The Basics of Beekeeping

by

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on behalf of the

Dunblane and Stirling Districts Beekeepers' Association

2009 edition

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Chapter 1

Introduction: The beekeeper and beekeeping

1.1 What is needed in a beekeeper?

The qualities which are needed in someone who is to be a successful beekeeper can be arranged under several headings.

- **Physique**

  Beekeeping involves the lifting, carrying and gentle handling of awkward heavy boxes weighing up to 30 kg (60 lb) in round figures. Every beekeeper must have the strength for this.

- **Access to a suitable site**

  Traditional requirements for an apiary site are: open sunny location but with some shade; ready access to clean fresh water for the bees (within 200 metres or 200 yards); the presence of ample amounts (many hectares/acres) of suitable foraging plants within 2 km (1 mile) — see later in this chapter. Of equal importance these days are protection from vandalism and screening (by hedges or distance) from neighbours who may be frightened of bees and complain if they are stung when bees are out of temper.

- **Available time**

  The keeping of even a few (3 or 4) stocks of bees demands roughly one afternoon a week during the active season from April to August. Bees given less attention than this will yield less well and may become a liability. In addition a fair amount of time will be required in August-September to process the honey crop. If heather honey is sought, more late season (August-October) work is involved. Bees satisfactorily bedded down for winter need very little attention from September to March — mainly an occasional glance to ensure that hives have not been disturbed by the weather or by vandals.

  Obviously keeping bees on a larger scale requires proportionately more effort.

- **Inclination and enthusiasm**

  There is no point in beginning to keep bees unless you are interested. Many beekeepers (including myself) enjoy working with bees in a small way and getting enough honey for family and friends. Others like the harder challenge of trying to make a small supplementary income by keeping 20 or more stocks, and selling honey either direct retail or selling to shops (which must be allowed a generous mark-up and so will not pay so well).

Those who keep 40 or more stocks are aiming to make a significant part of their income from their bees. It is a hard and demanding occupation on this scale and the return is very uncertain, being dependent on weather and fluctuating honey prices which naturally fall during glut years. Competition from imported honey from countries with easier climates than ours — Mexico, Australia, etc. — limit the income that can be made. The *average* annual yield per stock in Scotland is around 15 kg (30 lb), and the wholesale price of Scottish honey in 2008 is about £3.00 per lb, so the basis of calculation is fairly clear. The provision of a pollination service to fruit growers and other farmers can help the commercial beekeeper to make a more reliable income. However if you are thinking of beekeeping on this scale, don't forget the overheads and inevitable costs!

In Scotland there are a very few people who can genuinely be classed as bee farmers. These are people who choose to make their principal livelihood, or at least a large part of it, from beekeeping. This involves keeping many hundreds of stocks of bees, and being knowledgeable and careful about making efficient use of the limited time that can be devoted to each individual colony. On this scale also it is worth the large outlay of investing in industrial-scale equipment for the extraction and bottling of honey, and for moving hives. Great care needs to be given to the siting of apiaries and stocking them to an appropriate level, so that no area is over-populated with your honey-bees. After all they cannot get more honey from a district than is available from the flowers that grow there. It is no use having your own bees competing to the death with one another and starving in consequence. That kind of beekeeping in my view should only be undertaken by someone who has been trained for it by working on a bee farm, so that the methods and hazards are explored before the big investment decisions are made.

1.2 Development of methods of beekeeping

Honey-bees in more or less their present form have existed on earth for far longer than human beings. From the very earliest human records there is evidence that men have sought their honey. There are several primitive stone-age cave paintings apparently showing men robbing bees' nests. Some people say they can even see in some of the pictures that the man is carrying a smoking torch — evidence that even at this early date smoke was being used to pacify the bees.

In prehistoric times the discovery must also have been made that if the hollow log containing a bees' nest was moved to a convenient place near home, the bees would continue to live in it, and also that if a swarm of bees was introduced to a hollow log, earthenware pot or straw skep in the evening, there was a good chance that they would set up home there.

All early civilisations in Europe and Asia show familiarity with beeswax and honey. There are many references in the Old Testament. Ancient Egyptian tombs that have been investigated by archaeologists have contained offerings to the dead of both beeswax and honey, remarkably well-preserved, especially the wax.

The ancient Greeks and Romans wrote many treatises on the art of beekeeping, some of which have come down to us. The system they describe is similar to one still practised in parts of Africa and the less well-developed parts of Europe even today, and was almost universal until about 100 years ago.

The bee-keeper using this primitive system starts by capturing a swarm, whose cluster he shakes from its branch into a box or basket, using smoke if necessary to subdue them. In the evening he throws the bees on to an upward sloping board leading up to the entrance to his bee-hive which is merely a hollow vessel of ten to twenty litres capacity, reasonably waterproof, made of wood, straw, pottery or whatever is available. The bees take up residence and the bee-keeper watches over them but does not otherwise interfere.

In their second season it is likely that further swarms will issue from the first stock, which the beekeeper tries to capture, so increasing his number of stocks.

At the end of every summer, the beekeeper assesses his stocks. Those hives which are very heavy with honey and those which are very light and not prospering he decides to sacrifice. Those of

middle weight he leaves to over-winter, hoping they will survive till next season.

By the use of much smoke and drumming on the sides of the hive the bees are driven from the hives to be sacrificed and all the combs inside are then removed for harvest. The honey is pressed out, and the residue is melted down for beeswax.

This is a very wasteful system. The best-yielding colonies and their brood-nests are destroyed. The worker bees driven off may gain entry to some of the other hives and supplement their numbers, but often the smoke used in this operation was that of burning sulphur which killed the workers.

In the eighteenth and nineteenth centuries many improvements in agricultural practice were being introduced in Western Europe and America, and those beekeepers who had enquiring minds began to consider how beekeeping might also be improved. Such improvement depends upon accurate knowledge of the needs and behaviour of the species being cultivated. This knowledge about bees was growing fast at that time.

The first systematic account of honeybees we have is that of the Greek philosopher Aristotle of about 350 BC contained in his works on the "Natural History of Animals" and "Reproduction of Animals". He distinguishes the drones, the workers and the queen and speculated that the queen might be female and the drones male. But as the mating of the queen and drones had never been observed, he remained doubtful about how bees reproduce, and in the end went along with the common male chauvinist line of his day that the bees were ruled by a king. This wrong belief about the sex of the queen persisted till the seventeenth century. Aristotle also noted the division of labour among the workers, and described swarming, although he could not explain it. He also noted how the workers carry "bee bread" — pollen — in the pollen baskets on their hind legs, and how honey is ripened by the worker bees. He also knew that a queenless stock becomes full of drones but could not account for it.

The sex of the "king" was questioned in 1586 by Luis Mendes de Torres of Spain who said she was the mother (a most accurate name) and in 1609 Charles Butler in England described in his work "The Feminine Monarchie" how the queen laid eggs. The date is just after the death of Queen Elizabeth I of England. In 1686 Swammerdam in Holland settled the matter by dissecting queens and drones using the newly invented microscope. He also showed that workers and queens are produced from the same eggs by the feeding of the larvae, as he got worker bees to raise queens from worker eggs placed in queen cells by him — a result confirmed in 1855 by Leuckart in Germany.

In 1730 de Réaumur in France and independently in 1792 John Hunter in Scotland discovered the spermatheca of the queen bee. In 1845 Dzierzon discovered parthenogenesis — the origin of drones from unfertilised eggs. Thus by the mid-nineteenth century a fairly complete picture of the biology of honeybees was available.

The practical question of how to manage bees without having to kill off stocks was now addressed. The main difficulty was how to remove some of the honeycomb from the bees without disrupting the hive to such an extent that it could not survive the winter.

François Huber, a blind beekeeper in Switzerland, had constructed in the eighteenth century an elaborate "leaf" hive which could be opened for investigation, and Hunter in Scotland made a hive in sections separated by a division board. These were experimental rather than practical however.

Wildman in England in 1773 designed a hive with combs built on wooden frames, and Kerr in Ayrshire in 1819 invented the "Stewarton" hive on a similar principle but with a separate top box like John Hunter's hive, that could be removed with its honey while leaving the brood-nest below intact.

The problem with all these initial designs lay in how the bees treated them. All cracks and crevices less than 6 mm ($\frac{1}{4}$ in) in width in a bees' nest are quickly filled by the bees with *propolis* — first described and named by Aristotle — a sticky mixture of resin collected by the bees with beeswax. It forms a very effective glue. Larger spaces are filled by the bees with comb in times of prosperity. Thus all the neatly fitting parts which went together so easily have to be separated with hammer and chisel and much loss of temper by bees and beekeeper.

In 1851 the Reverend Lorenzo Lorraine Langstroth in America, noting that the spaces left by the bees between their combs were about 6 mm ($\frac{1}{4}$ in) wide, proposed that if a "bee space" of this

size was left between all separable parts, the bees would leave them free. He then designed on this principle a hive with movable wooden frames in which the bees would build their combs, basically the modern Langstroth hive, which is still in use with some simplifications. As Wedmore says in his book, this invention was treated like so many others as "*not good, then not new, then not invention, a thing anyone might have done, and [was] then brought into general use*". It is no exaggeration to say that modern beekeeping practice is totally dependent on Langstroth's observation which turned out to be more or less completely correct, although sometimes bees seem to forget it, and a fair bit of ungluing is needed!

Four other inventions play a major role in modern beekeeping:– the modern smoker invented by Quinby in the USA in 1866, the queen excluder invented by the Abbé Colin in France in 1849, embossed beeswax foundation by Kretschmer and Mehring in Germany in the 1850s, and the centrifugal honey extractor invented by Hruschka of Austria in Italy in 1865.

How all these inventions are used will be described later.

The most complete and up-to-date account of the development of methods of beekeeping is "The World History of Beekeeping and Honey Hunting" by Eva Crane *(Duckworth, 1999).*

1.3 Significant bee forage plants in our Association area

Gardens in small towns in Scotland contain a wide variety of flowers, many of which are valuable bee plants. However it is only when large acreages are available that they make a significant contribution to the honey crop from a colony of bees. For this reason I mention very few of such plants in the table below, and instead concentrate on those plants which are of such wide occurrence that they can be more or less guaranteed year after year to make a useful contribution.

One crop in particular, namely Oil Seed Rape, was in the 1980s and early 1990s very widely cultivated throughout Scotland, and transformed honey yields. To a large extent it compensated for the loss of what used to be a major source, namely large amounts of wild white clover in grazing land, much of which has disappeared due to the widespread use of artificial nitrogenous fertilisers on grassland. Because of reductions in subsidies, the cultivation of oil-seed rape has declined in the last few years, and tree sources such as sycamore and lime are becoming of greater importance, though if you are fortunate enough to be near fields of oil-seed rape a crop is more or less guaranteed.

Season	Primary sources	Secondary sources
Very early (March/April)	Willow	Dandelion
Early (May)	Sycamore, autumn-sown Oil Seed Rape	broom, hawthorn
Mid-season (June)	Raspberry, spring-sown Oil Seed Rape	cotoneaster
High season (July)	Clover, lime tree, rose bay willow herb (fireweed)	bramble etc.
Late season (August)	Heather (if you take bees to moor)	

Note that this table has been compiled from experience in the Dunblane area. If you live elsewhere, then some of what is shown here may be lacking, and you may have other sources which are not shown here. It is up to you to explore the flowers of your own area. Your bees will open your eyes to aspects of the flowering scene which you never saw before.

Chapter 2

The basic biology of *Apis mellifera*, the western honeybee

2.1 Introduction

Honeybees and silk-worms are the only two insect species directly exploited by man. Of the two species, the honeybee has by far the more elaborately organised life. Moreover this organisation has been surprisingly little altered by the "domestication" of the bees. For once the Law is right in classifying bees as animals *ferae naturae* — of a wild nature.

A great deal is now known about how a honeybee colony functions, and to keep bees successfully and pleasurably it is very useful to know as much about this as possible. What follows is an outline of the principal facts. If you become a bee-keeper, then it will be your pleasure to amplify this knowledge, by wider reading, by listening to your fellow bee-keepers, and by direct observation. Although the bees have not read any of the books, it is likely that they will in the end prove to be your most valuable teachers.

2.2 The place of the honey bee in nature

The scientific classification of living creatures initiated in the eighteenth century by Linnaeus places honey bees in the scheme (which is now tied to Darwin's theory of evolution) like this:—

KINGDOMS	Animal	Plant	...	
PHYLA	*Arthropoda*	*Mollusca*	*Chordata*	...
CLASSES	*Insecta*	*Crustacea*	...	
ORDERS	*Hymenoptera*	*Diptera*	*Coleoptera*	...
SUPERFAMILIES	Bees (*Apoidea*)	Ants	Wasps	...
FAMILIES	True bees (*Apidae*)	Leaf-cutters (*Megachilidae*)	Miners (4 families)	Plasterers (*Colletidae*)
GENERA	Honeybees	Bumblebees	...	
SPECIES	Western honeybee *Apis mellifera*	Eastern honeybee *Apis cerana*	Giant honeybee *Apis dorsata*	Little honeybee *Apis florea*

In the fossil record the *hymenoptera* first appear about 150 million years ago in the Jurassic period, or, as some others claim, 225 million years ago in the Mesozoic period. Bees first appeared about 26 million years ago, at the same time as the majority of flowering plants. This is no coincidence. Flowering plants need a mechanism whereby the pollen (male reproductive cells) can be transported to another plant of the same species to fertilise the female reproductive cell and form a fertile seed.

Many plants use the wind, notably most of the grasses, which is why their pollen is such a common cause of hay fever. But many insects feed on plants, and their ability to move from plant to plant has allowed the plants to evolve flowers with *nectaries* which secrete the sugary fluid nectar as a deliberate attractant for the insects. The pollen which is dusted on to the feeding insects is then spread by them from plant to plant, as the plants require.

Nectar is an excellent source of carbohydrate (energy food) and pollen itself is a source of protein (body-building food). The bees and the flowering plants have thus evolved in co-operation with one another. The bees have specialised in exploiting this food source, and live solely on these plant products. Some of the plants have in turn come to rely ever more heavily on such systematic visitors as the bees, and will completely fail to set fertile seed unless they are visited by bees. There is a double cost involved for the plants. First of all the production of nectar involves using up energy which could have been spent in other ways, and secondly there is a risk of failure to set seed if bees do not visit. But these plants find these costs worth paying for the generally reliable pollination service provided.

An example of this plant specialisation is provided by plants of the pea family, the most obvious one locally for our bees being the broom, whose flower relies entirely on being "tripped" by a bee in order to be fertilised.

Among the ants, wasps and bees it is remarkable that from the original solitary forms, socially organised species have evolved in all three superfamilies, with remarkably similar forms of social organisation. The ways of life of these super-families are however fundamentally different. The ants in general are eaters of a wide variety of foodstuffs, although individual species of ants have specialised in many remarkable ways. Wasps usually feed on other insects (or other forms of animal food). Bees, as stated above, specialise in one particular form of plant food. There are exceptions to these general rules in all the superfamilies.

Solitary wasps and bees of numerous species exist. Their general life pattern is that the female after mating prepares a nest, often in an underground burrow, which she stocks with sufficient food of the appropriate kind, and on it she lays her eggs which she then abandons. Many species of solitary wasps use their ovipositors as stings in this process to paralyse but not kill insect food left for their young. This is perhaps the most likely evolutionary origin of the sting present in most wasps and bees. There may be one nest with several eggs, or several nests with one egg each. The eggs hatch into larvae or maggots which live on the food provided, and after growing to adult size pupate — form a chrysalis like a butterfly's. From these the adults of the next generation emerge in due course.

An intermediate stage of social organisation is exhibited by the bumblebees and by the familiar wasps we all know and (generally) hate. A queen (female) which after mating at the end of the previous summer has hibernated alone in a sheltered spot throughout the winter finds a suitable site in the spring. There she builds a small nest in which she lays a few eggs. She herself brings food to the developing larvae, and feeds and tends them. These emerge as sexually imperfect females called workers, who then take over the nursery and feeding duties, the queen confining her activity after that to the laying of ever larger numbers of eggs in a nest which is steadily expanded by the increasing number of workers. At the end of the summer a special generation of eggs is laid by the queen which emerge as sexually mature males (drones) and females (queens). These fly from the nest and mate away from home on the wing, thus avoiding close in-breeding as far as possible as mates from other nests will also be available. The rest of the colony then goes into decline and dies out. It is at this stage that the worker wasps cease to hunt for insect food and become a nuisance to us as in their dying days they seek to assuage their discontent with our plums, pears and jam.

The honeybees, like the ants, have taken social organisation a stage further. They almost certainly evolved in the tropics and subtropical regions, the only regions where the giant honey bee and the little honey bee are found. They store large amounts of honey, which is derived from nectar by a process of concentration and partial digestion. This stored food enables their colonies like ant nests to be perennial.

Instead of individual queens founding new colonies, these are produced from the old one by the process known as *swarming*. The giant and little honeybees have nests consisting of a single comb

containing both honey stores and developing bees. Both the western and the eastern honeybees have larger nests — much larger in the case of the western honeybee — of many parallel vertical combs. The amount of stored honey frequently reaches 50 kg (100 lb) or more. This feature has enabled the western honeybee (with the assistance of humans) to extend its range from the tropics to the sub-arctic regions. It has also made it worthwhile for people to exploit it both for its yield of honey and for its unequalled usefulness as an agricultural crop pollinator, since honeybees can be available in reasonably large numbers to pollinate even the earliest spring flowers.

The details of the life-cycle of the western honeybee colony as it has been elucidated by many people over the centuries are explained in the following sections.

2.3 Where bees live

In many places in Scotland even now, colonies of honey-bees live on completely untended — in hollows in stone walls, roof-spaces of buildings etc. This situation is changing however now that the *Varroa* mite has become a widespread problem. It is unfortunately likely to be killing off most wild honeybee colonies unmanaged by beekeepers, though a few do appear to be tough enough to survive.

Before people made buildings, there were many more trees, and hollow trunks of old trees are undoubtedly the honey-bees' natural site for a home. A wild honey-bees' nest contains within the hollow usually from five to twelve honey-combs attached to the under-side of whatever is acting as roof, and hanging down roughly parallel to one another with spaces of about 6 mm (1/4 inch) between them. The combs are about 35 mm ($1\frac{1}{2}$ inches) thick, and consist of roughly horizontal hexagonal cells built of beeswax out on each side from a wax mid-rib.

2.4 The end of summer

In August/September a prosperous colony will have the upper part of all the combs filled with up to 50 kg (100 lb) or more of honey, these cells being sealed over with wax cappings. Some cells lower down the combs will contain pollen, much of it sealed over with a layer of honey. A darker looking area of comb near the bottom centre will contain cells where developing larvae are being reared by the bees to provide the next generation. Some cells near the bottom will be empty.

There will be between 8 000 and 80 000 **worker bees** in the colony, a few hundred **drones** (males), and a single **queen** or sexually mature female which lays all the eggs, but can do nothing else — not even feed herself. Incidentally, the drones too have to be fed by the workers, since they do not know how to feed themselves.

