forced to expand by one of the following methods:
1 Reversing the frames at the edge of the brood area.
2 Adding empty frames to the centre of the brood area.
3 Scoring or 'scarifying' the surface of the obstructing honey.
Number two is the best method, but be careful and don't overdo it. There must be enough bees to cover the extra frames added, otherwise the bees will be stressed and in trying to cover all the frames, some may get chilled and die.

During March, April and early May inspections at fourteen day intervals will usually be enough. Keep putting on supers and monitor the flow of honey into them. If the flow is very rapid then extra supers may be needed to cope with the sheer volume of liquid, until the bees can evaporate it down.

A honey flow will, like artificial feeding, stimulate the colony to make the queen lay more, and at this time the colony may expand very rapidly. As May progresses, watch out for signs of swarming, and the frequency of your inspections may have to increase to once a week.

3 Crop Spraying
Although you will have asked any farmer or contractor for 24 hours advance notice of spraying, realise that you will be very lucky to get any warning at all.

Be aware however that it is an offence for anyone who spray crops in which bees are working if they have been notified beforehand of the need for advance warning to the beekeeper, and have failed to give such warning.

What to do if potentially dangerous spraying takes place:
1 You could move the bees right away from the danger area. This is usually impossible.
2 You could shut the bees in. This is very dangerous to the bees, will most likely cause suffocation and death.
3 You can turn the hives through 90 degrees at roughly two hour intervals, if the bees are flying, until the spraying danger is over. This confuses the foraging bees, disrupts foraging bahaviour, and may give some margin of safety.
4 Put strands of grass, hay, leaves, or a sheet of glass, across the entrance. has the same effect as 3 but probably not as good.
5 Put one-way spray entrances on the hives. This can obstruct the doorway in a large hive, and though it prevents most bees getting out again, can cause overheating as well.
6 Contact your local Association for advice.

2 Summer Management.

This is the busiest time for the beekeeper, from late May until at least August. It is concerned with the following

- Controlling swarming - loss of a swarm equates to loss of a honey crop
- Rearing and introducing new queens
- Harvesting the spring crop and main summer crop
- Maintaining the momentum which the spring build-up will have generated

All this of course depends on the weather!

2.1 Controlling swarming.

Swarming does not always follow the obvious preparations of drone and queen cells, as the bees may change their mind if the weather changes. But very changeable weather and a ‘stop - start’ honey flow, will often trigger the start of swarming. In order to control swarming, regular inspections must be made. Remember that a queen cell is sealed 8 days after the egg is laid. At this point a swarm may try to leave (or sooner in exceptional circumstances for example if the weather is very hot or the hive very overcrowded with bees, honey or both).

2.1.1 Regular Inspections.

By inspecting the colony every 7-9 days, and cutting out all queen cells as they are seen, swarming may be delayed. Remember that a 3-day old worker grub can still become a queen, and even if every queen cell is removed, in just another 7 days a queen cell can again be sealed.

This method can sometimes be effective as a part of swarm control in the early part of the season, helped perhaps by a change in the weather which may diver the bees from the urge to swarm, but remember this - if the colony has reached the critical mass and stage where swarming is inevitable, the removal of queen cells will not prevent it. The swarm will leave, with no queen cells in the hive, only queen cell 'cups' containing eggs, which the remaining workers will use to rear new queens.

2.1.2 Clipping the wings of Queens.

Clipped queens cannot fly. If a colony tries to swarm with a clipped queen, the swarm will most probably fly back to the parent hive, but the clipped queen will be lost - fallen into the grass in front of the hive. Therefore clipped queens will buy you a little time, as the swarm of the stock with the clipped queen will emerge, not with the old clipped queen, but with the first virgin queen to emerge some days later. So even colonies with clipped queens must be regularly inspected every 7-9 days. If every queen cell from this colony is removed (and this requires good eyesight, and the bees to be shaken or brushed from every frame) then this can work as a method of swarm prevention. The chances however of the queen going missing as described above, are high. You will then discover on your inspection that there are no eggs, and a lot of 'emergency' queen cells which have been raised from worker cells by the bees extending and expanding the mouth of the worker cell outwards and downwards, and the grub is floated up and out into the queen cell on an extended pool of royal jelly. When you see this, coupled to the absence of eggs, you deduce that the colony tried to swarm some days before, lost its queen, returned home and is now awaiting the emergence of the first virgin queen with which to swarm again. Rest assured that unless you intervene, this is what will happen.