2.5 Stings

All worker and queen honeybees have at their tail end both an ovipositor for laying eggs and a sting. The queen has an unbarbed sting which she never uses except in fighting a rival queen. She mainly uses her ovipositor. Workers normally do not lay eggs, but the worker's sting is a sophisticated barbed weapon which is highly effective against large animals like human beings, for which the stealing of the nutritious honey store is an attractive idea. Bees away from home only sting if they are crushed or hit. Near home, if the alarm is raised, they can become extremely aggressive. Any vibration or waved arms will arouse them at the end of summer when they have much to defend. Hair-spray smells, sweat or whisky breath are also attacked.

The scent of one sting attracts more bees to the attack and the result can be unpleasant and dangerous if you are unprotected. The sting is usually left behind by the bee when she tears herself free, and continues to inject venom by reflex action for up to half an hour. The bee herself dies.

If you are attacked when without protective clothing then:–

- Move away from the colony site/beehive quickly and quietly.
- If bees continue to follow you, go under trees or go indoors.
- As soon as practicable remove the sting by *scraping* it out with a finger-nail or other tool: do not pinch it out or you will inject more venom.
- Do not return to the site without protective clothing or you *will* be stung again.

Most people when stung experience a sharp pain immediately, but if the sting is promptly removed they suffer no further ill effects apart from inflammation and itching of the place for a day or two afterwards. Many people are unreasonably frightened of being stung by bees. There can very occasionally be serious consequences, but it is important to keep a sensible view of these risks.

An excellent and up-to-date explanation for the layman of the medical risks involved is *"Medical Aspects of Beekeeping"* by Harry Riches, MD, FRCP published by Northern Bee Books in 2000. Dr Riches is himself both a doctor and a beekeeper and ex-President of the British Beekeepers' Association who dealt with his own allergy to bee-stings with complete success. I would recommend anyone worried about stings to read this book. In an appendix to this chapter is a brief summary of his main recommendations.

2.6 The casting of the drones

In August/September the number of drones present in the bee colony rapidly diminishes, since with the onset of the colder shorter days, the workers actively eject them to die of cold and starvation overnight when they are excluded. They have no role to play in the winter, and retaining them would reduce the colony's chances of surviving the winter.

2.7 Wintering

As the days shorten, the queen's laying is reduced and stops, the last of the developing larvae — the brood — emerges as worker bees, and the workers in the colony then allow the temperature in the nest to drop from about 33^0C (92^0F) to about 15^0C (60^0F). They become much more lethargic and cluster together in the centre of the nest, just below the main bulk of the honey store, many creeping into the now empty cells where larvae were recently being reared.

Only on warm dry days in winter do a few bees fly to empty their bowels and to collect fresh water.

As winter progresses, the cluster gradually eats its way up through the honey store which was gathered to enable the colony to survive the winter. Food is shared, and by metabolising it, the cluster maintains the temperature at the centre at about 15^0C (60^0F), although in severe frosty weather bees on the outside of the cluster may become chilled and die despite tighter clustering.

2.8 The spring build-up: brood-rearing

With the longer days of February the colony becomes much more active. Workers feed the queen more generously and she begins to lay again in cells at the heart of the cluster. By consuming more honey the workers again raise the temperature to around 33^0C (92^0F) which is the temperature necessary for brood rearing. The colony starts to use up its stores much more quickly and may at this time be in danger of starvation.

The eggs which are only about 1.5 mm ($\frac{1}{16}$ inch) in length are laid upright one per cell at the base. After 3 days larvae emerge and lie coiled at the bases of the cells. The workers immediately

begin to feed them. These cells are the *open brood*. Initially their food is "bee-milk" — a glandular secretion produced from glands in the heads of young worker bees which have been feeding on pollen. This food is very rich in protein. After two days, more honey and pollen is added to the diet of the larvae. Five days after hatching the larvae have grown so large that they can no longer lie curled in the bases of their cells. The worker bees then cap these brood cells with a very porous wax/pollen capping of a light brown colour, unlike the white wax cappings of the honey store, and the larvae inside stretch out, defecate, and line their cells with silk cocoons which they spin, and which after many generations largely replace the original wax of the brood cells. They shed the last of their larval skins and become pupae. These cells are the *sealed brood*.

Fourteen days later the pupae have metamorphosed into worker bees which with their powerful jaws bite their way out through the capping and join the colony, where, after an initial feed they take up duty as cell cleaners and nurses of larvae.

2.9 Foraging, colony growth and bee longevity

In March, or even earlier, fine days allow some of the older workers to seek fresh pollen and nectar from early spring flowers to replenish the depleted stores. Bad weather now can spell disaster. A worker which finds a good source of food, on returning home signals its location to her sisters by the *dance language* first discovered in the twentieth century by Karl von Frisch. Thus many workers are quickly directed to any good food source. Water is also collected to dilute the very concentrated winter honey.

As the first of the queen's new brood emerges, the worker population, which may have dwindled to as low as 3 or 4 thousand begins to recover, and brood rearing now begins in earnest. All those workers which started their lives in the autumn are nearing the end of their span, and most will be dead by May, most dying when on foraging trips. Moreover the active summer workers, unlike the somnolent winter ones, only live for about six weeks of adult life. Only the queen has a longer life-span which may be as long as 3 or even 5 years. Spring advances and more plentiful nectar and pollen become available. The large empty areas of comb left by the winter feeding are gradually filled again, with honey above and an expanding brood-nest surrounded by stores of pollen below. At first the honey cells are open and contain a watery nectar, but this is soon ripened and concentrated by the addition of digestive enzymes by the bees, and by the fanning action of their wings which evaporates the excess moisture. When sufficiently concentrated, the honey is again sealed with wax to prevent it from reabsorbing atmospheric moisture on damp days.

At the height of May the queen will lay between 1000 and 2000 eggs per day. The emerging workers pass through a regular cycle of duties, the young ones doing domestic work for 2 to 3 weeks, then moving on to guard duty at the doorway, and finally becoming foragers for nectar and pollen.

2.10 Reproduction: Dzierzon's rule, and drones

Towards the outside edges of the combs there are usually found patches of cells which are slightly larger than the usual standard being 6 mm ($\frac{1}{4}$ in) across instead of 5 mm ($\frac{1}{5}$ in). When the queen has filled the central areas with brood, she starts to lay in these cells.

A remarkable fact was discovered about 1845 by the Silesian bee-keeper Johann Dzierzon. It has since been amply confirmed by many experiments, notably those of Gilbert Barratt of England published around 1919. Also it is now known that a similar phenomenon is found among most of the hymenoptera — ants, wasps, other species of bees etc.

The queen bee on first emerging in her youth does not begin laying until she has been on a *mating flight*, on which she flies up to a height of about 10 m (30 feet), at which height her scent suddenly becomes strongly attractive to drones who spend all fine summer days patrolling in "drone congregation areas" on the look-out for flying queens. The queen mates with about a dozen or so drones in succession, each drone dying in the act. The spermatozoa from the drones' semen then lodge in a

special organ in the queen's abdomen called the *spermatheca* where they remain viable throughout her life.

Each egg that the queen lays in one of the smaller cells, she fertilises with some of the spermatozoa that she has stored. But when she lays in the larger cells, she refrains from fertilising the egg. However unlike the eggs of mammals or birds which die if they are unfertilised, these eggs develop. The remarkable fact Dzierzon noted was that *all* the fertilised eggs, which have both a father and a mother, develop into females — workers or queens — whereas *all* the others, which have a mother but no father develop into males — drones. The drones are reared exactly like the workers, but the mature larvae are larger and are covered with a dome-shaped rather than a flat capping, so giving sealed drone-brood the appearance of a lot of bullet ends sticking out from the comb. Their pupation phase lasts for sixteen days instead of fourteen. Because of their origin it is now known that drones are also peculiar in that each cell of their bodies only has half the expected complement of chromosomes in it. They are what biologists call *haploid* organisms.

The operation of Dzierzon's rule also explains how queen bumblebees and queen wasps are able to control the sex of their offspring in order to create initial generations of all-female workers when establishing their colonies in the spring.

2.11 Swarming and the rearing of new queens

When June arrives, if the colony is prospering, the whole nest becomes overcrowded. This often triggers the remaining part of the bees' reproductive cycle. It is clear that in a sense an individual bee is of no account, but that the unit of honeybee life is the colony. This is potentially immortal, but it may perish through accident, disease or starvation. Thus it is essential that there should be a mechanism for increasing the number of colonies. This is provided by swarming.

In late May or early June the workers construct of beeswax five to twenty *queen cups* like inverted acorn cups protruding from the faces and edges of the combs. When conditions are ripe, as determined by the circulating chemical secretions from queen and workers called *pheromones*, the queen will lay a fertilised female egg in each of these. The workers now control the development of the resulting larvae by a specially generous diet of what is called Royal Jelly, the significant component of which was proved by the work of Asencot and Lensky in Israel in the 1970s (*"The effect of sugars and juvenile hormone on the differentiation of the female honeybee larvae"*, Moshe Asencot and Yaacov Lensky, Life Sciences Vol 18, 603–700; *"The effect of sugars and juvenile hormone on the differentiation of the female honeybee larvae (Apis mellifera L.)"*, Thesis submitted for the degree of Doctor of Philosophy by Azencot Moshe to the Hebrew University of Jerusalem, Rehovot, August 1977) to be additional honey. The ideas of the late Barbara Cartland and others that there is some special life-prolonging magic about it are probably nonsense. These larvae grow larger than any others because the special diet stimulates a hormonal trigger in the larvae when they are about 36 hours old and this completely alters their future development. As the larvae grow, the cups in which they are housed are extended into vertical *queen cells* about 25 to 35 mm (1 to $1\frac{1}{2}$ in) in length, with the opening at the bottom. Like other brood cells they are finally capped when the larvae are five days old. The resulting pupae mature more quickly than those of workers or drones, and emerge as virgin queens after a mere 8 days.

In the meantime remarkable things have been happening in the colony. On the first fine day after the capping of the first queen cell, usually around mid-day, great excitement builds up and shortly clouds of workers fly up into the air and hover in front of the nest. They are joined by the queen who usually quickly settles on a nearby branch of a tree or other convenient spot. The masses of swarming workers then gather round her and gradually build up into a dense suspended cluster like a large bunch of grapes — the swarm.

If left to its own devices the swarm will remain in place for perhaps a few hours or a few days. The workers have all filled their stomachs with honey and are placid and content. But scouts from the swarm are away exploring for a new home. Each scout which finds a possible site returns and signals its find by dancing on the surface of the swarm cluster, trying to encourage others to go and look at

this possibility. Ultimately the swarm becomes "of one mind" and lifts off to fly in a "bee-line" to its new home. There the workers immediately set to work to clean out rubbish and to build new combs from wax secreted by glands under their abdomens. They work urgently and with haste. They have about two months to build up from nothing a honey store and a young worker population adequate to see them through the winter.

The parent colony has a few days to wait until a young queen emerges. When she does, she may depart with a second smaller swarm or *cast*. A third and even a fourth cast may go, some with several queens, but they become progressively smaller and have less chance of surviving than the *prime swarm*.

Ultimately a queen emerges that the workers allow to take over the old home. Her first task is to seek out any unhatched queen cells or other virgin queens at large. When two meet they fight to the death. This is the only time a queen uses her unbarbed sting.

Thereafter, usually about two to three weeks after the departure of the prime swarm, the virgin queen goes out on her mating flight, and returns to resume after another day or two the interrupted egg-laying and build up again the now much shrunken population.

2.12 Queen production in other circumstances

If a queen becomes old so that her pheromonal secretions are deficient, the bees will supersede her. A small number of queen cells is built, but no swarm departs. The first queen to emerge flies and mates, the workers tearing down the other queen cells and destroying the inmates. The new queen may lay for a time beside her mother, but soon the older queen is neglected by the workers and dies.

If a queen suddenly dies, the workers deprived of her pheromones immediately convert a few cells with young worker larvae into makeshift emergency queen cells and thus save the colony from extinction by raising a new queen. If no young enough worker larvae are present, or if the loss occurs in winter, the colony is doomed.

2.13 Autumn returns

Finally the annual cycle returns to autumn and again the preparations for winter begin with the casting of the drones.

Appendix 2.1 — Developmental details for the different castes of honeybees

It is an essential part of what a bee-keeper must know to remember the developmental times for the different castes, since interpreting what you see, and planning and executing various manipulations depend on this knowledge.

CASTE	WHERE	EGG DAYS	UNSEALED DAYS	SEALED DAYS	TOTAL DAYS
Queen	Queen cell	3	5	8	16
Worker	Small comb cell	3	5	13	21
Drone	Large comb cell (domed capping)	3	6	15	24

Appendix 2.2 — Drone layers

If a queen is prevented by bad weather from taking her mating flight for too long (3 weeks), or if she finds no drones because of the lateness of the season, she may start to lay unmated. She will then never mate and all her eggs will develop into drones. The colony she rules will quickly die out.

If a colony becomes hopelessly queenless, the ovaries of some of the workers are stimulated by the feeding of the other bees who have no queen to feed, and they will then start to lay a few eggs irregularly dispersed through the cells. Again only drones can result as workers are anatomically incapable of mating.

The bee-keeper can detect these conditions in beehives by finding the small-size worker cells sealed with the domed drone cappings. Clearly these colonies require immediate remedial action if they are to survive. Combs which have been used for such irregular production of drone brood will never be used thereafter for satisfactory rearing of worker brood, and have to be scrapped.

Appendix 2.3 — Up to date advice about bee stings

- A severe stinging, involving the reception of many hundreds of stings is a potential hazard to life for anyone, but no beekeeper should ever be in danger of that provided sensible precautions are taken when handling bees.
- Being stung inside the mouth (involving the danger of suffocation due to swelling of the throat) or being stung in the ball of the eye (involving possible loss of the sight of the eye) are hazards that should be avoided by always wearing a veil when handling bees. Incidentally a bee which gets *inside* a veil hardly ever stings. She is always in a panic to get out!
- Normally a sting, if promptly removed, gives a sharp pain initially, which subsides within a minute or so, followed by slight itching for a day or so afterwards. The use of antihistamine cream for this itching is not recommended as it can sometimes set up a dermatitis. If the itching is troublesome, Dr Riches recommends the use of a cold compress or calamine lotion. Most beekeepers do not use anything, as to most people it is less bother than a nettle-sting.
- When a beginner starts to keep bees, the first sting or two provoke little reaction, but a minority go on to experience occasional quite severe swelling locally. Usually this simply subsides after a time as they develop an immunity mediated by the IgG immune response, and thereafter experience little trouble from the occasional sting. If the local swelling is troublesome, Dr Riches recommends

taking an antihistamine *tablet* (Piriton (chlorpheniramine)), available over the counter from pharmacists, an hour or so before working with the bees. This can cause drowsiness which can be dangerous if you are going to drive or work with dangerous machinery of any kind. A slightly more expensive alternative in that case is Zirtek (cetirazine), which is less likely to cause drowsiness. Of course before taking any medication you should ensure that you do not suffer from any medical condition that might make it dangerous. Read the instructions!

- A small minority of people develop a severe allergy to bee-stings mediated by the IgE immune response. This can lead to an extremely dangerous anaphylactic reaction in this minority, with breathlessness, nausea, sickness and fainting. Such a reaction must be regarded as a medical emergency, and hospital help sought urgently, since people can die of anaphylactic shock.
- If people who develop a severe allergy to bee-stings wish to continue to work with bees, then immunotherapy with pure bee venom is recommended. This involves a course of hospital administered injections with slowly increasing doses of bee venom following a careful program. Successful completion of such a treatment renders people more or less normal in their reaction to stings, though it is recommended that they should try to get stung once a week or so to keep their IgG immunity levels up. Unfortunately this treatment is not usually available on the NHS! Again the use of an antihistamine tablet before visiting the bees is recommended.
- For a fuller exposition, consult *"Medical Aspects of Beekeeping"* by Harry Riches MD FRCP published in 2000 by Northern Bee Books (ISBN 0–907908–94–2).

Chapter 3

Beekeeping Equipment

This section will be largely a practical demonstration. We shall not try to explain all the possible uses of all the types of equipment, but will try to show all those which are the essential everyday tools of the beekeeper and how they work.

They are grouped under five separate headings:– (1) Beehives and their accessories, (2) protective clothing to prevent stings, (3) tools used in opening, inspecting, manipulating and transporting hives, (4) equipment used in handling the crops of honey and beeswax, (5) miscellaneous and specialist items.

3.1 Beehives and their accessories

The old-fashioned straw skep is still available from suppliers. It is now a rather expensive item, though originally it was a cheap option which any farmer could make from his own straw. When used as a beehive, it does not permit modern methods of beekeeping. It can be useful for catching a swarm, but the same job can be done just as well with a cardboard box, available free from your local supermarket.

Too many different patterns of beehives are readily available on the market in Britain. All are equally well liked by the bees, but different beekeepers all swear by their own favourites. The problem they cause is that parts from one type of hive will not fit another type. The one crucial piece of advice about them to intending beekeepers is to CHOOSE ONE READILY AVAILABLE TYPE, THEN STICK TO IT AND REFUSE ALL OFFERS OF INCOMPATIBLE EQUIPMENT.

The essence of modern beekeeping practice as initiated by Langstroth is complete flexibility, allowing boxes or even individual combs to be transferred between hives. Any mixed equipment will tie your hands and be a source of frustration.

3.1.1 Parts of a hive and its accessories

Most modern beehives follow the pattern of the original Langstroth hive as it has been simplified by commercial beekeepers. The Langstroth pattern itself is in almost universal use throughout the USA, Canada, Australia and New Zealand. It consists of a *floor*, which is a rectangular board with raised $\frac{1}{2}$ inch (about 13 mm) wooden cleats on three of its four sides, the fourth open side providing an entrance slot; one or more *brood boxes* which are simple rectangular wooden boxes without top or bottom, having rebates cut in the top edges of a pair of opposite sides to hold the ends of the top bars of the carefully dimensioned wooden *frames* in which the bees are guided to build their combs. These boxes simply stack one above the other. There will also be several shallower *honey supers* of the same basic design as the brood boxes; a *crown board*, which is a flat board to cover the topmost box, and which may have one or two feed/bee-escape holes cut in it; and finally a *roof* with sides which fit down over the topmost box for security against wind, and which is covered with roofing felt or metal to make it weather-tight.

Most beekeepers will also use a *queen excluder* — either a sheet of slotted zinc or plastic, or a frame of accurately spaced wires — which can be laid to fit exactly between two boxes. The slots are just wide enough for worker bees to pass through, but prevent the passage of queen or drones which are larger. Those honey supers above the queen excluder remain entirely free of brood which simplifies harvesting at the end of the summer.

There may also be an *entrance block* to close the entrance for transporting the bees if necessary, and when this is inserted so as to close the entrance completely, the solid crown board must be replaced by a perforated zinc *transportation screen*, and the roof removed to allow top ventilation to the imprisoned bees. For transport, some means of securing the stacked boxes to one another are needed. Some of the options available are *ratchet hive straps*, or *plastic tapes*, or simply *wooden battens* nailed or screwed to the hive sides.