2.1.3 Plenty of room.

Another way to help prevent, or at least to delay swarming, is to provide the colony with plenty of room for expansion when needed, and to allow plenty of ventilation in warm weather.

2.2 Managing Swarming

The best forms of swarm control harness the bees' attempts to raise a new queen and split the colony in two, but control the process in such a way as to raise only one queen, allow her to become the new queen in the colony, and to make the colony believe it has split when in fact this has been under your control, not the bees'. Most methods which rely on these tricks will also result in an increase in the overall number of stocks, and this may not be what you want once you are an established beekeeper unless you suffer an unusually high loss rate among your colonies.

All these methods rely of separating what some experts call 'replete bees' - that is to say, workers which are full of honey with nowhere to put it, sitting isolated from the queen in corners of the hive, and making queen cells as a result - out into a unit of their own so that they are forced to go to work in some way.

This web site is not the place to go into these methods in great detail as there are excellent accounts of them in many books. However there is a method which can be applied to a whole apiary systematically, which has worked well for me for the past fifteen years with less than five percent failure rate (i.e. colony going queenless).

As soon as queen cells are seen in any hive in the apiary, remove the queen from every colony. Keep the best two or three queens by making up 3-frame nucleus boxes to contain them with some workers shaken into the box from their parent hive. Kill the remaining queens. Remove any queen cells which have grubs in them.

Nine days later (not eight, not ten, but nine) examine each colony, which will all contain emergency queen cells in addition to any that were already started. Select one good queen cell near the centre of the colony if possible, away from areas of drone brood, as the new potential queen. Do not shake this frame, but remove any additional queen cells from it. Now shake the bees from every other frame in the hive, and remove every other queen cell you find. Do not leave a single one more or the colony will swarm.

Replace queen excluder and supers on the hive. A week later check that the queen cell has emerged successfully, and allow the queen to mate - it is best to leave the hive undisturbed for the next 2-3 weeks while the queen orientates, matures, mates and starts to lay. Within five weeks of removing the old queen, the new queens should be laying once more. It is extremely unlikely that such colonies will make any further attempt to swarm in that year. The standby queens can be used to requeen any colony which fails to raise a new queen, or sold.

For information on other methods of swarm control see the textbooks.

If you discover that a colony has swarmed, then you are restricted to limiting further damage. Try to catch the swarm. Wait till it settles and shade it if possible from the sun. If it can be cut neatly from its resting place, do so at once and drop the whole thing into a hessian sack or other well ventilated container, seal it up so that air can get in and out but bees cannot, and put it in a cool dark place until evening. In the evening drop the whole lot into a prepared hive with combs or foundation, where they should settle happily at once. The swarmed stock should be examined at once, and cut out all the queen cells. It is likely that one or more will contain young queens being held inside by the workers. You may safely release one or more of these queens into the hive to run about, but DO NOT leave any more unemerged queen cells in the colony or it will swarm again. The young queens will fight among themselves until one remains. She will mate and begin to lay within 2-3 weeks.

2.3 Queenlessness

Sometimes you may think a stock is queenless, and you should make sure of this before requeening it. If you are requeening, remove and kill the old queen first before introducing the new queen. To test for queenlessness, put in a

frame containing eggs or brood under three days old. Within 3-5 days a queenless stock will have raised emergency queen cells on this frame. If they have not done so, repeat with a fresh frame of brood and eggs. Failure to raise a queen cell on the second test frame as well indicates a very strong probability that the stock has no queen. (For the curious among you, the reason for testing twice is this: if the hive has been queenless for some time, a few workers may have started to lay or at least develop functional ovaries and to produce a small amount of pseudo-queen pheromones. This may be enough to suppress the production of queen cells. The presence of brood to feed forces the workers to divert food from these 'laying' workers, their ovaries atrophy once more, they stop producing pheromones and the workers will then make queen cells.)