Feeders are also available to give supplementary feeding of sugar syrup in September to those stocks which have been left after harvest with too little honey to see them through the winter, or to those stocks found in spring to be dangerously near starvation, or as a boost to a newly established swarm. There are two basic designs, *contact feeders* which slowly drip feed syrup through the perforated lid of the inverted feeder, and *rapid feeders* which allow access to the surface of a large volume of syrup through a *narrow* slot, so the bees do not drown themselves in the syrup. All contact feeders have to be enclosed by an empty super, as do some rapid feeders, though the *Ashforth* and *Miller* designs are of the size of a hive box, and simply sit above the top box of the hive under the crown board.

3.1.2 The WBC hive

The diversity of hive types in Britain is due to the efforts of many well-meaning amateurs near the beginning of the twentieth century. Chief among them must be mentioned William Broughton Carr who designed what is still called the WBC hive. This is the pattern of hive you see in all the pretty rural pictures. Carr's idea was that bees would fare better in Britain's damp climate if protected from the weather by double wooden walls, like the cavity walls of a house. His design is considerably more complicated as it consists of a number of rather flimsily constructed inner boxes that carry the frames with their ends right on the tops of the side walls. These are built up on a solid wooden floor standing on wooden legs with a specially constructed entrance, and the stack of boxes is topped either by a crown board or (more traditionally) by a cloth "quilt". But then stoutly built telescopic outer wooden "lifts" are placed around the inner boxes resting at the bottom on the outer edges of the floor, and a pitched roof covers the stack of lifts. It is an excellent hive for the bees, but uses a great deal of timber and is therefore both expensive and heavy. It is also tricky to transport with bees in it.

The frames used in the WBC hive are different in size from those used in the Langstroth hive, and they have extra long top bars which make them very easy to handle, but awkward to fit into a Langstroth-type box, even if it is re-dimensioned otherwise. However the WBC hive became so popular in Britain that these frames have become the British Standard.

3.1.3 The National, Smith and Wormit Commercial hives

Several Langstroth-type single-walled hives have been designed around the British Standard frame. The original National hive was at one time adopted as the British Standard Hive. This has specially thickened front and back walls to its boxes to accommodate the long top bars of the British Standard frame. A close relative is the Wormit Commercial Hive designed by the Appliance Dealers Messrs. R. Steele and Brodie of Wormit in Fife, who for long were the principal suppliers of beekeeping equipment in Scotland, but who closed in 1998. This hive has slots cut into the bottoms of the box walls which engage with wooden ridges set into the tops of the walls of the box below. This makes a very solid hive, excellent for transport, but whose boxes can be difficult to separate for inspection.

The Smith Hive, designed by Willy Smith of Innerleithen fits the British Standard frames into a Langstroth-type box by chopping 19 mm ($\frac{3}{4}$ inch) off each end of the long top bars, reducing them

from 432 mm (17 inches) to 394 mm ($15\frac{1}{2}$ inches). It is the simplest and cheapest of the British designs.

Now that Steele and Brodie are out of business, the Wormit Commercial hive is no longer available commercially, but there are still a few beekeepers using them. They are *almost* completely compatible with National hives, but not with Smith ones because the Smith hive uses frames with shorter top bars. For the same reason, Smith and National hives are incompatible.

The most commonly used hive type throughout the UK is probably the Modified National, which is the same design as the original National, but with a simplified front and rear wall construction to the hive boxes. In Scotland however, and certainly in this area, the Smith hive has, until recently been almost equally popular. However the Modified National is being actively promoted by most of the equipment suppliers and so is probably going to become the *de facto* standard for the whole of the UK.

3.1.4 Some more unusual hive designs

Less common patterns are the Modified Dadant and Langstroth Jumbo hives which are American designs taking larger frames to encourage big brood nests; the Glen Hive which is an enlarged version of the WBC; and the Modified Commercial which is a version of the National with deeper brood boxes and brood frames. A new addition to this range is the Dartington Long Hive which expands horizontally rather than vertically, and works well for any beekeeper who never moves his bees. All these hives with extra large brood boxes require a physique something like Desperate Dan's to move them around, and are perhaps best avoided by lesser mortals, unless as a user of Dartington hives, you can manage never to move your hives. The bees love them all!

3.1.5 Top and bottom bee-space

Difficulties of compatibility of equipment are compounded by inconsistency in using *top bee-space* or *bottom bee-space*. Langstroth's principle requires there to be a 6 mm ($\frac{1}{4}$ inch) bee-space between ALL separable parts, and in particular between the tops of the frames in a lower box, and the bottoms of the frames in the box above. *Either* the top bars may lie flush with the top of the box, and the bottom of each box must protrude 6 mm ($\frac{1}{4}$ inch) below the bottoms of the bottom bars of the frames it holds (bottom bee-space), *or* the top bars fit 6 mm ($\frac{1}{4}$ inch) down from the top of the box, and the bottoms of the frames in the box above hang flush with the bottom of the box they are in (top bee-space).

The original Langstroth design, the WBC hive, the Wormit Commercial and the original and modified National designs used the first arrangement. Most others use the second, which is generally thought nowadays to be slightly more convenient for the beekeeper. All modern Langstroth hives and some modern National hives have gone over to this second arrangement of top bee-space. Before buying additional equipment, make sure it matches yours in this regard, because mixing these types leads to a well and truly gummed up hive in working which you are almost bound to kill many bees unavoidably.

3.1.6 Putting hives and frames together

Assembling hive boxes and roofs

If hive boxes and roofs are being bought new, some money can be saved, and transport made easier, if they are bought "in the flat". They then have to be assembled, which is a reasonably straightforward job with hammer and nails, though for knocking together the joints on Smith type hives, hammering the parts through a piece of scrap wood avoids the bruising of the wood that direct hammering will cause. Glueing the joints as well as nailing them is recommended. The instructions that come with the boxes are fairly clear, and anyone who can put together an Ikea flat pack need have no fear.

The top quality traditional hives are of western red cedar and are best left unpainted. If any wood treatment is applied, then

- only apply it to the *outside* of the boxes where the bees don't walk much;

- make sure it is a type which does *not* contain an insecticide as protection against woodworm. That would kill your bees in short order! The manufacturers of beekeeping equipment sell a recommended type, though many beekeepers successfully leave western red cedar boxes totally untreated, and they last for many years.

In recent years, some manufacturers have been experimenting with hives made of the plastic polystyrene, to National or other designs. They are said to keep the bees very dry and warm in winter, and they have other advantages. The boxes are supplied flat packed and require no glue or tools to assemble. They are supplied with a mesh floor as standard and so, taking into account the ongoing problems with Varroa, this is a big advantage. They are however not very cheap, and of course cannot be scorched with a blowlamp to disinfect them.

Assembling frames and foundation in which the bees will build combs

The frames for the bees to build their combs in, of whatever design, are best bought in pieces for assembly at home. When frames are assembled the parts fit snugly together and many beginners think that friction with added propolis is all that is needed to keep them together. Don't make that mistake, or you will one day lift a comb by its top bar to inspect it, only to have the whole thing suddenly detach itself to fall in a hopeless mess at your feet of squashed bees (maybe including the queen!), spilled honey, broken comb, and destroyed brood. Even worse, you may find that when you prise out the top bar with your hive tool, the top bar is all you get, and the comb and the rest of the frame is still in the hive, and totally impossible to get out. Frames MUST be securely nailed, and frame nails are readily available.

One nail must be inserted through each side bar into the top bar, and then the frame turned over and the same done on the other side. Also nails should be inserted from the bottom of the frame through each bottom bar into the side bar. Some people nail across through both bottom bars. Although this is very secure, it prevents the bottom bars from being prised out again in order to insert fresh wax foundation again at a later date. However if you are prepared to scrap brood frames when the comb becomes unsatisfactory, this does not matter. The cost of each frame is currently about £1 (2008 prices). Before fully assembling the frame however, remember that *wax foundation* must be secured inside it.

Foundation is the name given to the sheets of beeswax embossed with the pattern of honeycomb cell bases which appliance dealers sell, and which is fitted inside each new frame before it is placed in the hive. It can be purchased with wire reinforcement inserted for additional strength in the brood nest, or for combs that will be spun in a centrifugal honey extractor. Alternatively thin unreinforced sheets can be bought if you decide to harvest your honey in the comb. Foundation is what guides the bees to build their comb where WE plan and not where THEY fancy, which might well be spanning three or four of the wooden frames, making it impossible to lift out individual combs for inspection, thus defeating the whole Langstroth philosophy. In assembling a new frame therefore, the order of operations is as follows.

First remove the wedge from the top bar, which is held there by a sliver of wood, and clean away that sliver with a sharp knife or your hive tool. Then assemble the top bar and the side bars, making sure the slots in the side bars are facing *inwards*. Nail the side bars to the top bar from each side as described above making sure the frame remains on the square.

Next fit the bottom bar on the side of the frame away from the wedge and nail it in place. Ensure that each end of the bottom bar lies flush with the outside edge of the side bar so that the side bars will hang truly parallel and at right angles to the top bar. If the frame is not to be given to the bees immediately, next fasten the wedge and the other bottom bar to the frame with sellotape and leave it like that until the day it is to be given to the bees. Foundation put into a frame quickly loses its attractive aroma of beeswax and goes stale, and then bees will not build satisfactory comb from it. Foundation kept in its air-tight plastic wrapper will keep in good condition for several years, provided you don't let mice get at it.

When inserting foundation into the frames, choose a warm day or a warm room to work in so that the wax is not too brittle. Carefully slide the foundation along the slots in the side bars, orienting the sheet if it is wired so that the hooked ends of the crimped wires, or the loops on the zig-zag wires (bent by you at right angles away from the sheet of wax) fit into the gap where the wedge came out. Then lay the wedge back into the place it came from and use it to nip the top of the sheet of foundation and to trap the ends of the wires, securing it with three nails. Finally insert the remaining bottom bar in the frame, ensuring that the bottom edge of the foundation can slide freely between the two bottom bars to allow for expansion when the bees warm up the wax, and finally nail that second bottom bar in place.

It is worth making sure you get all this right. Frames which have not been correctly assembled will put both you and the bees throughly out of temper, probably on a day when you are both already fed up because the weather is bad.

Spacing frames in the hive

The standard frames with straight side-bars must be spaced apart in the hive by some sort of spacer. The traditional British spacer is the "metal end" which is going out of favour as it quickly goes rusty, gets clogged with propolis and finally collapses at a crucial moment after cutting your glove and your finger inside it. The modern replacement, the "plastic end", is a little better but can slide off the short lugs of Smith frames at embarrassing moments. Most users of the Smith hive prefer the alternative of self-spacing Hoffmann frames, whose side-bars are thickened at the top so that they are in contact over a short distance when the frames are correctly spaced. The bees do propolise the contact area, but it is small enough to be tolerable. Alternatively Hoffmann converter clips in plastic can be nailed to the side bars of conventional frames to do the same job. In the honey supers, straight-sided Manley frames in contact throughout their depth are excellent, since they hardly ever have to be inspected, and so the fact that they get propolised hard together does not matter, since they only need to be dealt with away from the bees at harvest time. These Manley frames are a little more expensive, as they use more timber, but they are very strong, hang beautifully straight in the honey extractor, and last for many years.

Another spacing alternative in honey supers is to use ordinary straight-sided frames without any attached spacer, but to fit *castellated spacers* inside the super, which are metal strips looking like the battlements on a castle, and into the gaps of which the frames fit neatly. Modern National supers are made with a slot to receive these castellated strips. They must *never* be used in the brood box however, since they prevent the frames from sliding along and make inspecting the brood box very difficult.

The WBC hive is designed to take 10 frames in a box at metal-end spacing. Some modern Hoffmann frames give a slightly closer spacing — $1\frac{3}{8}$ inches (3.5 cm) instead of $1\frac{1}{2}$ inches (3.8 cm) — and it is then possible to squeeze an eleventh frame in. This is inadvisable as the frames jam hopelessly after a little propolis has been added by the bees. It makes for much easier working if the end space is filled with a *dummy* — a simple wooden board cut into the shape of a frame, and easily made at home from an off-cut of shelving. The Smith and National hives take 11 frames at metal end spacing and the same argument applies here about adding a 12th frame when the narrower Hoffmann spacing is used.

3.1.7 Choices to be made for dealing with the honey crop

In the 1980s and 1990s much of the honey harvested in Scotland was Oil Seed Rape honey, which tends to granulate very hard in the comb unless one is very prompt at extracting it. If you have this crop in your area, you may have to cut out all the honey comb from the supers, and to soften the honey for harvest with gentle heat. If so, do not use wired foundation in the supers, but instead use just part sheets of unwired (possibly home-made) foundation. These can be quite quickly inserted, held in place by the wedge only. With care even these combs can be extracted if the honey has after all remained liquid.

This also allows you the option of just cutting the combs out of the frames and using it as honey-in-the-comb, saving the trouble of spinning the honey out using an extractor.

When harvest time comes at the end of the season, the bees have to be separated from the honey-combs that you want to harvest. The commonest way to get bees off the honey combs you wish to remove is to use a *clearer board*. The crown board can double up for this job, but two *Porter bee-escapes* are needed to fit into the two holes in the crown board. The modern plastic type are less trouble than the old tinplate ones. Before they are used it is a good idea to dismantle them so that you understand how they work as one-way valves to allow bees out but not back in again, and also to smear a little petroleum jelly on the sliding parts, so that when the springs are gummed up with propolis you can get them apart to clean up the mess. Canadian or French style clearer boards (using a rhomboid or other shape of escape with no moving parts) are simpler and more effective. Do not leave clearer boards in contact with the bees for more than a couple of days at most. If you do, the bees will gum up any Porter escapes with propolis making them unusable unless they are carefully ungummed, or the bees will learn to find their way back through the maze of the escape and take back all the honey for their own use.

3.2 Protective clothing

Although the choice is varied, it is not so crucial to make the right choice and stick to it. To work bees with confidence it is essential to feel adequately protected, and it is not hard to obtain clothing that will under normal conditions keep all stings at bay. Note that this is NOT a licence to ill-treat your bees, nor is it a guarantee that you will not be stung. In fact I can guarantee that if you keep bees for long, you certainly WILL be stung. But it will be your own fault when it happens, and you certainly need never get a severe stinging unless you are careless.

A well-fitting hat-and-veil or helmet-and-veil combination to protect the head and neck is the basis of the armoury, backed up by some form of overall or bee suit, which also keeps your other garments clean from honey, wax and propolis. An alternative is a full bee suit with a veil incorporated into it. The bee suit gets dirty surprisingly quickly, so regular laundering is a good idea.

Some beekeepers dislike using gloves and are prepared to tolerate some stings to their hands. Many prefer to use gloves with elasticated gauntlets to cover the wrists. Various types are sold by the beekeeping appliance dealers, but if you are buying gloves make sure they fit your hands.

A pair of wellingtons to protect the ankles completes the outfit.

3.3 Tools for working with bees

The *smoker* and the *hive-tool* are the two things that are never long out of the beekeeper's hands when hives are being visited.

A *copper* smoker, well cared for will last for twenty years or more. A tinplate one at about half the price will rust through in two seasons. Stainless steel ones at an even higher price than copper are now available if you wish to treat yourself to a luxury.

The *hive tool* is used as a lever, hook, scraper, screwdriver, and even hammer when need be. Get one painted a good bright colour (or paint it so yourself) or you will lose it in the grass, on the hive roof, under your tool-box etc. ten times in one afternoon — the author speaks from experience. Without it propolis will beat you. With it you can keep propolis at bay.

Two *cover-cloths* or *rollers* to lay over the tops of the frames when a hive is being examined will help to keep the bees subdued with much less use of smoke, and also help to keep some heat in the hive if it has to be examined on a cool or breezy day. They are simply made at home of some stout cloth of a size to cover the hive top, and with a wooden batten sewn into or tacked to each of two opposite ends. A cloth can be rolled back to expose one frame at a time and the other rolled on from the opposite side. Some people like to dampen the cloths before use as the bees are repelled by the cold

wet cloth. The appliance dealers also now sell cover cloths fitted to a wire frame with a gap which can be slid over the frames to give the right size of working space at all times. Perhaps sliding is not quite so kind to the bees as unrolling however.

If you intend to transport hives, note that it is really a two-person job, and if you cannot get a *hive-trolley* near your hives, then a pair of *hive carriers* makes that unpleasant lifting job just about bearable.

A few simple joinery and general tools such as a hammer, a screwdriver, a saw and perhaps a chisel will let you do routine maintenance and repair work. If you are more ambitious and wish to build your own hive, than a rebating plane and some form of jig-saw will be needed. Making your own frames is not recommended unless you are a dedicated joiner. It is of course helpful to have access to a good work-bench for joinery work.

3.4 Equipment for handling the crops of beeswax and honey

If you are content to deal *only* with honey in the comb, then little equipment is needed, apart from common kitchen utensils.

For extracted honey you will need a centrifugal extractor — DON'T rely on borrowing, though SHARING may be a good idea. This is an expensive item new, particularly now that new regulations are insistent that stainless steel must be the metal used. You will also then need a settling tank or "ripener" as it is called, although this can be of plastic. You will also need at least one strainer to filter out particles of wax and other debris from the honey.

Various patent devices are available for processing beeswax, but on a small scale an ordinary kitchen double boiler is helpful. Small moulds for casting blocks of wax can be bought, but wax can be cast into a block in a pie dish or pyrex bowl with sloping sides.

Preliminary washing of honey residue from wax before it is melted down can be done in a washing-up bowl, and the washing water then strained off through an ordinary kitchen sieve or strainer. For those who wish to try making mead, the strained honey from wax cappings is usually a good starting point.

A solar wax extractor which uses the heat of the sun to separate beeswax from debris is useful if there is a fair quantity of wax to handle.

3.5 Miscellaneous and specialist items

One or two *nucleus boxes* which are miniature hives taking 5 or six brood frames only are convenient for rearing new queens.

Special paint sets for marking queens with a dab of paint on the back of the thorax can be obtained, although this is not necessary, since the bees always know where the queen is, even if you don't. However it is sometimes very useful to be able to spot her easily.

There are plenty of other goodies to be seen in the catalogues of the appliance dealers, but in my view most of the essentials are listed above.

Chapter 4

Handling bees — basic skills

4.1 Introduction

The foundation of the enjoyable working of bees is to work in co-operation with the bees as far as possible. Beginners are always tempted to open the hive to look in to see how the bees are doing. It is necessary to do this periodically, and it should then be done quietly, quickly and efficiently, but unnecessary disturbance is as foolish as digging up one's potatoes to see how they are growing.

In approaching a beehive, as far as possible keep out of the line of flight of the bees to and from the entrance, and stand behind the hive, or to one side. If there are trees or bushes nearby which force the bees to fly high when approaching the hive, it can help the beekeeper in this respect. Any stamping on the ground or vibration — e.g., from a lawnmower — will be felt by the bees and may trigger their alarm reaction, so avoid it if you wish to inspect the hives, and if you are prudent you will wear your veil if your work near the hives necessitates such disturbance. The scent of cut and bruised vegetation is also alarming to the bees, so lawnmowing is doubly disturbing.

Bees keep the interior of their hive very warm, and they do not enjoy having the roof removed on a cold, wet, windy or thundery day any more than you would. They show their annoyance in the only way they can. So except in dire necessity, wait for warm quiet weather before opening a hive. If you must do so on a bad day, plan carefully what must be done, and work fast.

4.2 Opening a hive and inspecting the combs

This is the basic skill that must be acquired, so I shall describe it in detail. I shall assume that a single-walled hive is in use. Common sense should tell you how the routine must be varied for a double-walled one.

BEFORE YOU START, HAVE CLEARLY IN MIND — EVEN WRITE DOWN IF YOU ARE INEXPERIENCED — WHAT IT IS YOU ARE PLANNING TO FIND AND DO.

- Before approaching the hive, light the smoker, and put on protective clothing. Probably the best fuel is a rolled up cartridge of hessian sacking, but a roll of corrugated cardboard is also a possibility, and I have often used a supply of dried grass (available free from any piece of rough ground), started off with half a sheet of newspaper. Make sure you have plenty of spare fuel in reserve and that the base of the fuel is well alight, and use the bellows until you are sure the smoker is producing plenty of cool white smoke. When the smoker starts to produce darker bluish smoke, it is a sign that the fuel is burning through. Re-fuel it before it turns into a flame-thrower!

- Before opening the hive, give one or two good puffs of smoke into the hive entrance, and leave the bees for about a minute for the smoke to take effect. No-one knows exactly why smoke pacifies

bees, but its effect is that when there is unsealed nectar in the hive, the smoked bees rush to gorge themselves and thereafter become much more placid. Smoke can also be used to drive bees from a particular area so that bees are not inadvertently crushed. Crushing bees, as well as being bad management, causes large quantities of alarm pheromone to be released and quickly puts the hive out of temper. If you have the misfortune to be stung at any time, then freeze for a moment and take stock. Scrape out the sting and then smoke the place vigorously to kill the sting scent and inhibit further attack. This routine should be followed even if the sting is received on a glove or other piece of clothing and causes you personally no inconvenience at all.

- After a quick reminder puff of smoke at the entrance, remove the roof, being careful to avoid bumping and vibration as far as possible. The roof can be laid down upside down on a level place somewhere conveniently within reach but out of the way. Honey supers above the queen excluder are not usually examined. They should be removed bodily and stacked inside the upturned roof. If there are several, take the crown board off the top one as you place it in the roof, and when the last super is on the stack, bump the bees off the crown board over the top of the brood chamber of the hive, and then cover the stack of supers with it. When the supers are restored at the end, make sure they go back the correct way round and in the correct order on to the hive.

  Removing a super that has been on the hive for some time is more than just a matter of lifting it off. First the seal of propolis at the junction of the boxes has to be broken by levering the boxes apart with the hive tool. As you part the boxes at one corner, puff smoke into the gap to keep bees away from the working area, so they won't be crushed as you withdraw the hive tool to move to the next corner. After all four corners have been freed, you may still find the tops of some of the frames in the lower box adhering to those in the upper box. If so *twist* the boxes apart and they should come free. This adhesion is usually worse in bottom bee-space hives, which is why they are falling out of favour. There is quite a knack in doing all this with the minimum of bumping and vibration, particularly if the super is full of honey and therefore heavy. Whenever bees are exposed during this process, give them two good puffs of the smoker. If boxes have been undisturbed for many weeks or months, the frames in the upper box are sometimes so firmly fixed to those in the lower box that the upper box is physically impossible to separate as a unit. In that case the only remedy is to obtain an empty box, and to lift out the frames from the upper box one by one, placing them in the empty box in order with the bees adhering. It is prudent to remove the propolis and brace comb from the bottom of each frame as you do so, so that when the boxes are put back together again, there is restored a proper bee space for the bees to respect. Once the upper box is lifted clear, you can also scrape the propolis and brace comb from the top bars of the frames in the box below. These are desperate measures, not needed if your hives are regularly inspected, *provided the boxes have a proper bee space between them.*

- Remove the queen excluder if there is one and examine it carefully to be sure the queen is not on it. Then lean it up in front of the hive. The bees on it will find their way home, and returning foragers will be confused by it and not bother you.

- If the queen is found at ANY time, her safe disposal must be your first thought. She should be safely escorted, by hand if necessary, on to the centre of a brood comb and replaced in the hive. Until you have found her and know where she is, assume she is on every frame you handle, and treat it with appropriate care. If you injure the queen, you have destroyed the value of your stock.

  A laying queen will hardly ever take wing except with a swarm. If you do ever have a queen fly off, then leave the frame tops exposed and wait ten minutes with no smoking. She will almost certainly return to the scent of the hive.

- Sometimes a hive has two boxes for the queen to lay in. In general if two boxes are to be inspected, it is best to lift off the upper one, and to start by inspecting the lower one, as then bees are not driven down as the upper combs are inspected, making a very crowded lower box when you come

to it. However if the two are badly stuck together with propolis, you will have to start with the upper one (see above).

If the upper box is lifted off first, stack it separately from the supers to avoid the risk of letting the queen get into the honey supers, preferably in another hive roof, and cover it with something else. Never leave unattended frames exposed. The bees become agitated, and in cool weather the brood may become chilled. It also tempts bees from other hives to start robbing the honey which soon leads to PANDEMONIUM.

- Smoke the tops of the frames in the box to be inspected, but do not puff too much smoke down between the frames — just enough to keep the bees down — and scrape off any brace comb built on the tops of the frames with the hive tool. There may be some drone brood among it if your inter-box space is a little too wide, but its loss is of no great importance. It is best to have with you a container for holding the scrapings, so that they can be disposed of away from the apiary, again to reduce the risk of tempting the hives to start robbing one another.

  Place a cover cloth over all the frame tops and roll it back from one side to expose the first two frames.

- While actually inspecting, use as little smoke as necessary to keep the bees subdued. With the hooked end of the hive tool, free the end frame by a horizontal twisting movement (or the dummy if there is one), lift it slowly and carefully out to avoid crushing bees. Inspect it carefully to be sure the queen is not on it — she will usually be found on a central frame where egg-laying is actively going on, but you never know. If she is NOT there, then this frame (or preferably the dummy) should be propped beside the hive. If it is a frame and contains brood, remember it must not be left out long enough to become chilled.

  Now free and lift the second frame, inspect it and return it to the place of the first frame or the dummy, without turning it round. In inspecting a frame, try not to hold it out horizontally, but turn it so that it is at all times supported by its wooden frame. This is especially important with new “green” combs full of honey which can sometimes drop out of the frame under their own weight. Also as far as possible hold frames over the hive in case the queen should drop off and be lost in the grass.

- At this stage bring the rolled-up second cover-cloth into use, by starting to unroll it over the frame you have replaced. Now work steadily across the box, lifting and inspecting each comb in turn and replacing it next to those you have already examined. As you work, move the slot between the cover-cloths with you by unrolling one and rolling up the other. Use only what smoke is necessary to keep the bees quiet. If you find a mass of them starting to pour out of the hive entrance and crowd up the face of the hive, you know you are over-smoking them.

- The *last* comb can be replaced in its own place. Then expose the side of the box where you began by rolling up the second cover-cloth, smoke there, and, using the hive tool as a lever, move the whole block of combs away from you back to its proper place. As the gap at the far end closes, smoke it to drive bees away before they are crushed. If metal ends are used they may buckle under the strain of this operation so that combs must be replaced one at a time. This is more disruptive to the hive and is another reason for avoiding metal ends. There will now be space to replace the first frame or the dummy in its proper place, again using smoke in the gap so that bees are not crushed. Note that if a dummy is in use, this last stage can be avoided, by simply placing the dummy at the other side of the box. No *combs* are moved by this operation and next time you simply start at the other side. Finally use the hive tool at each end of the block of combs to lever them close together into a solid block and to ensure that there is a bee space at each end of the block.

- If there is another brood box, it may now be replaced and examined in its turn — or the top one removed, stacked and covered if the inspection is top down. However if a primary objective of the

inspection is to find the queen, then the top box, if stacked initially, should be examined *where it is* if the queen was not found in the bottom box, or the queen may run down from the top box into the bottom box before she is found.

- After all the brood boxes have been inspected and replaced, cover the top box temporarily with a cover-cloth. Then bump any adhering bees off the queen excluder in front of the hive by knocking the edge of it against the palm of your hand. Clean any brace comb off the excluder with the hive tool, being careful not to bend the wires or open up the slots, or it will no longer exclude the queen.

  Then quickly but gently remove the cover-cloth, give a puff or two of smoke over the frame tops to clear them of bees, replace the excluder, and on it stack the honey supers in the order they were in before they came off. Lastly bump any bees off the crown board into the top super and replace it, using a little smoke if necessary to avoid crushing bees.

I have described this in great detail. Your own working practice will almost certainly vary from this a little, but it is important to develop a well-organised systematic routine that becomes second nature, so that you can concentrate on the *objects* of your inspection. As a beginner you will want to practise this for its own sake, but remember that it is disruptive to the colony, and you should in general not look into a hive more than once a week unless it is really necessary.

4.3 Spring inspection

It is important to inspect hives briefly as soon as spring weather permits.

In March, even if it is cold, each colony's food supply should be checked, but this does NOT constitute an inspection. An experienced hand can usually determine by "hefting" — lifting one edge of the hive a little from below — whether there is still enough weight of honey left in it. If in doubt, put on your veil, light your smoker, briefly lift the crown board and ONLY IF NECESSARY give a little smoke to drive the bees down. If no bees are visible, then, if they are not dead already, all is well — they are down below a good "crown" of honey. Close the hive up and wait for a warm day. If bees are up, then free one *central* top frame and lift it half out. If it has NOT got at least an inch (2.5 cm) wide band of sealed honey at the top, assume the bees are runnning short, replace the frame, tighten up the frames, close up the hive, put on a feeder and start feeding sugar syrup, if the weather is reasonably warm. If it is very cold, this feed will have to be in solid form as candy placed directly over the cluster of bees in contact with them. See the Appendix to this chapter for a candy recipe. Do not over-feed at this stage, or you will encourage the bees into excessive early activity which is self-defeating, and more importantly you will clog up with syrup all the empty cells in the brood frames where the queen should be starting to lay, and you will make the bees feel the hive is congested very early. This is likely to encourage early swarming which you do NOT wish. A maximum of 2 to 3 kg of sugar as syrup should allow the bees to survive until the weather warms up, unless the spring is very late and cold.

The true spring inspection should take place on the first day you are free when the sun shines and you are comfortable without a jersey — temperature over 16^0 C (60^0 F) — and when there is not too much wind. There will be no honey supers on yet.

Have a clean spare floor with you. Lift off the roof after smoking at the entrance as usual. Then quickly stack ALL the brood boxes of the hive inside the roof. Carefully remove the hive floor from the stand, but do not shake off the adhering bees or the debris. Clean away quickly any rubbish from below where the floor was, and place the clean floor on the stand, and by wedging it up if necessary, make sure it does not rock, and that it is level from side to side and slopes slightly from back to front, so that any rain that blows into the entrance will drain out. Replace the bottom brood box on the clean floor, and if there is more than one, cover the other(s) with the crown board. Now begin an orthodox inspection of the brood boxes as described in the last section. You have four questions to settle, all related to one another:

1. Is the colony queen-right?
2. Is the colony healthy?
3. How far developed is the colony?
4. Is there sufficient food for the colony?

1. To anwer this question, you do NOT have to find the queen, though it is always reassuring if you do. The real proof of this however is the presence of developing brood in all stages including SEALED BROOD WITH WORKER CAPPINGS, and a HEALTHY PATTERN OF EGG-LAYING, with brood spreading out in concentric ovals from the central area where egg-laying started, so that the open brood is on the outside with eggs beyond that — unless the "first round" is already emerging as young workers, and the queen is starting again from the middle.
2. Pests and diseases of bees are a large topic dealt with at length in Chapter 6. Here is only a brief description of what is to be expected in a healthy colony; of some common but not too serious problems that are often found; and a brief indication of how to look out for the few really serious problems that need to be watched for. Thankfully most of the serious diseases are rare.

   Healthy **brood** will appear in the spring as concentric ovals of brood in all stages of development as described above. Look for *eggs* in particular to be sure a laying queen is present. The *open brood* should consist of pearly white larvae lying curled up in the bases of the cells with a small amount of whitish liquid bee milk. The *sealed brood* should be in even slabs of pale brown roughish cappings all of uniform appearance. At the end of its development phase there will be gaps in the pattern where bees have emerged, and you will probably see young adult bees emerging as you look at the comb, looking rather under-sized and covered with greyish downy hair. If the pattern contains too many gaps early on, it may be a sign of a failing queen.

   The most common but not too serious problem with the brood is *chalk brood* where isolated uncapped cells among the sealed brood contain chalk-like mummified dead larvae. Try to avoid damp, and scrap old combs to reduce the level of this fungus infection.

   The two rare but serious infections of the brood are American Foul Brood (AFB) and European Foul Brood (EFB). AFB shows as dark sunken cappings among the sealed brood covering rotting smelly remains of dead larvae that can be drawn out into a slimy "rope" with a matchstick. EFB shows as contorted "melted down" dead larvae among the mature open brood.

   After winter there will inevitably be some dead bees on the floor and outside the hive, but the living **adult bees** should all be active and healthy looking. Watch out for brown fouling of the combs and frames indicating *dysentery* which may have several different causes.

   Now that *Varroa* has spread widely Scotland, monitoring and dealing with this infestation has become a permanent necessity in this area and elsewhere. The details of how to do so are in Chapter 6.

   If *wax moths* get into a hive (looking something like clothes moths) their larvae can quickly wreck large areas of comb which they reduce to a crumbly brown frass. They are usually more of a problem in combs (particularly brood combs) stored away from hives. Stored combs which become infested should be burned, and any wax moth pupae adhering to and concealed in crevices of woodwork destroyed. Wax moth infestation in a working colony is usually a sign of a weak colony. Get rid of the worst of the infestation, and try to clean things up as best you can.

   If *mice* get into a hive, it is obvious, as they wreck the combs, eat the honey and kill the bees. Fit mouse-guards in autumn to avoid the problem in future. If any bees are still alive, they need to be fed, and urgently given clean combs (not foundation) to try to rescue them. This is not easy to achieve and usually mouse-infested stocks die.

Slugs often take up residence in damp hives with weak stocks. Kill them, don't just throw them out, or they will return. Try to keep hives dry and strong.

If you find suspect brood comb, unhealthy looking bees or strange creatures in the floor debris, then send a 5 cm square of comb, or a sample of 20 to 30 adult bees (killed by an hour in the deep freeze) or as much floor debris as you can collect in a *cardboard* box or *paper* envelope (NB NOT plastic which rots the sample) to the Scottish Agricultural Science Agency. Their full contact details are given in Chapter 6 later. Remember to enclose a covering letter giving your name and address, explaining what the sample is, what problem you suspect and saying where the bees are kept. You will be sent a FREE EXPERT DIAGNOSIS. This is a valuable service, so use it sensibly.

The two serious conditions AFB and EFB, and two other infestations which have thankfully not yet appeared in this country are legally notifiable diseases. If you find you have any of them, you are legally obliged to notify your local office of the Scottish Government Rural Directorate (SGRD). The contact details are given in Chapter 6.

Infestation by *Varroa* is now endemic in virtually the whole of Scotland apart from some of the outlying islands and the extreme north and north-west. Because it had become so widespread, it was in 2007 removed from the list of notifiable diseases by the Scottish Government.

3. The development of the colony can be assessed by noting how many combs are occupied by the brood nest as it spreads out from its winter centre. I sometimes liken its development to the spread of a fire through the kindling and fuel laid out in a grate. Once it occupies all but the two outside combs on each side, the time has come, if the weather is fair, to put on the first honey super over a queen excluder. Do this too early rather than too late, or your hive may swarm before the end of May. Always ensure throughout the summer that you give ample room for the storage of honey.

4. A *full* brood comb of honey holds about 2.5 kg (5 lb). A *full* shallow comb holds about 1.5 kg (3 lb). Total colony reserves should never be allowed to fall below 5 kg (10 lb), and if they are falling to near this level, the beekeeper must be prepared to feed if the weather turns cold or wet, especially if this happens in the middle of summer when colonies are large and active and can soon use up a small reserve.

   On the other hand if excessive reserve slabs of sealed honey or sugar syrup in the brood combs are restricting the queen's laying space, an excellent way of stimulating rapid development is to break with the hive tool the cappings over these slabs in two combs adjacent to the brood nest. The bees will then clean out these cells and prepare them for the queen, re-storing the honey elsewhere, provided you have given them room to do so, which you should have done. The extra feeding also stimulates the workers to greater activity.

After completing your spring inspection and closing up the hive, carefully examine the debris on the old floor you removed and laid aside. Quite a lot can be learned from the pattern of winter debris on it. If it is wet, almost certainly the hive roof is leaking, or the slope of the hive is failing to drain out rainwater which blows in. The cause should be determined and remedied immediately. Then clean this hive floor thoroughly by scraping it with the hive tool, and if possible scorching it with a blow-lamp to disinfect it. It can then be used to replace the hive floor from the next hive that will be inspected.

One of the measures now adopted by many beekeepers to help in the control of *Varroa* infestation is the use of *open mesh floors*, through the mesh of which any dislodged *Varroa* mites will fall to become chilled and die. When these are in use the necessity to supply a clean floor for each hive at spring inspection is less urgent, but the floor should nevertheless be inspected, and any accumulation of debris on the floor removed. Also no tray should be left below such a floor except for a short period, since the accumulation of debris on the tray provides an ideal breeding-ground for wax moths.

Chapter 5

Swarm control and other special tasks

5.1 A swarm control system

More has been written in modern beekeeping books about the control of swarming than about any other topic. Swarming is a natural part of the bees' reproductive process and is therefore an impulse that is very hard to suppress altogether. However modern hives make it very easy for the beekeeper to increase the number of stocks in summer as and when it is desired to do so, and the bees' inclination to do so naturally at a time of their choosing to a place not usually in the beekeeper's apiary is now reasonably regarded by beekeepers as a nuisance which unnecessarily divides and diminishes their honey-gathering stocks. Add to this that a swarm which absconds and sets up home in the disused chimney of a house — a very common destination of a swarm left to its own devices — very often becomes a severe nuisance to the householder, as the worker bees usually find their way behind the plasterwork of rooms in the house and emerge into the rooms where they cause alarm and confusion, and you will understand that a beekeeper who allows swarms to fly at will these days is not the most popular person.

The system I shall describe here is a variant of the *Demaree system*. There are many others and they are well worth studying. None of these sytems gives a 100% guarantee of avoiding all swarms. You may well have to deal at some time with a swarm from one of your own hives, as well as strays you may find or be called to deal with by others.

Almost all satisfactory systems of swarm control are based upon the same principle, namely that if the queen and her retinue of attendant workers can be physically separated from the bulk of the brood nest, and in particular from the stimulus of developing queen cells, then they will begin a new brood nest and will as an *artificial swarm* move on to the post-swarming phase of the colony's life-cycle.

The Demaree system requires the use of a second reserve brood box for each hive to be treated, equipped either with frames with foundation or preferably with drawn combs. I find it prudent, when possible, to keep a second such box on each hive throughout the year. In winter the bees have full access to both brood boxes. In summer I keep the reserve brood box above the queen excluder as a larger honey super until it is needed.