2.4 Uniting

It sometimes happens - at any time of the year - that stocks must be united, i.e. two small colonies joined to make one big one, or a queenless colony united to one with a queen. Because each colony has a unique 'odour' (discernible only to the bees!), the two sets of bees must be introduced to each other gradually. This may be achieved as follows. Place a single sheet of newspaper of the top of the frames of one of the stocks (usually the one with the queen) and pepper it with about twenty or so tiny pinholes made with the corner of the hive tool. Make sure the other stock has no queen, then place it above the newspaper, along with all its supers et. Put the crownboard and roof back on and leave it undisturbed for a minimum of 48 hours, and five days if possible.

2.5 Introducing Queens

Make sure the stock to which the queen is to be introduced has no queen already. Use an introduction cage with a plug or a single layer of paper, or a plug of soft honey, and the queen ONLY safe inside it. Secure the cage to a brood frame near the centre with a matchstick (taking care not to spear the queen in the process.) The bees will feed the new queen through the mesh of the cage, get to know her, and in due course eat through the paper or honey plug and release her. Wait a week then check that she as been released, when the empty cage can be removed. Also remove any queen cells as the queen's imprisonment may have allowed bees in parts of the brood nest to make a few queen cells.

A word of caution. If you are trying to introduce a queen to a colony which has been queenless for some time, and developed laying workers, be prepared for a high probability of failure. Many beekeepers will not try to introduce a queen under these circumstances, but will just break up the queenless colony by shaking all the bees onto the ground, removing the hive, and allow the bees to beg homes in the adjacent hives. It is surprising just how many of them will do this! If you prefer to persevere, you can adopt the strategy suggested above under queenlessness, but introduce at least two frames of eggs or brood on each occasion. Leave each set of frames for about 5-6 days, remove them back to their parent hive and replace with another two frames of eggs. By the third set of frames, the colony may raise queen cells,

at which point you can decide if you want to let them raise a queen, or try to introduce one.

2.6 Summer Honey Flow Management
BY the end of June or beginning of July, the first crop of honey will usually be ready. If you are in an area of oilseed rape or wild cherry, then you may have a crop earlier than this. Wait until the honey cells are mostly capped, or give the frame a hard shake. If no honey flies out, it is ripe and can safely be removed. Comb sections or comb for selling as cut comb MUST be capped however.

Extraction is done by means of a centrifugal extractor - see catalogues for models. There are two basic types, the radial or tangential. These refer to the position of the frames in the drum. The radial takes more frames and is usual for those with more than just a few hives. The combs must first have the cappings removed with a knife, then the frames are placed in the drum so that their weights are balanced across the drum. In a tangential type the frames will have to be turned to extract the second side.

The honey should be run from the extractor through a coarse sieve to remove wax fragments al large debris, than a finer sieve to remove the finer wax particles and any bits of dead bees, wings, wood fragments etc. All extracting should be done in warm rooms, which helps keep the honey ripe and flowing, and with the windows shut to prevent the bees coming back to retrieve their honey.

Allow the honey to stand for 24 - 48 hours, during which the bubbles will rise to the surface and may be skimmed off.

Watch out for a ‘gap’ in the honey flow between June and July, or between the Spring and Summer flows. You may have to feed, especially if the first honey crop has been removed. Continue to add supers during July and a second or even third crop may be removed if the flow continues.

2.7 Continuing Summer Inspections
Once the urge for swarming has ceased in the bees (usually by about the end of July) the frequency of inspections can be reduced considerably. If a hive has by now a new queen from the current season, it is extremely unlikely that such a hive will make any further attempt to swarm in the current year. Inspections will be mostly concerned with resolving any difficulties in ‘problem’ hives, and making sure that supers are added in response to continuing honey flow.

It is useful too to remember to keep the grass and growth of any plants around hives well trimmed at this time of year, especially around the entrances.