In May most colonies will build a number of queen cups throughout the brood nest. The first step in swarm control is to detect the time when the bees start to rear queens in some of them. This involves inspecting the brood nest at intervals of no more than nine days, so that there is no time for a queen cell to be sealed without the beekeeper's knowledge. Inspections should start in mid-May and continue until at least mid-July.

As soon as an occupied queen cell is found at an inspection, the swarm-control system must be put into operation, although as a temporary holding measure ALL queen cups within the brood chambers may be destroyed *provided eggs are present in the brood combs.* However then the colony

must be dealt with again within five days, since the worker bees may choose to treat this situation as an emergency and convert some of the developing worker larvae into queens.
The swarm-control procedure proper consists of the following steps. You will need altogether three solid stands on which to place boxes from the hive you are dealing with. One can be the roof of the hive you are treating. Use roofs from other hives, or make suitable preparations beforehand for the other two places.

- Remove and stack inside the roof of the hive you are dealing with the honey supers. That may already have been done if you are carrying out swarm control as a result of what you have just found in the course of an inspection.
- Remove a comb from the centre of the reserve brood box and place that box on the second stand fairly near where you are working. Keep the spare comb handy. You will need it at the end.
- Next — the hard bit — look through the brood nest and FIND THE QUEEN. She will be on a comb you are inspecting. If you prudently marked her in April it makes the job easier. Keep your eye on her to make sure she stays on that comb. Remove any developing queen cells from that comb, and place it with adhering bees and queen into the empty space you made in the reserve box, and cover that box temporarily with one of your cover cloths.
- Cover the brood nest with your other cover cloth, remove it from the hive floor, and place it on the third spare stand. It is now without the queen but still with developing queen cells.
- Place the box which now contains the queen and her retinue, on the hive floor.
- Put the queen excluder above this box, then the honey supers which you can cover with the cover cloth that came from the box now housing the queen.

That concludes the main part of the operation, but you still have the queen cells to deal with. Two courses are open to you.

1. If you wish to *make increase* or *rear a new queen*, then make up a nucleus from what is now the old brood nest by transferring a comb with at least one well-developed queen cell, two or three combs well stocked with honey and pollen, and two more combs of mainly *sealed* brood into a nucleus box or spare brood box. Be very careful that you do not damage any of the queen cells you are using. Shake into it the workers from three or four more combs, as most of the older workers will desert the nucleus and return to their old home. Don't include too much brood, especially unsealed brood, as it may well become chilled in the small nucleus, and keep the brood all together in the centre of the nucleus box, where the queen cell(s) must also be. Place the nucleus box in a quiet corner, making sure it is adequately protected from the weather, and that it has only a *small* entrance, easy to defend, and do not disturb it for at least a fortnight.

   After making up the nucleus, go through the remaining frames of the old brood nest and remove all the queen cells and cups. Be thorough, shaking the bees off every comb to make sure you don't miss any. That box can now be placed right on top of the honey supers of the hive. The space in it should be filled with the spare comb that came out at the beginning and enough further frames of foundation or drawn combs if you have them to fill the space. Finally replace the crown board and the roof. A further inspection of the top box must be made five or six days later. It may reveal an attempt by the workers in it to raise one or more emergency queen cells. These must be removed to prevent further attempts at swarming, but thereafter the stock should settle down.

2. If you do not wish to attempt to raise a new queen, then simply carry out the operations detailed in the second paragraph above, to ensure that no queen cell is reared in the old brood nest. After six days all the larvae in the old brood nest should be too old to convert to queens and it can be left to look after itself. One further inspection may be prudent however, since determined bees

sometimes produce queen cells from worker larvae that are really too old resulting in poor queens which can nevertheless still stimulate the colony to swarm with the old queen.

The queen in the bottom box of the original hive is now busy establishing a new brood nest, and has ample room. It is unlikely that more queen cells will be built there for two or three weeks provided the bees have ample space, but do check within a week since if the bees have really got the swarming fever they may not settle down. The only remedy then may be to remove the old queen, and let the bees re-queen themselves as though it was a swarmed stock.

The top box with the old brood nest will gradually become a honey super as the brood in it emerges and goes down to join the queen in the bottom box. One problem that arises is that any drones which emerge there will be trapped above the queen excluder, and an attempt should be made to release as many as possible at routine inspections.

If further swarming attempts are detected later, the operation can be repeated, simply reversing the roles of the two boxes. However if a young queen has been successfully reared and mated, and is laying in the nucleus, it may be a good idea to re-queen at this time and get rid of the old lady who is so determined to leave you. For the procedure, see later on uniting stocks.

5.2 Help! I can't find the queen

Finally here is a way of dealing with the situation when you CANNOT FIND THE QUEEN. You will need one more brood box. Remove the old brood box containing the brood nest, the queen, and the developing queen cells on to a stance just behind the hive and beside it on another stance place another completely empty brood box. Place the reserve brood box on the hive floor, after removing one central comb, and above it place an empty honey super with no frames in it. Now remove the frames one at a time from the old brood box, inspect each frame to try to find the queen, but if you do not see her, shake all the bees from that frame down into the empty super on top of the frames of the reserve brood box so that they can crawl down on to the empty combs in that box, and put the comb you are holding, now without bees, into the empty brood box. Work steadily and calmly in this way across the whole of the old brood box, using smoke as necessary. If you find the queen now, revert to the original method by placing the comb containing her (after removing queen cells) into the gap, but if you do not, you can be fairly sure after you have shaken the last frame that you have transferred her successfully. Then as a last precaution shake the adhering bees from the old brood box into the empty super above the box on the hive stand, along with the rest in case the queen is there, and finally smoke and shake the bees down from the empty super into the reserve brood box, remove that super, fill the gap in the bottom box again with the comb you removed, put on the queen excluder, put the honey supers on, and place the old brood nest right at the top, after either destroying all the queen cells in it, or leaving one good one if you want to make up a nucleus.

You will not be able to make up that nucleus immediately if you work like this, since you will have shaken all the bees out of the brood nest. However when you have reconstructed the hive with the brood nest on top, the nurse bees will quickly return to the new top box to tend the open brood there, and next day, or after a period of at least two hours, you will be able to make up a nucleus as you would have done if you had found the queen in the orthodox way.

5.3 Catching a swarm

When you find a swarm — your own or somebody else's — it is one of the most delightful parts of beekeeping to deal with it, if it is in an easy place. This is particularly so if it is in a stranger's garden who doesn't know about bees. All sorts of passers-by are willing to stop and watch from a distance while you work what looks like big magic, when in fact with a placid newly-emerged swarm it is child's play.

In a hard place — up a high tree, in a chimney, under the eaves of a roof — it is less fun; and you may break your leg or your neck, although the bees still won't hurt you.

However if the swarm has been out for a few days and is stale, they will have used up their reserves of honey and be far less amiable. Then be sure your veil is secure.

A swarm can only be taken when it has clustered. Ideally it will do so as my first one did from a few slender twigs low in a privet hedge, hanging there like a bunch of exotic fruit, with a few bees buzzing around it.

Necessary equipment:–

- veil and protective clothing;
- smoker, fuel and matches;
- a cardboard or other open box at least 30 cm (1 ft) cube;
- a dustsheet;
- secateurs;
- a small stone;
- a piece of string;

Method: Put on protective clothing. Light the smoker. Approach the swarm quietly with *no* smoke. Place the dustsheet on the ground below the swarm cluster. Place the box on the dustsheet. Gently grasp the twigs above the swarm cluster and support its weight — up to 3 kg (6 lb) of bees, so quite heavy. Cut the twigs with the secateurs *above* your supporting hand. Lower the swarm gently into the box. *Slowly* and *gently* invert the box on the sheet and prop up one corner with the small stone, so that there is a gap for bees to fly in and out. Most of the bees will cling to the inside of the box and cluster there.

By now quite a few bees will have taken wing. Smoke their old clustering place *heavily* and use smoke to break up any clusters forming away from the box. KEEP SMOKE AWAY FROM THE BOX. Provided the queen is in the box — which she almost certainly is — the bees in and around the box will start to fan out scent from the box at the propped up corner wth their tails up exposing the scent-giving *Nasonov organ* at the tips of their abdomens. As they do so more and more of the flying bees will re-join the main cluster in and around the box and gradually enter the box to join the rest of the swarm.

Wait till you are satisfied that you have 90% or more of the swarm in the box, gently remove the stone, fold the sheet up over the box, tie it securely with the string, and put your prize in a cool sheltered spot until evening, making sure they have adequate ventilation.

If the cluster is in a slightly harder place like a wall or a large tree branch, then as much of it as possible must be *knocked* or lifted by handfuls and *thrown* firmly into the box, which is then inverted as before. If you find the queen, cage her in an empty matchbox, just open a crack, and place her in the cardboard box beside the bees. The rest of the swarm will then join her.

Having got as much as possible of the swarm into the box, proceed as before. The bees will *always* return to the queen, so you *must* get her in. Until the cluster in the box is well-established with the queen there too, the swarm will keep trying to re-cluster where it first was, because the queen's scent clings there, and even after the main body are settling down in the box, clusters will keep trying to re-form on the old place, and there is always the danger that they may entice the queen back to join them. If it is feasible to give that place a dab of old car engine oil, it quickly cures that problem.

5.4 Hiving a swarm

In the evening the swarm must be hived, which is another fascinating operation. Prepare an empty hive (have you got a spare one?) on what is to be its permanent stand, with a floor, brood box fitted with sheets of foundation, a feeder, a crownboard and a roof. Put thin sugar syrup into the feeder before you hive the swarm.

Sloping *up* into the entrance with *no gap* lay a board of plywood or hardboard or other convenient material (hiving board), about 45 cm by 60 cm (18 in by 2 feet), and lay a white sheet over it.

As the sun is setting bring the swarm to the hive, carrying it gently in its wrapped up box. Put on your veil and protective clothing, open the box and bump the swarm out firmly on to the hiving board, making sure that you have knocked all the bees out of the box. They will not fly much at that time of day, which is the reason for waiting till evening, but will spread out like liquid on the board. Gradually a few leading bees will start to run up the board and when they find the hive with its inviting smell of beeswax, will start to fan scent to call the others. Like an orderly army on the march the swarm will walk in and take possession. It may take two hours for all to enter. If you watch carefully you may see the queen go in. Once you see them beginning to march in in a body you may leave them. Next day remove the hiving board.

A newly hived swarm should be fed generously with sugar syrup. They will repay you by drawing out beautiful straight combs of worker cells on the frames of foundation you have given them.

After a day or two, look in quietly and remove any frames the swarm is not covering. Put a dummy at one end of the remaining block of combs and move the block gently over to the opposite side of the hive. Fill the resulting empty space with loosely folded rags or crumpled newspaper to prevent the swarm from clustering there and drawing wild unframed comb hanging directly from the crownboard. Swarms love empty spaces so this is a very necessary precaution. The frames removed can later be replaced one at a time as the new colony develops and needs the space.

An inspection after a week or two should show a healthily developing brood nest. Remember however that not a single new worker can emerge from it until three weeks have passed, and that until then the swarm will dwindle through natural losses.

5.5 Dealing with a swarmed stock

If the swarm came from one of your own hives, then you must at all costs prevent the issuing of *casts*. Sometimes a swarm may have gone without your knowledge. If an inspection shows a depleted hive and several queen cells, some sealed, you will know that they have gone beyond recall, and that your hive is for the meantime queenless. While it remains queenless it will be short-tempered. There are two possible courses of action.

The first is to write off the hive as a production unit of honey for the season, but to treat it as a potential source of young queens. It may be possible to make up from its brood frames 3 or 4 viable nuclei, with one queen cell each. This should only be done if the hive had proved itself earlier as having a strain of productive and gentle bees. If this course is taken, the honey supers can perhaps be given to other hives to finish, after shaking off most of the bees into the nuclei.

The second course is to see that the hive re-queens itself at least as fast as possible, and builds up again for the later part of the season. Note however that a new queen hatching in a well-populated stock takes a very long time to get mated. The natural order of things after a hive has finished swarming without interference, is for a new queen to emerge into a depleted hive, and in these circumstance it is found that she is much quicker to go out on her mating flight and to start laying.

To achieve the re-queening of a full stock after it has swarmed, the brood combs should be inspected until a well-formed but preferably *unsealed* queen cell, well placed in the middle of a comb is found. The bees should then be gently *brushed* from this comb, and any other queen cells on it destroyed. The top bar of this frame should them be marked with a drawing-pin and the comb gently

and carefully replaced in the hive. That queen cell is your precious new queen and must be handled with care.

Next the bees should be bumped off every other brood frame in turn into the hive and *all* other queen cells destroyed. Don't miss any.

N.B. Always locate and mark the queen cell you are going to KEEP before any queen cells at all are DESTROYED.

If in going through the hive you come across a newly emerged virgin queen, or, as quite often happens, one issues from a cell when you break the top with your hive tool, ALL other queen cells should be destroyed. It actually doesn't matter if more than one virgin gets loose, since without a sealed cell to leave behind, the hive will not swarm. Instead the workers will let the virgin queens settle their differences in the usual way.

If there is still open brood in the hive at this stage, further inspections three days and six days later are needed to make sure the bees have not constructed new emergency queen cells on some of the young larvae. If they have, these must also be destroyed.

The stock should now be left for ten days or so, and then the marked queen cell sought out to make sure that the new queen has emerged as shown by a neat round hole at its lower end. The stock must now be left for the new queen to mate and begin laying.

As stated above a virgin queen in a small nucleus usually mates and begins laying much sooner than one in a large prosperous colony. Initially the swarmed stock will in fact recover strength quite quickly as the old queen's remaining brood matures and emerges. However after three weeks this is followed by a steady decline, since the gap in egg-laying after the swarm's departure means that there is then a corresponding gap in the emergence of young workers. If you have available a young mated queen in a nucleus to re-queen the swarmed stock immediately, this will avoid the long decline caused by a long gap in egg-laying. Note however that if you are going to re-queen with a young mated queen, you should destroy all queen cells, wait five days and destroy any further late queen cells, then wait another five days and check again for queen cells, at which point you may unite the stock with the nucleus (see later on uniting stocks). If you unite them earlier, the old stock may still have the swarming fever and fly off with your lovely new queen.

A swarmed stock that has re-queened itself or has been re-queened will not usually swarm again that season, but needs to be nursed back to strength.

5.6 Hiving a swarm on the site it came from

If the swarm that emerged was caught, a slightly different plan often works well.

In the evening remove the hive that has swarmed to a new site, and on the old site place a new brood box with empty combs or frames of foundation, but one frame of sealed brood from the swarmed stock after destroying any queen cells on it. Hive the swarm in this new hive on the old site, and then top it up next day with a queen excluder and the supers from the old hive. Usually the swarm will settle down and do well, as they will be joined by all the foraging workers from the old hive who of course make their way home to the old site. The old brood box on its new site should be treated as a swarmed stock in the usual way, and when its new queen is laying, the old queen can be destroyed and the two stocks re-united (see on *uniting* later on). With luck this will become a really powerful stock for late sources such as heather.

5.7 Moving bees: the heather flow

Foraging worker bees have accurately memorised the site of their home. If it is moved more than about 1 metre (3 feet), they will not be able to find it and will cluster on the old site when they return, become chilled at night, and die.

The only exception (apart from when they swarm) is that if their home is moved more than about 5 km (3 miles), they will be in completely unfamiliar territory where they are forced to re-learn everything, and will not return to their old home. Hence the rule for moving bees — "Less than 3 feet or more than 3 miles". When nuclei are set up in the home apiary it must be remembered that by this mechanism they will lose most of their foraging workers, retaining only the young nurse bees, who will gradually mature into foraging workers with a new base. Apart from their small size, this is why such nuclei are weak in guard bees and tend to be robbed by other colonies unless they have small entrances, easy to guard.

For long moves such as are made to the heather over distances greater than three miles, motor transport is obviously needed. On the day *before* the move, the hive boxes should be arranged with adequate empty super storage space above, but with enough stores in the hives to ensure that the bees do not starve if the weather turns bad. The crown board should be replaced with a travelling screen of perforated zinc or wire mesh to give complete top ventilation. The boxes should then be securely fastened together with ratchet straps, or by nailing battens to them, or by some other method. Whatever method is used, it must also ensure that both the floor and the screen board on top are secure. Means should also be laid ready for the final shutting of the hive entrances. A strip of foam rubber is extremely effective and is less trouble than the traditional wooden entrance block. Then the hive roofs should be replaced and the bees left to fly until the actual time of the move.

Next evening, as soon as the bees have stopped flying, the hive entrances should be closed and the roofs removed to give top ventilation through the travelling screens. In hot weather a powerful stock completely enclosed without adequate ventilation can in its panic quickly raise the temperature inside the hive above the melting point of beeswax. The bees and brood will then be engulfed and drowned in the collapsing mess of honey combs.

Hives are then loaded up for transport and driven to the new site. There is much to be said for leaving this move until early morning since placing of the bees on the heather site can then take place with dawn breaking, rather than with the sun setting to leave you to blunder about in the dark. Of course you must have obtained permission to place your bees on the moor, and if you are prudent you will have been there a week or so earlier to reconnoitre and prepare hive stands.

Place ALL the hives on site before releasing ANY. You must aim to have this completed before 10 a.m. at the latest. Then put on your protective clothing and quickly open each hive, immediately replacing the roof so that the flying workers do not cluster on top of the screen and become trapped. Then leave the bees to settle.

A later visit can be made and warm packing placed above the travelling screen to conserve heat. Bees at the heather are notoriously ill-tempered so be prepared!

The return from the moors is just the same operation in reverse, but is less fun as the days are shorter by September, the weather is usually worse, and if you have been successful the hives are much heavier.

5.8 Removing honey

Once a honey super is full and the cells are capped it is ready for harvest and may be removed. A glance inside heavy supers will show when this is so. If the honey is even in part from the Oil Seed Rape crop, and you wish to extract it by spinning, it is vital to take it off promptly, since this particular honey granulates very quickly and very hard in the comb. If you leave it too long, you will have no option but to break up the combs and soften the honey again with gentle heat, or else to sell or use the honey as honey in the comb. It is worth while emptying and replacing supers if they are filled before the last flow, and of course this should be done before moving to the heather. Note however that you must at all times ensure that you leave on the hives a sufficient reserve of honey to tide them over a few weeks of bad weather when they cannot forage for more. As was said earlier, bees in their active summer mode use much more food than when they are clustered for winter, and can quickly starve if this precaution is not observed.

To remove a super, lift it off the hive, replace all the other boxes if it was not the top super, place the crown board on next with two Porter bee-escapes fitted into the two feed holes, or instead use another type of clearer board. Then put on the full super and finally the travelling screen to make the super bee tight apart from way down through clearer board. Then replace the roof. In twenty four hours almost all the workers in the full super will have gone down through the clearer board to re-join the queen and the rest of the colony and the super can be removed without further disturbance of the colony. Do not wait longer than this, or the honey may start to granulate in the comb, or robber bees may find a way in and remove the honey. Also if Porter escapes are left on the hive too long, the bees will jam the springs with propolis rendering them ineffective, or else, if another type of clearer board is in use, the bees will learn how to get back through the maze and will rob out the honey.

When Porter escapes are removed, and feeding is not going on, the holes in the crown board should be covered with pieces of scrap wood, or something else convenient, to prevent the bees from accessing the space under the roof and building wild comb there, which would make it difficult to lift the roof off.

5.9 Uniting stocks

It is often desirable to unite together two stocks, particularly in autumn, so that a weak stock need not be wintered. If a young queen has been raised in a nucleus, this is the way to use her to replace an older queen, particularly one that has been involved in swarming.

Bees from different stocks will fight one another if indiscriminately mixed, so precautions must be taken.

The job is most easily done if no honey supers are involved and the best time is in the autumn after all these have been removed. The stock with the new queen must be housed in a full-sized brood box able to sit above the original hive. It does not need to have all the space in the box filled with empty combs if it was a nucleus, but the last comb should have a dummy outside it, the combs being packed to one side of the box.

If the stock being re-queened is not queenless, the queen to be replaced must be found and destroyed, preferably in the early afternoon, and then all left quiet until sunset. At sunset, quietly and with as little disturbance and smoke as possible, remove the roof and crownboard from the now queenless stock, and cover it with a single sheet of newspaper, which can be secured with drawing pins if it threatens to blow away.

Then take the roof quietly off the other stock, but leave the crown board on. Lift its box away from its floor and place it gently on the newspaper, taking care not to tear it, but squaring the boxes together. Then replace a roof and leave them alone for a week.

The bees will chew their way through the newspaper and unite peacefully, as their scents will be mingled by the time they can get at one another. A mess of chewed up newspaper outside the hive entrance next day is a sign of success.

After a week combs may be readjusted as you please between one or two boxes to give good wintering conditions.

If uniting when honey supers are on, then the excluder should be placed *above* the supers when the old queen has been destroyed, and the newspaper should be laid on it or under it. At the readjustment a week later, the new queen with her brood nest should be moved below the supers and united with the other nest, and the normal pattern restored. It may be necessary at that time to remove a few emergency queen cells from the old brood nest, since the new queen was so widely separated from it for a week.

5.10 Feeding bees

If remaining stores are inadequate in September, or if stores are short in spring, or if a swarm is hived, bees should be fed with sugar syrup.

Feeders for feeding syrup are of several types. A *contact* feeder consists of a jar or pail with a lid perforated by several small holes. Inverted over a hole in the crown board it will be slowly emptied by the bees as long as the holes are small enough to allow a partial vacuum to appear in the pail so the feed doesn't all run out at once. It must be protected by an empty super which holds the roof clear.

Much more rapid feeding is achieved by various patterns of *rapid* feeders of which the best and most capacious are the overall Miller and Ashforth designs that need no super to house them. I regard the other patterns as rather footling. Bees will take down and store in one or two days a 3 kg feed from an Ashforth feeder which allows stores to be rapidly brought up to an adequate level and ripened by the bees in September. The principle of all these feeders is that the bees are allowed access to the surface of the syrup through a narrow slot, so that they don't fall in and drown themselves.

For spring feeding or the feeding of a swarm, such rapid feeding is less desirable, since it is not the aim to fill the combs then with sugar syrup, or the queen's laying room may be restricted. Feeding smaller amounts over a longer period is then better, and a contact feeder is probably best.

If bees are found by a quick glance under the crown board in mid-winter to have eaten their way up through their stores, solid food must be given in contact with the bees, since they will not enter a feeder at that time of year, and any syrup given will not be ripened, but ferment and give the bees dysentery. The traditional solid feed is candy made from sugar, for which a recipe is given in the Appendix to this chapter. Alternatively Archie Ferguson's trick with sugar bags may be used. That too is described in the Appendix. The solid feed must be placed in direct contact with the bees at the top of the cluster, either by placing it over the feed hole in the crown board if the bees are under that hole, or by removing the crown board and placing the candy directly over the bees. If the latter technique is used, then the cluster should be covered with an old piece of blanket or an old jumper to keep heat in, and if necessary an empty super placed between the cluster and the roof.

5.11 Preparing bees for winter

During September all colonies should be prepared for winter. Weak stocks should be united with others so that all have large enough worker populations to form viable clusters. If possible all should be headed by queens under three years old.

Every colony should have its stores checked and be fed if necessary to bring the weight of sealed stores up to at least 15 kg (30 lb) and preferably 20 kg (40 lb).

If any honey supers are being left on over winter be sure to *remove the queen excluder*, so that the queen can move up with the cluster if necessary. The workers will not abandon the queen and will stay down and starve with her if she cannot get up.

Make sure all hives are water-tight and will not blow over and that they are not rocking on their stands. Bees dislike a hive which moves when they are sleeping. Also be sure each hive slopes from back to front a little, to help any rain-water that blows in at the entrance to drain out again. If an open mesh floor is in use, this is not such a necessary precaution, as water will drain out through the open mesh.

In the first week of October fit *mouse-guards* to all the hive entrances. Special mouse-guards can be bought, but a simple and effective one consists of a strip of perforated zinc cut with a truly straight edge to the width of the entrance and fastened across it with drawing pins to leave an entrance slot NO MORE THAN 6 mm ($\frac{1}{4}$ in) HIGH. This can be achieved by resting the strip on two ordinary pencils at either end of the hive entrance as you pin it up. The bees thoroughly dislike this operation, so wear your full protective clothing while you do it, and have the smoker going or you will bodge the job.

If mice get into a bee-hive in winter they can very effectively kill it by eating the combs — honey, wax and brood. They will also eat the bees. They then nest, as they find a warm dry beehive an ideal nesting box, and they will then produce more mice to trouble you next year.

Appendix 5.1 — recipes for bee feed

Recipes for sugar syrup

3 kg (about 6 lb) of ordinary granulated sugar to one kettleful of water (about 1.75 litres or 3 pints) makes a plentiful feed for autumn use. Put the sugar into a plastic pail with a snap-on lid or other convenient receptacle. Bring the water to the boil and pour it over the sugar. Stir till the sugar is dissolved, snap on the lid and take the feed to the bees. The actual quantities can be varied to suit the capacity of your feeder, but keep to these proportions.

For spring use or for feeding a swarm, syrup with half that concentration of sugar is more appropriate.

Recipe for candy

Ingredients

- White granulated sugar — 5 measures by volume.
- Water — 1 measure by volume.

or

To each 1 kg of sugar use 180 ml of water,

or

To each 1 lb of sugar use 3 fluid ounces of water.

Equipment

- Cooking stove.
- Thick bottomed saucepan of adequate capacity.
- Wooden spoon.
- Disposable moulds to receive candy.

Method

- Prepare the moulds for the candy. Small ice cream tubs, or halves of discarded small cardboard soft drink cartons, or sheets of A4 paper with the edges folded up by about half an inch and stapled to make shallow trays are all satisfactory. These will be used to give the candy to the bees and are usually discarded afterwards.
- Place the sugar and water in the saucepan, bring to the boil slowly while stirring with the wooden spoon to prevent the mixture from "catching".
- Boil vigorously for *three minutes exactly* stirring occasionally.
- Remove the saucepan from the heat, and if possible cool it rapidly, say in a sink partly filled with cold water, while *beating the mixture vigorously with the wooden spoon.*
- As soon as the mixture starts to thicken, turn it out into the moulds and let it set.

Archie Ferguson's method with sugar bags

Buy a few bags of sugar. Without opening the bags, dip them briefly in cold water and let them dry and harden. The timing of the dipping in cold water is critical. Too short a time and the sugar fails to harden, too long and the sugar melts into a syrupy liquid. The time needed depends on the quality of the bag.

Remove the crown board and place an empty super over the hive. Tear away the paper from one side of the hardened bags, and lay them gently over the cluster of bees. Cover them with an old blanket and over all place the crown board and roof. The bees will eat their way up through the crystallised sugar as though it were candy.

Chapter 6

Diseases and pests

6.1 Introduction

In this chapter all those diseases and pests which need to be of practical concern to the beekeeper are systematically dealt with. The chapter is arranged by the types of causative agents of the problems that arise, from the smallest — the viruses, to the largest — human beings. With the exception of the *Varroa* mite however, most of the serious diseases are uncommon, so apart from dealing with *Varroa* you can expect not to have to worry often about disease.

Note however that there are **four** diseases of bees which are at present (2009) **notifiable by law**. They are **American Foul Brood**, **European Foul Brood**, infestation with the ***Tropilaelaps* mite** and infestation with the **Small Hive Beetle (*Aethina tumida*)**. If you discover that your bees have any of these then you are obliged by law to report the matter to the local Bees Officer of the Scottish Government Rural Directorate (SGRD). *Varroa* infestation had become so widespread in Scotland by 2007 that in that year this was removed from the list of notifiable diseases.

6.2 Viruses

The systematic study of viruses is fairly recent, as it is only since the development of the electron microscope that it has been possible to see these tiny entities, which are in fact not independent living creatures. Each one consists of just a small amount of either DNA or RNA — the stuff of the genetic code — surrounded by a protein coat and little more. They can only reproduce by gaining entry to a living cell, usually a specific cell type of a much more complex organism, and inside the cell taking over and turning most of the cell contents into further copies of the virus particle. The dead cell then bursts open releasing the new virus particles to infect further cells of the host organism, or to be released into the outside world to seek a new host. The most successful viruses are ones which can readily pass by infection from one host organism to another, but which do not seriously disrupt the life of the host, and certainly do not kill it. Most human beings who have suffered from chickenpox continue to carry the virus for the rest of their lives, and it is only rarely that the virus is *activated* or undergoes *induction* in the human's later life producing the much more serious affliction known as shingles. It is significant that shingles normally appears when a person is under severe stress, either from the pressures of life, or from some other disease, and this pattern is one which is of great importance when honey bee viruses are considered.

The work of L. Bailey and Colin Denholm at Rothamsted IACR in England have greatly extended our knowledge of the great range of viruses which are present among honeybees. Among those which have been identified are Sac-brood virus (SBV), Acute Paralysis virus (APV), Slow Paralysis virus (SPV), Cloudy Wing virus (CWV), Deformed Wing virus (DWV) and Black Queen Cell virus (BQCV).

Almost all these viruses can be shown to be present at low levels in a high proportion of bee colonies. When this is the case the colonies remain perfectly healthy, but as for shingles among human beings, when the colony comes under stress, or the levels of virus present are raised above a certain level, the colony begins to suffer as a result.

Sac-brood virus causes a failure of affected larvae to moult properly. The moulted skin fails to detach itself from the larval head, and the larva dies becoming initially a fluid-filled sac enclosed within the skin which has not been moulted. Ultimately this dries up within the brood cell and forms a distinctive "Chinese slipper" appearance.

Acute Paralysis virus and Slow Paralysis virus both cause affected adult bees to develop paralysis of their flight muscles, and to become black and shiny. Sometimes other workers attempt to eject the paralysed workers, and a severe attack of paralysis can look like robbing by another hive. Acute Paralysis virus kills its victims more quickly than Slow Paralysis virus.

The other viruses cause developmental problems in the affected brood of a kind reflected by the name of each particular virus.

For none of these viral infections is there any direct treatment available, and the only action the beekeeper can take is to try to reduce the level of stress on the colony so that the activated virus returns again to its quiescent state. Very often the stress is caused by a disease or infestation of another type, and the beekeeper must endeavour to control that.

6.3 Bacterial infections

Two of the most serious diseases of honey-bees are caused by bacteria, which are the organisms most of us mean when we talk of "germs". These can be seen under a high-power optical microscope, and were the first kind of pathogens to be widely studied following the work of Pasteur and Koch in the nineteenth century. Many of them are susceptible to antibiotics, which viruses are not, and the widespread use of antibiotics in both human and veterinary medicine shows their importance as a group of disease-causing entities.

6.3.1 American Foul Brood

American Foul Brood (AFB) is a disease of the sealed brood caused by a spore-forming rod-shaped bacterium called *Bacillus larvae* (White). It is by no means restricted to America, but got its name because it was first described there. Because the bacterium forms spores when it is not actively infecting a honey-bee larva, and because these spores are resistant to drying out, to cold, and to a rather high level also of heat, it is extremely difficult to eradicate this infection. The spores can live for many years in old comb or stored honey, or even in honey in jars for human consumption (where they do no harm at all to humans). For this reason it is very bad policy ever to feed bees on honey from an unknown source — imported honey poses a very real danger of causing an outbreak of AFB if it used as feed for bees. The sharing of honey processing equipment can also be hazardous, and should not be allowed in areas where AFB is present. For this reason also it is good policy never to encourage robbing by leaving traces of honey around the apiary after inspections of hives.

Larvae become infected by being fed with honey containing spores of *B. larvae* by the workers. It is only after the larvae have pupated that the infection spreads through the larval tissue and the larva dies inside the sealed cell. The capping of the cell then takes on a wet and sunken appearance, and the worker bees may make some attempt — usually unsuccessful — to clean out the cell, so that the capping may be perforated. At this stage a matchstick inserted into the cell, twisted and withdrawn can draw out the rotting larval remains into a sticky thread 2 to 4 cm in length. This appearance is almost diagnostic of AFB, but diagnosis should be confirmed by microscopic examination of the larval remains by an expert in the subject.

Later the larval remains dry out into a scale which is so securely attached to the cell floor that the bees cannot detach it to clean out the cell, and the brood combs of a severely infected colony

contain many unused cells and so take on a suspicious "pepper-box" appearance. The scales contain many thousands of spores of *B. larvae* and form a long-term reservoir for repeated re-infection of successive generations of larvae.

Colonies infected with AFB usually die out within at most two years of becoming infected. In the last stages of the disease they become a serious hazard for all beekeepers in the area, since the weakened stock becomes a target for robber bees from any colony within a mile of the infected one. The robbers inevitably pick up spores of *B. larvae* and take them home to start an infection within their own colony.

Some races of honey-bees have been found to have an innate hygienic behaviour, so that they make determined and successful efforts to clean out the remains of infected larvae. Some of these races can tolerate infection with AFB, and in parts of the world where AFB is endemic, efforts are being made to breed such strains up so that no other treatment is necessary.

B. larvae in its *active* phase (not its spore phase) is susceptible to sulphathiazole and some other antibiotics, and in some countries over-seas, treatment for AFB with antibiotics is routine. This carries two hazards with it. The first is that it is all too easy to suppress but not eradicate an infection by this means. In this way outbreaks of the disease can be allowed to continue for many years as a threat to other beekeepers. The other difficulty is that treatment with antibiotics (some of which are used in human medicine) carries with it the risk that honey will become contaminated with significant residues of antibiotic, which may interfere with the medical treatment of people who have eaten such contaminated honey.

Within the UK AFB is a notifiable disease, and so must by law in Scotland be reported to the local SGRD officer when it is detected. Local Bees Officers are also obliged by law to seal up any colony known to be infected with AFB, to kill the bees, usually by introducing petrol through the feed hole, and to destroy all the bees and combs by fire at night when no robbers will be flying. The remains must then be buried in a pit. The hive boxes themselves may be kept for re-use if desired, but they must be disinfected by scorching with a blowlamp.

Note also that spores of AFB may be carried on apiary equipment such as hive tools, gloves and smokers. Any metal items can of course be disinfected either by prolonged boiling, or by scorching, but clothing is more difficult, and gloves and cover cloths in particular might be best burned after they have been in contact with AFB.

Because of the rigorous destruction policy, outbreaks of AFB in this country are now thankfully rare, but it is essential to remain vigilant. An outbreak did occur in Perth in 2005.

6.3.2 European Foul Brood

Just as AFB is by no means confined to America, so European Foul Brood (EFB) is not confined to Europe. It is unfortunately fairly common in the UK, but appears usually to be confined to particular areas. It is commoner in southern England than it is in Scotland.

It is again a brood disease caused by infection with another bacterium *Streptococcus pluton* (White). As for AFB the infection is introduced to the larvae by the workers with the brood food. Infected larvae usually succumb within the last day or so before the cell is sealed, so that this is a disease of the *open* brood, the dead larvae lying in twisted and uncomfortable looking postures in their cells. Later the remains "melt down" and then dry out, but can be cleaned out by the bees. As for AFB, colonies severely affected with EFB will normally die out, and the infective agent can be spread from colony to colony by both drifting and robbing.

Because this bacterium does not form spores, it is rather easier to eliminate, and it is susceptible to the antibiotic Terramycin.

Like AFB, EFB is a notifiable disease, and so must by law in Scotland be reported to the local SGRD office as described for AFB. However Bees Officers have some discretion about how they will treat an outbreak of EFB. The default treatment is to destroy the colony as for AFB, but it is permitted for Bees Officers at their discretion to treat a mild outbreak with an antibiotic. Note however

that honey from such a treated colony must not be sold to the public.

Because the bacterium is not spore-forming, there is less danger of long-term infection being carried in old combs or on apiary equipment, but sensible disinfection procedures should be carried out nevertheless.

6.4 Fungus infections

Several brood diseases are caused by fungus infections, of which I shall only describe two.

6.4.1 Chalk Brood

The fungus *Ascosphaera apis* (Maasen) develops inside the rear end of larvae being reared in cold and damp combs where spores of this fungus are present. The mycelium of the fungus spreads throughout the larva as it matures, and converts the whole larva before it pupates into a chalk-like mummy which lies quite loose in the cell amongst the sealed brood of its unaffected sisters.

Avoidance of weak colonies and damp conditions reduces the effect of this fungus, but almost every colony in Scotland with our damp mild winters suffers to some extent from this problem.

6.4.2 Stone Brood

The only bee disease which I know which can pose a potential threat to human health is the infection of brood by the fungus *Aspergillus flavus*. The larvae after death become hard and stone-like, and this infection is a much more serious business. Fortunately this infection does not occur in the UK, since the spore dust from larvae affected by this can cause a quite serious lung infection in the beekeeper if it is breathed in.

6.5 Protozoal infections

The protozoa are single-celled organisms, some of which are quite large. All can be seen under a microscope. Two of them are responsible for infections of honey-bee colonies which are of fairly frequent occurrence.

6.5.1 Nosema disease

Nosema apis (Zander) is a protozoan which infects the mid-gut of the adult bee. If severe enough, the infection causes dysentery in the bee and shortens its life. Those bees suffering from dysentery, which either through weakness or through adverse weather are unable to fly to empty their bowels, will foul the combs, and other bees in cleaning up the mess will pick up the spores of *Nosema* so spreading the infection.

In warm summer weather any infection with *Nosema* tends to die out as infected bees die, usually away from the hive, and the number of infective spores in the hive falls. Weak colonies in a damp cold spring if infected may suffer severely enough to perish.

In addition the stress of a severe *Nosema* infection may be enough to trigger into action some of the latent virus infections within a colony, as mentioned in the first section of this chapter. The combination of *Nosema* and APV or SPV can be deadly and wipe out a colony quite quickly.

If *Nosema* infection is suspected, then a sample of adult bees showing signs of weakness should be sent off with an appropriate covering note for analysis to the address in Edinburgh given at the end of this chapter.

Good hygiene measures by the beekeeper can greatly reduce the severity of any *Nosema* infection. The regular replacement of combs prevents the build-up of undue numbers of spores of *Nosema*. The thorough cleaning of floors and exposed frame surfaces at spring inspections also helps.