3.0 Autumn Management.

3.1 Harvest

This is the time of year for gathering the heather honey harvest (if it is available) and then for preparing the bees for winter.

Most beekeepers looking for a crop of heather honey will have decided on a site months beforehand. Stocks intended for the heather moors should be strong and have a good young queen and a good reserve of honey before they are put to the moor. If the weather in August is poor the colonies may well come home lighter than when they left, so once again, be prepared to feed if necessary.

Heather honey cannot be spun from the combs. It is unique in that it is thixotropic - it sets like jelly - so has to be pressed out of the combs. Heather honey also tends to have a slightly higher water content than other honeys so it is that bit more likely to ferment if not properly handled. A warm extracting environment is therefore even more important.

3.2 Bedding down bees for Winter.

Certainly by late August or the first week of September, the honey flows are usually over. As soon as the bees start to desert the supers or section crates for the brood box, they must be removed. Sealed honey can be extracted. Unsealed honey, if unripe, should not be mixed with ripe honey and should be fed back to the bees. Colonies going into the winter must be of good size (covering at least 8-9 frames in the brood nest) and have a healthy young queen. Small colonies and ‘nucs’ which may be left over from any manipulations must now be rationalised and united where necessary into stocks of appropriate size.

The colonies will also require a minimum of 40 - 50 pounds of honey to last the winter, and feeding must therefore begin as soon as the honey supers have been removed. Thick syrup in the form of two pounds of sugar per pint of water, must be fed. A colony will easily take down the equivalent of 9 -10 bags of sugar over a 2-3 week period. Do not be mean t your bees. Feed until they will take no more. A full British Standard deep frame holds about 5 pounds; a shallow holds about three.

Now is also a good time to do a Varroa test with Bayvarol (see elsewhere).

By the beginning of October feeding should be complete. By now daytime temperatures may even be below ten Celsius, and at this point the bees will cluster and stop taking down feed anyway. If you suspect that any colonies may still be short of food, make a note and be ready to feed them solid feed in the form of candy. Liquid feeds are totally unsuitable between about October and March.

If you work your colonies on a deep brood box and shallow brood box above, or if you leave a super of honey on over the winter, now is the time to remove any queen excluders between the two boxes.

Cover the feed hole or replace the crownboard with a quilt. Make sure the roof is correctly in pace and weighted down to prevent it being blown off. Put mouse guards into the doors of the hives, and they are ready for the worst the winter can throw at them.

Now is also a good time to start planning for next year's beekeeping.

4.0 Winter Management
Tasks during winter are few, but very important.

4.1 Check the food supply of the hives. Do not remove frames as this will destroy the cluster, unless you are VERY worried about a colony. Peel back the cover very gently and look down between the frames. Also look to see how close the bees are to the tops of the frames. Be quick about it and choose a mild day if you can. You will not need to carry out any checks of this sort until about December at the earliest if you fed correctly. As soon as the bees are approaching the tops of the frames be ready to give them locks of candy, and once you have fed this, re-check every 5-6 weeks to see if they need more.

4.2 Check for mice. If you use mouse guards clear the dead bees which accumulate from behind the guards regularly so that the bees can fly to excrete on fine days without being hemmed in by carcasses. If mice are found in the hive, try and remove them and renew the guards. Mice cause the bees to be more active and increase food consumption, as well as eating and destroying a significant amount of comb and food.

4.3 Check for dampness in the hive, caused by leaks or condensation from the bees' metabolism. If quilts or cover boards become wet, replace them with dry ones. This is a problem usually later in the winter as brood rearing begins.

4.4 Check for rain or snow blowing into hives. Repair or patch.

4.5 Check for any other weather related damage.

4.6 Prepare hives and equipment for the coming season. Adopt a pro-active rather than a reactive approach to this. Remember to order supplies of hive parts, tools, equipment and consumables in plenty of time. Also look for early signs of any fields of oilseed rape or other crops which might have a relevance to the coming season's honey flow or crop spraying activity, and prepare your response in plenty of time.