Because *Nosema* spores are triggered into development by the acid environment of the bee's stomach, combs can also be effectively disinfected from *Nosema* by fumigation with glacial acetic acid, which fools the spores into starting development before they are inside a bee. Up to three boxes of *unoccupied* combs should be stacked over a board providing an air-tight seal. Above them should be placed an empty super with another board at hand to provide an air-tight seal at the top of the stack. On top of the combs should be placed a saucer with a piece of wadding on which should be poured 15 ml (one tablespoonful) of glacial acetic acid. The stack should then be sealed with the top board. The stack must be maintained for 24 hours at a very warm temperature (55^0 C). Before re-use the boxes must be ventilated thoroughly to remove the acid fumes.

This treatment has several disadvantages. Glacial acetic acid is a highly corrosive chemical, and must be handled with extreme care using protective gauntlets and eye goggles. If any is spilled on the skin, wash immediately with plenty of cold water, and seek medical advice. The acid also corrodes the frame nails and the reinforcement wires in the comb foundation.

One specialist antibiotic treatment is also effective against *Nosema* if it is found to be a serious problem. The antibiotic fumagillin, available as the medicament "Fumidil B" from the bee appliance dealers, is used only for the treatment of *Nosema*. This should be supplied in autumn feed as recommended by the manufacturer if *Nosema* is proving to be an intractable problem.

6.5.2 Amoeba disease

The protozoan *Malpighamoeba mellificae* (Prell) is another which causes digestive problems to the adult bee. This one infects the Malpighian tubules in the bee's lower digestive tract which act as the bee's kidneys. The result is again dysentery. It is not at all easy without microscopic examintation to distinguish between Amoeba disease and Nosema disease, so here the help of the diagnostic unit in Edinburgh is essential if it is necessary to be sure what the problem is.

The same hygiene and fumigation measures which are effective against Nosema disease are also effective against this one. "Fumidil B" however is of no use against the Amoeba.

Once more the principal problem with this disease is probably that it is a stress inducer which may trigger viruses into activity.

6.6 Arachnid infestations

The spiders, ticks and mites all have eight legs and form the family of the arachnids. They cause many problems of troublesome infestations in agriculture, and two of them are important problems for the beekeeper.

6.6.1 Acarine disease

In the 1920s in the UK the so-called "Isle of Wight disease" caused enormous losses to beekeepers in this country, and a large proportion of the stocks of the old British black bee were wiped out. At the time the trouble was eventually attributed to a mite *Acarapis woodi* (Rennie), which parasitises the thoracic tracheae (breathing tubes) of the bee. Bees lightly infested with this mite can survive, but have a shortened life-span, and weakened flying capability, and those severely infested die of the infestation.

The infestation can be diagnosed by dissecting out the main thoracic tracheae of infested bees and examining them under a low-power microscope, when the mites can be clearly seen.

The treatments developed for acarine disease at that time consisted mainly of fumigation with different substances, the most effective of which were the vapour of nitrobenzene, and "Folbex" strips, in which the active ingredient was contained in impregnated blotting paper also containing potassium chlorate so that it would continue to smoulder when lit. All these treatments are now banned because of the potentially harmful residues they may leave behind. However the modern acaricides developed in the 1980s for treating *Varroa* have now effectively replaced them.

Although acarine continues to occur among honey-bee colonies in Britain, it is seldom now reported as a serious problem. A new view of "Isle of Wight" disease has recently been proposed. It may well be that the mite entered Britain through the South of England at the start of the twentieth century, probably because of the increased amount of travel and trade developing then. The bees then being kept in this country were meeting a new parasite for the first time, and were extremely stressed by it, so that latent viral infections were triggered into activity, and caused viral reactions of sufficient severity to kill colonies. Certainly many of the symptoms attributed to "Isle of Wight" disease are very like those observed in colonies suffering from severe outbreaks of APV or SPV.

6.6.2 Varroasis

The origin and spread of the condition

The parasitic mite *Varroa jacobsoni* (Oudemans 1904) is a natural parasite of the Eastern honeybee *Apis cerana*, discovered in 1904 on the Eastern honeybee in Java by Edward Jacobson, and sent to Holland for classification and description by the famous scientist Dr A. C. Oudemans. Attempts to keep the Western honeybee (our bee) *Apis mellifera* in Asia at the beginning of this century always failed — perhaps because of *Varroa*. Some time in the 1950s attempts to keep our bees in Japan succeeded, but the bees tended to die out, and the problem was attributed to infestation with *V. jacobsoni*. More recent work however by Dr D. L. Anderson in Indonesia, as explained in *The Scottish Beekeeper* of 2001 January has established that the mites present on the western honey-bee belong to a larger but closely related species, now to be called *Varroa destructor* (Anderson, Trueman 2000), which may perhaps be related to a parasite of the eastern honeybee. Throughout Europe and Africa the race of *Varroa destructor* present is the Korean one, but in America it is the race from Japan and Thailand.

Although *A. cerana* can live with *Varroa*, because of a slightly shorter sealed brood time, and an aggressive behaviour by the adult bees towards the mites, European races of *A. mellifera* which lack these traits usually succumb, colonies dying out in the second or third year of infestation.

Somehow infested colonies of *A. mellifera* were transported across the Ural Mountains into the East of the Soviet Union, and since then the infestation has spread steadily through the world's population of western honeybee colonies in all continents, largely through the uncontrolled importation of colonies from infested areas.

In summer 1992 the first known cases in the UK were reported from Hampshire in the south of England. In 1996 the infestation had spread throughout England and most of Wales and reached as far as the Scottish border. Until 1997 only sporadic cases had been reported in Scotland, but in the summer of 1998 major outbreaks were identified in the Dumfries area, around Peebles and in St Andrews. In August 2002 it was first found in the Stirling area, and is now widespread in our area. In the summer of 2003 it was also found in Islay and in some other small islands, and in the light of this SEERAD (at that time the authorised Government Department) decided to declare the whole of Scotland a Statutory Infested Area (SIA), so there is now no LEGAL restriction on where you may move bees within Scotland. Nevertheless it is decidedly wrong to take bees you know or suspect may be infested with *Varroa* to areas where it has not yet been found, particularly to the more remote island groups such as the Outer Hebrides or Shetland.

One universal experience in the spread of the infestation is that beekeepers are almost always unaware of its arrival for some time after *Varroa* is present in an area. After one beekeeper's stocks are found to be infested, further investigation almost always reveals that the infestation has spread widely. This was indeed what happened to us locally here around Stirling.

The effects of *Varroa*

Adult female *Varroa* mites can live on adult bees. They tend to adhere to the under-side of the abdomen, between the segments, where they bite through the cuticle and suck the bee's blood (haemolymph). These female mites however always seek when possible to enter *brood cells* just before they are capped,

preferring drone brood when it is available, presumably because of its longer time as sealed brood. Within the brood cell the mite is stimulated by the hormones it receives when it sucks the larva's blood to begin egg-laying. Like the bees themselves the mites reproduce parthenogenetically, unfertilised eggs developing into males, and fertilised ones into females. The first egg laid is always an unfertilised (male) one, and the remainder are females. The adult female mite continues to lay individual eggs at 30 hour intervals. Once they have matured sufficiently, the single male mates with all the young females. Because of the mites' developmental time, only one or occasionally two young females (together with their mother) can emerge with the bee when a worker bee has finished development. From a drone cell on average about four can emerge. The male mite always dies when the bee emerges. The mother mite can enter a second and even a third brood cell before she dies. Bee brood which has been parasitised develops into stunted and short-lived bees which are not much use to the colony, particularly if more than one adult female mite has been breeding in that cell, which occurs when the mite population builds up sufficiently. Because of the relatively slow build-up of the *Varroa* population in a bee colony, it can take two or even three years before the bee colony collapses, but in the meantime the infestation has been passed on to other colonies by adult mites adhering to bees entering other colonies, especially drones which are not colony-loyal. Drones are powerful fliers and can easily fly 10 km (5 miles or more).

A secondary effect of *Varroa* infestation, which some of the most recent research suggests may even be one of the principal ones causing colony collapse, is, as for so many of the other diseases described before this one, that the transmission of blood-borne infections between adult bees, and the stress of the infestation by the mites can cause epidemics within a colony of various viral infections, which are almost always present at low levels, but which do not usually cause a problem. Most of the viruses mentioned at the start of this chapter have a role to play here. Many recent colony losses have been reported in spring, perhaps caused by the shortened life-span of the wintering workers caused by the activation by *Varroa* of the Deformed Wing Virus within the colony.

Dealing with *Varroa*

Integrated Pest Management

As this pest must now be considered endemic, we have to learn to live with it. For the first time beekeepers are having to learn about Integrated Pest Management (IPM). The principles of this are:–

- monitor colonies for levels of infestation;
- be aware of appropriate trigger levels for
  - light infestation: no action needed;
  - moderate infestation: light action needed;
  - heavy infestation: severe risk, urgent need of treatment.
- treat only when necessary;
- choose a treatment appropriate to the season, the level of infestation and the strength of the colony.

Monitoring *Varroa* infestation levels

Two simple methods are available:–

- use of an open mesh floor and monitoring Daily Natural Mite Drop;
- in the *summer only*, the search of sealed drone brood for level of infestation.

Daily Natural Mite Drop

It is now widely accepted that colonies do well if kept permanently on an open mesh floor instead of a solid wooden one. These can be constructed so that a tray can be inserted below the mesh. It is recommended that this is presented with a sticky upper surface — a sheet of "Fablon" with the backing removed and laid in sticky side up does well. Alternatively simply grease the tray with petroleum jelly. The tray is left in for about a week (longer in winter), and then the adhering mites are counted and the total divided by the number of days the tray was in place, to get the average daily natural mite drop. NOTE THAT NO TREATMENT MUST BE GOING ON WHILE THE COUNT IS TAKING PLACE. The table below gives a rough guide as to when action is needed:–

	Average Daily Natural Mite Drop		
Jan to Mar	Less than 2 No action	2 to 7 Plan control	More than 7 Consider immediate control
Apr to Jun	Less than 1 No action	1 to 7 Light control	More than 7 Severe risk
Jul to Aug	Less than 2 No action	2 to 7 Light control	More than 7 Severe risk
Sep to Dec	Less than 6 No action	6 to 8 Light control	More than 8 Severe risk

Inspecting sealed drone brood

By inserting an uncapping fork into sealed drone brood and removing the pupae, *Varroa* on them can easily be seen and counted. This method can only be used in summer but then the following rough guide table is useful. At least 50 pupae should be inspected.

	Proportion of infested pupae		
Up to June	Less than 2% No action	2% to 4% Plan control	More than 4% Consider immediate control
Jun and Jul	Less than 3% No action	3% to 7% Light control	More than 7% Severe risk
Aug	Less than 5% No action	5% to 10% Light control	More than 10% Severe risk

Overview of treatment methods

There are three main approaches to treating varroasis. The first is an attempt to keep the infestation down to a tolerable level for as long as possible by means of various biomechanical treatments. It has the advantage that we do not need to introduce any poisonous chemicals into the hive, and that we can carry these measures out at any time whether or not honey supers are on the hive. They need to be carefully managed if they are not to disrupt the normal hive routine, put the bees under stress, and almost certainly reduce honey yields. They could well form the basis of the proposed "Light controls" above.

The second approach is the orthodox use of one or other of the permitted acaricides.

The third approach is the use of some of the alternative substances which, while not licensed as treatments for the infestation, are of proven efficacy in reducing mite populations.

Some suggestions for manipulative treatments

The first manipulative treatment is rather time-consuming, unless well managed is very disruptive to the stock, but could be expected to put a severe check on the development of the mite population.

- At the end of May (after the foraging population for the main honey flow has already been produced by the queen's laying) cage the queen (using a **White** cage whose walls are made of

queen excluder to confine the queen but allow workers free access) for 9 days on an empty frame of drawn comb.

- Repeat for a second period of 9 days on another similar comb, keeping the first comb in the hive for the bees to finish sealing the brood on it.
- Ideally do it again for a third period of 9 days.
- Release the queen.
- As soon as each of the combs of brood laid by the trapped queen is sealed, remove it. Placing it overnight in the deep-freeze will kill all the trapped *Varroa*, and of course the brood as well. Then the frame can be uncapped and re-used.

The idea of the treatment is that because of the queen's caging, there will be a complete absence of open brood in the rest of the hive. All the female *Varroa* mites looking for places to lay will be attracted to the bait combs, and will then be destroyed along with their offspring. The problem is the long interruption to the queen's normal production of worker brood in the middle of the active season. If the timing is correct however, all the foraging bees needed for the main honey-flow will already have been reared, and having less brood to tend, will forage more actively. A careful check for queen cells on the bait combs, and initially elsewhere in the brood nest, must be maintained, and of course it can only be done if queens can be handled reliably and with confidence. It is also quite time-consuming. Colonies treated this way will seriously decline in August and so will be useless for the heather flow, but can be expected to recover well for winter.

The second manipulative treatment which could be almost equally effective is to use the brood nest from an artificial swarm set up at the end of May to found a new colony for the late heather flow. This may well become the standard practice for those wishing to work the heather, since autumn treatments after return from the heather are likely to be too late to produce an adequate healthy population of wintering workers. Try to prevent cross-infestation of such a stock however, since it relies on its broodless period while awaiting a new queen (possibly supplemented by some chemical treatment then), to bring its *Varroa* population down to a low level.

A less disruptive treatment, which will also be less effective, but which I would thoroughly recommend in reducing the *Varroa* population while supers are on, and acaricides cannot be used, is the following fairly simple plan.

- Introduce into the brood chamber near the outside edges of the brood nest two *shallow* frames (of the size used in the supers), fitted with ordinary foundation.
- Let the bees (as they will) draw "wild" comb below the bottom bar of the shallow frame. Most of the cells in this position are likely to be drone cells.
- When the brood which is laid in this wild comb is mainly sealed, cut off these wild combs, put them in the deep freeze for 24 hours, and then dump them.
- After the wild comb has been cut off, the shallow combs can be given back to the bees and the operation repeated.

Many of the *Varroa* will have been attracted into the drone cells here. You will lose some (but not much) worker brood as well, but will make significant inroads into the mite population. The queen's laying has not been interrupted, and the colony can be expected to flourish as usual.

More elaborate variations on these themes are to be found in some of the literature, and this is clearly an area where your own experimentation is likely to pay well. None of us in Scotland has yet had enough experience to know how best to operate in our local conditions, but listen to those who are now gaining painful experience.

Using Bayvarol, Apistan or Apiguard to treat varroasis

There are currently (2009 January) three products whose use is licensed for the treatment of varroasis in this country. Bayvarol and Apistan are acaricide strips whose active ingredient is a synthetic pyrethroid. Apiguard is a preparation whose active ingredient is thymol.

Bayvarol

- When *Varroa* first was found in the UK, this was the only remedy legally permitted here.
- It consists of chemically impregnated plastic strips for suspension between the combs of a colony.
- It is manufactured by Bayer plc.
- It is sold in packs of 5 sachets.
- Each sachet contains 4 strips — enough for one brood box.
- The active ingredient is *flumethrin*.

Apistan

- It has been widely used as a treatment on continental Europe.
- It also consists of chemically impregnated plastic strips for suspension between combs.
- It was only licensed for use in this country in 1998 December.
- The active ingredient is *fluvalinate*.
- The recommended dosage of Apistan is two strips per brood box.

These are both very effective, killing more than 98% of the mites, as long as the mites have not developed a resistance to them, but they involve introducing fat-soluble acaricides into the hive, and residues of these chemicals can be found in the wax of the combs after hives have been treated. For this reason the advice is universally given that these substances should NOT be used when honey supers are on the hives. Also, as with all chemicals which are used as pesticides, they have the problem that their prolonged use is likely to cause the development of resistant strains of the pest, because of the selection pressure which the widespread use of the chemicals puts on the pest population. Those pest organisms which have some degree of resistance to the chemical will be more likely to survive and to produce offspring which inherit the resistance of their parents. As different resistant strains inter-breed, the most resistant lines come to predominate in the population, and ultimately the chemical becomes ineffective in controlling the pest. Some years ago the first reports of *Varroa* resistant to Apistan appeared in both Switzerland and Belgium. Reports of resistant *Varroa* in South-West England have also appeared during 2001, and within 2003 in Wales and also further north in England. The most northerly report so far (2006) is from Cumbria which is disturbingly near us.

Bayvarol and Apistan are of low toxicity to mammals, so are fairly safe for us to use, but observe sensible precautions when handling them. Keep them sealed in their sachets till they are needed, use gloves when handling them, and wash your hands after working with them. They may be disposed of after use in normal domestic rubbish, but avoid contaminating water courses with them as they are poisonous to fish.

If it is essential, then an acaricide can be used in the early spring before honey supers go on, but this is not a particularly good time of year, since the brood nest is expanding, and an ever increasing number of the *Varroa* will be able to find safe shelter from the poison inside developing brood cells.

It is far better to apply the treatment at the end of the summer after all the honey supers have come off, when the queen is cutting down her laying, and more and more of the *Varroa* are being

forced out into the open hive where they will meet the full force of the chemical. Ideally however this treatment should be started in August before all the wintering workers have been produced by the queen's laying. This makes it difficult to combine with working for heather honey.

The recommended number of strips should be suspended between brood combs *where it is seen that there are plenty of active worker bees around the brood area.* If double brood chambers are in use, then double the number of strips will be needed, unless these extra boxes can be temporarily removed and stored while treatment is going on. A nucleus box needs treatment with half the full number of strips.

The bees absorb the chemical into their body fluids. They are tolerant of it. They pass it around among one another, and the *Varroa* which feed on them absorb a dose fatal to them.

Treatment must last six to eight weeks, to ensure that all the *Varroa* in brood cells when treatment begins are forced out into the hive where they will meet the chemical. At the end of this time *the strips MUST be withdrawn and disposed of* so that any surviving mites do not get prolonged exposure to a sub-lethal dose from depleted strips, since this would encourage the development of resistant strains of mites. The principle is the same as that of your doctor when you are prescribed an antibiotic. You are advised to complete the course and then to STOP taking it altogether. **DO NOT LEAVE BAYVAROL OR APISTAN STRIPS ON HIVES OVER THE WINTER**. Follow the manufacturer's instructions with both Bayvarol and Apistan.

The current price of Apistan from Thornes (2009 January) is £19 per pack, and a pack is enough to treat 5 hives. Other suppliers may be found which are somewhat cheaper. Bayvarol is not currently being advertised by Thornes.

Apiguard

Apiguard is a completely different type of treatment. It comes in small plastic containers, and the instructions are to open a container and place it on top of the brood combs open side up. The bees dislike the strong smell of thymol, and break up the sticky substance and carry it out of the hive. In doing so they spread the chemical widely about, and it kills the *Varroa*. After a fortnight, a second container should be added, and after a further three weeks any residue should be removed from both containers and scattered over the tops of the brood frames, the containers being removed. Apiguard does not achieve quite the high rate of kill of the two acaricides, but is an extremely useful alternative where mites resistant to the acaricides have developed. It works best when the temperature is above 16^0C (60^0F). It should not be used when honey supers are on, as the thymol will certainly taint the honey. Its cost is about the same as that of Apistan.

Legal requirements for handling veterinary medicines

Bayvarol, Apistan and Apiguard are all licensed veterinary medicines. The law requires those handling such medicines to keep written records of purchases and other acquisitions, of uses and of disposals of them, with dates, and to store them safely away from foodstuffs and away from access by those not authorised to use them, so do take care to comply with the law. Note that they must not be used after the expiry date shown on the packaging, so do not over-purchase.

The use of alternative substances

Other substances which have been found to be reasonably effective in controlling *Varroa* are the three organic acids, lactic acid, oxalic acid and formic acid. I shall not go into the use of these here, as it is a rather specialised area, and some of them (particularly formic acid) are very dangerous to handle, all requiring the systematic use of protective clothing and good precautions to avoid contact with the skin. Oxalic acid is interesting however, as it can be effectively used either by the trickle method or by the sublimation method in mid-winter, when there is very little danger of contaminating honey for human consumption.

Certainly in order to avoid as long as possible the development of mites resistant to Apistan, it is recommended that some variation in treatment methods should be used.

Long-term prospects

There is much active research work going on just now on breeding a strain of the Western honeybee which shows the same degree of resistance to *Varroa* as the Eastern honeybee. There have been some reports of progress, the most recent that I have seen being one in *The Scottish Beekeeper* for 2001 January. In my view that will be the long-term solution. However, we have not reached that point yet, and experience elsewhere suggests that those who do not treat their bees against *Varroa* when it arrives, after two to three years will have no bees.

There is also active research into finding possible diseases which will knock out the *Varroa* mite itself.

One factor which may have more influence on the outcome of this problem than the scientists acknowledge is the continued existence in our countryside of feral colonies of honeybees. These will of course initially be largely destroyed by *Varroa*, as the rabbits were by myxomatosis. However the sites where they lived will still contain combs full of honey, and will be very attractive to escaping swarms. These stocks of course will repeatedly become infested, and will be a continuing source of reinfestation for our bees. However they will also be *untreated* and, as happened with the rabbits, among them natural selection for resistance to *Varroa* will continue to operate except in so far as they cross-breed with our bees which are being treated. It took the rabbits about twenty years to solve the myxomatosis problem for themselves completely without assistance. Will the honeybees do the same, and if so how quickly?

6.6.3 *Tropilaelaps clareae*

This mite, which is a parasite of the giant honey-bee species *Apis dorsata* and *Apis laboriosa* has now been found also in some parts of Asia as a serious parasite of the western honey-bee. Its life-cycle is very similar to that of *Varroa* but it has so far not been detected anywhere in Europe. However SGRD have also made it a notifiable disease. Let us hope we never need to worry about it.

6.7 Insect infestations

6.7.1 Braula

The so-called Bee Louse *Braula coeca* is actually a wingless fly. It occurs very commonly in bee-hives, and the queen and her retinue are most frequently parasitised. The adult fly, which is about the same size as *Varroa* but longer from front to back than from side to side, and with only six legs rather than eight, typically perches on the back of the thorax of a bee on the comb, from where it occasionally runs down to steal a drop of food as bees exchange food between one another. The adults appear to do no significant damage in a bee colony, and most beekeepers ignore them. If however you are wishing to have comb honey for show or for sale, you may wish to try to reduce the *Braula* population, since their larvae live on the wax of the honey cappings in the combs, and make unsightly tunnels there.

The chemicals which kill *Varroa* are said also to be effective against *Braula* so perhaps this is a problem which will diminish in future.

6.7.2 Wax moths

Two species of moths, the Lesser Wax Moth *Achroia grisella* and the Greater Wax Moth *Galleria melonella* have evolved to live in their larval phase by feeding on beeswax and the debris of pupal skins etc in the brood combs of honey bees. The Greater Wax Moth does not usually cause much problem in Scotland because the climate is too severe for it, although it can be a serious menace further south, as the damage it does is much worse than that caused by the Lesser Wax Moth. In particular the pupae of the Greater Wax Moth usually are set into hollows which the larvae dig out in the woodwork of the hive, causing quite severe damage to the wood in the process.

The Lesser Wax Moth looks very like the common clothes moth, and has very similar habits, except that its larvae feed on wax combs not woollen fabric. Any strong stock will hardly allow any wax moths to survive within a hive, unless there are crevices where the moths and their larvae can hide and the bees cannot reach them. The larvae of both kinds of moths however can quickly wreck any stored brood combs when they are kept away from bees, turning them into a crumbly brown frass interwoven with silk tunnels where the larvae have burrowed. The times of greatest danger are in spring and autumn, since in the cold winter months the weather is too cold to allow the eggs to hatch out. In summer most combs are in use and not stored, but any that are stored are certainly in danger.

Combs of honey supers which have *never* had brood reared in them are comparatively safe, since the moth larvae require larval debris as well as wax in order to grow satisfactorily.

The best remedy is to keep a watchful eye out, and to burn any combs that become infested. Moths and larvae in combs can be effectively killed by a twenty-four hour spell in a deep freeze, but the danger is reinfestation from outside, so a box of combs treated in this way should before storage be wrapped in an individual plastic bag, carefully sealed with tape. If a box has been infested by this pest, it is a good idea to scorch the box with a blowlamp to kill any remaining eggs or pupae. Combs in it are probably beyond redemption.

Note that wax-moth is a very common problem to meet if you buy second-hand equipment that has lain neglected for some time, and it is wise to ensure that you don't in this way introduce this pest into your apiary. Also do not keep *Varroa* monitoring trays for long periods under open-mesh floors, as the space above them is wax-moth heaven.

6.7.3 Ants and wasps

Ants can become a serious problem to a bee colony if they discover a way into a hive by which they can rob the honey store. In extreme cases it may be necessary to set the hive on a stand with its legs resting in tins of oil to keep ants out.

In the autumn when bees have acquired a large honey store, worker wasps can be very aggressive in trying to gain admission to the hive past the guard bees in order to rob honey. If there are too many, it may be worth looking for the wasp's nest and destroying it. I have also seen a queen wasp in spring sneak into a hive past the guard bees, and emerge a minute or so later with a bee larva in her jaws to take to feed to her own young. Wasps are definitely not good news, but usually the threat they pose is not too serious.

6.7.4 The Small Hive Beetle

The Small Hive Beetle *Aethina tumida*, is a pest of honey-bee colonies native to South Africa. The damage it does is very similar to the damage caused by wax-moths, the larvae destroying combs. In South Africa it has never caused much concern, but it has been recently found in Florida where it is now regarded as a serious problem, particularly of stored comb. So far it has not been found in this country, but the fact that pupae can be imported with fruit and vegetables have caused SGRD to be worried in case it appears, and it too has been made a notifiable disease of honey-bees. The beetles pupate away from the hive, so that pupae can be readily carried away from vegetable plots on the roots of vegetables. Once again, let us hope it never reaches us.

6.8 Amphibians, birds and mammals

Toads and frogs are said sometimes to lie in ambush in front of beehives and to capture worker bees as they fly out to forage. I can hardly believe that a hive placed in a reasonably dry site will suffer seriously from this particular threat.

Small birds such as tits and flycatchers do however sometimes find it worth their while to ambush bees in this way as they fly in and out, and if they can be discouraged it would make sense.

The most serious bird problem however is undoubtedly that posed by the Great Green Woodpecker, which can in short order drill a hole through the side of a brood box, and then have a very profitable time feasting on the bees and larvae within. Not only does this damage the colony, but also it does very significant damage to the beehive itself. In areas where this bird is common, it is sometimes necessary to protect hives from it by some sort of cage made of wire netting.

Both mice and shrews can be a pest to colonies of bees. Field mice in winter will readily take up occupation in a hive, nest there, foul the combs so that bees will not use them again, and eat the bees' stores, the bees themselves, and a large part of the brood nest. They must be kept out at all costs, and mouse guards are the solution. In summer the bees can protect themselves against mice. Shrews do not usually permanently occupy a hive, but they will sneak in and out if they can to have a feast of bees. This can destroy a hive in winter if it goes unchecked.

6.9 Human pests

The most obvious way in which people damage bee colonies is by deliberate vandalism. Teenage boys (and younger) particularly delight in kicking over or throwing stones at beehives in winter, with damage which can be very serious to the bees at that time of year. Such activity does not usually take place in summer! Having hives in a place where access is not easy and/or they are under a vigilant eye are the best remedies, but are not always easy to ensure.

Neighbours of a beekeeper who are, reasonably or unreasonably, afraid of bees are nowadays making it ever more difficult to keep bees in our increasingly urban environment. There is no doubt that trying to make allies rather than enemies is the best approach. Timely gifts of honey, and meticulous attention to swarm control so that bees are not a nuisance are the two best actions here.

The main threat to bees from people however is undoubtedly the risk of having bees poisoned by the spraying of agricultural or garden chemicals. Very often these chemicals are insecticides aimed at controlling insect pests. If they are applied at a time and place where our bees are foraging however, they will kill the bees very effectively. Most beekeeping associations have some form of compensation scheme to help in such cases, and the beekeeper may have a case at law if his stocks have been damaged by reckless and negligent application of sprays.

In order to establish a claim for such damage however it is necessary to be able to prove that the bees have been poisoned by the spray that was applied. Usually there is no shortage of dead bees around the hive for the beekeeper to collect if this has happened. In this case a large sample should be collected and sent off for analysis to the Scottish Agricultural Science Agency (SASA) whose contact details are given below. Many more than 30 bees should be sent in this case, since quite elaborate chemical analysis will be needed to determine exactly what chemical is involved.

The covering letter should contain as much information as the beekeeper can obtain about the time and place of the spray, who was applying it, and if possible exactly what chemical was being sprayed.

6.10 Useful contact addresses for help in dealing with bee diseases

6.10.1 The Scottish Agricultural Science Agency

This government agency provides a *free* diagnostic and advisory service for all bee diseases, supported by European Union money, so use it wisely and well. Always send specimens in *paper* or *cardboard* packing, not plastic, which causes them to rot. Remember to enclose a covering letter giving your own contact details, and saying what you believe the problem is. It is also helpful if you indicate where the bees are kept from which the specimen came.

Mrs. Fiona Highet
Bee Diseases Section
Scottish Agricultural Science Agency
1 Roddinglaw Road
Edinburgh
EH12 9JF
Telephone:– 0131–244–8883

6.10.2 The local SGRD Officer

If you have the misfortune to find one of the four notifiable diseases listed at the beginning of this chapter then you have a legal obligation to report the matter to the Local Bees Officer of the Scottish Government Rural Directorate (SGRD). The Stirling SGRD Bees Officer in 2009 can be contacted at

Local Bees Officer
SGRD Local Office
Broxden Business Park
Lamberkine Drive
Perth PH1 1RZ
Tel:– 01738–602000
email:– SGRPID.Perth@scotland.gsi.ov.uk

and for other areas of Scotland the appropriate contact can be found by looking up "Scottish Government" in the local Telephone Directory, by consulting the Scottish Beekeepers' Association Local Secretaries' Manual or by looking on the Internet at

`http://www.scotland.gov.uk/Topics/Agriculture/AOcontacts/contacts`

6.10.3 The Scottish Beekeepers' Association Bee Diseases Convener

The Scottish Beekeepers' Association keeps a vigilant watch for the occurrence of any of the serious diseases throughout Scotland, and their Bee Diseases Convener should always be advised of the occurrence of any serious problem. The Convener is also always willing to give help and advice free of charge if it does not demand too much time. The contact details are published monthly in the SBA's magazine *"The Scottish Beekeeper"*. In 2009 the Bee Diseases Convener is

Professor Alan Teale
Burnside Lodge, Dunira,
Crieff, PH6 2JZ
Tel: 01764–670735
email: `teale@f2s.com`

Chapter 7

The Annual cycle of Beekeeping: Setting up as a beekeeper

7.1 The year's work in outline

Summarising how the various techniques described in section 5 fit into an annual cycle which in turn fits into the natural cycle of the honeybee colony described in section 2 gives us the following calendar for local conditions here.

- **August:**– Start of the beekeeper's busiest period. Honey removed after the main July flow must be dealt with and beeswax processed. If heather honey is sought, then at the beginning of the month strong colonies headed by young queens must be prepared with some reserve stores but also ample empty combs for the moors, and transported to a site which must have been previously arranged and prepared. Ensure the hives will not be knocked over by grazing sheep or cattle.

  Some swarm control inspection may still be needed, but the swarming season ends by the middle of this month at latest. Many hives now cast their drones, so try to ensure that all young queens are mated and laying by then, or mating may be unsuccessful. Queen rearing must now stop for that reason.

  As the queen's laying starts to be reduced, now is the moment to check for heavy late-summer *Varroa* infestation by checking natural mite drop. Once this check is complete, this is the ideal month for starting treatment with acaricides against *Varroa* where it is needed. It should be started when necessary immediately after the honey supers have been removed and continue for the recommended period of six to eight weeks — neither less nor more.

- **September:**– the busiest month. Assess all stocks and unite weak ones in preparation for winter. Feed with sugar syrup those low in stores. Continue processing honey and wax. In the middle of this month, hives at the heather must be brought back, the honey removed and processed, and these stocks fed. ALL AUTUMN FEEDING SHOULD BE OVER BY THE END OF SEPTEMBER to allow the bees to ripen the feed and seal it before the cold weather begins, or else the stored syrup may ferment leading to dysentery among the bees. Remember to check these stocks for *Varroa* on their return from the heather, and hope that no late-starting treatment against the mite is needed as it will be less effective now, but must be done if infestation is heavy.

- **October:**– Put mouse guards on all hives at the beginning of the month and make a final check of winter security. Finish processing late honey and wax.

  Ideally treatment for *Varroa* with acaricides should be over by the end of this month and all strips removed from the hives.

- **November:**– A quiet month. Periodically check hives have not been disturbed by weather or vandals. Do not disturb the bees.
- **December:**– As November. If treatment for *Varroa* with oxalic acid is to be done, this is the month for it. If correctly done it involves minimum disturbance.
- **January:**– As December. Do NOT remove snow from hive entrances, but clear it off roofs. Bees are best left lightly imprisoned in bright snowy weather, or many may come out and be chilled on clear frosty days.
- **February:**– Brood rearing will usually re-start this month. If there is a mild spell, check quickly for honey reserves and feed solid sugar as necessary. A good month to check natural mite drop of *Varroa* in case some spring treatment is needed for heavily infested colonies. Mouse guards should be removed in mid-February to allow workers bringing in early pollen unrestricted access.
- **March:**– Some time this month check food reserves in ALL hives. Syrup may now be fed if the weather is mild, but solid sugar may be safer if it is cold. Where reserves are adequate, do nothing.
- **April:**– If foul weather persists, feed syrup to all stocks. This is the month of greatest danger of starvation. When fair weather occurs, make spring inspections. Willow should be yielding early nectar which will be seen in combs, as well as plentiful pollen which will also be seen on the hind legs of returning foragers. If so, feeding is unnecessary.
- **May:**– Spring inspections should be complete by mid-month and regular swarm-control inspections begin now. Also any spring treatment against *Varroa* involving chemicals should be brought to an end.

  As soon as the major honey flows from sycamore and oil seed rape begin, put honey supers over queen excluders on well-developed stocks. Do this too soon rather than too late. Be prepared to start taking swarm control measures towards the end of this month, and if possible take the opportunity to rear early young queens. Keep adding supers, when the top one is about half full. You may remove full supers for extraction, but it is a good policy to leave at least one half full super on each hive throughout the summer to tide the stock over a spell of bad weather.
- **June:**– The main swarming month: ideal for queen rearing. Sometimes there is a gap in the honey flow this month with adverse weather. If young *mated and laying* queens become available, some stocks preparing to swarm may be re-queened to dissuade them from it. A good month to check drone brood for any unexpected build-up of *Varroa* requiring urgent action.
- **July:**– Swarm control continues but the risk is less now. Late swarms this month will do little good this year. The main honey flow should occur now, weather permitting. Keep adding supers as necessary, but if weather is bad you may even have to feed! More re-queening may become possible.
- **August:**– completes the cycle again.

7.2 Setting up as a beekeeper

- **A Choosing an apiary site**

  The site should be open and sunny but sheltered from strong winds. Fresh water from a source nearby where bees can safely drink is an advantage. Avoid frost pockets and damp areas. Hives must not be subject to vandalism and should be screened by trees or fencing from human passers-by to keep both bees and passers-by happy. If the apiary is away from home, convenient vehicular access is important to avoid the necessity of carrying heavy honey-filled supers over long distances.

- **B Setting up hive stands**

  Hives must not be set unprotected on the ground, or the damp will quickly rot the floor away, and vegetation will grow up and block the hive entrances.

  Wooden stands are often used, but they must be stoutly built as hives when full weigh 50 to 100 kg (100 to 200 lb). Another good and simple solution is to set each one on a concrete slab — or better a stack of two concrete slabs. Using part slabs for the upper layer leaving a central ventilation channel under the hive floor from side to side is a useful refinement. Even WBC hives last longer if their legs are placed on stone, not earth. Bees' natural inclination is to choose a site quite high off the ground, so lifting them up about a couple of feet is good for them, and good for your back too when you are working the hives.

  The ground in front of the hives must either have the vegetation regularly cut down to leave a clear flight path for the bees, or be treated so that nothing grows there — tarmac, weedkiller, or corrugated sheets are three possibilities. You will be able to think of others.

  As the beekeeper should work the hives from behind, a space should be left behind the hives which gives the beekeeper convenient access. If the space there is level and wide enough to accommodate roofs and stacks of supers etc., lifted off during inspections, working the hives is much easier.

  It is generally believed the hives work best if the entrances face south or south-east. However this is not a matter of first importance.

  Check that each stand you construct is

  – solid and firm and not rocking;
  – level from side to side;
  – sloping slightly from back to front with the front lower than the back.

  Time spent on these details *before* the bees are on your hands will save much labour and heartache later.

- **C Obtaining equipment**

  This will be dealt with under the same general headings as were used earlier in Chapter 3.

  1. **Hives and accessories**

     First decide on a hive type, then do your best to stick to this one type and acquire no other. The simplest in Britain are probably National and Smith, as Langstroth extracting equipment is not so readily available as equipment to handle British Standard frames. National and Smith are certainly the most widely used locally, though we had until recently also users of WBC, Glen and Wormit Commercial hives, as well as some private oddities of no recognisable type.

     Some of you may have inherited or be going to acquire bees already in hives. In this case, provided the hives are sound and of a single orthodox kind, I would advise sticking to that kind, at least to begin with.

     The next decision to make is how many hives to stock. I would always advise starting in a small way, with one or at most two hives. In the second or third season it would be sensible to expand a little. I personally feel that 3 hives is the minimum to keep in the long run, as the loss of a queen, perhaps during the winter, can then be made good by splitting another stock, or perhaps by robbing one of the other hives of a frame containing worker eggs from which the queenless stock can rear a new queen. Even with two hives, it is all too easy to end up with both hives hopelessly queenless, and then the only remedy is to appeal for help to another beekeeper, or else to hope that you may find a swarm to take during the summer.

Later when you have learned by experience exactly what is involved, it will be time enough to consider any further expansion. Note that it is important to be ruthless about uniting stocks in the autumn, or your successful experiments in queen rearing can quickly lead to uncontrolled creeping expansion, which soon gets as out of hand as rabbit breeding.

What constitutes a single hive? The whole point of the modern system of beekeeping is that all parts are interchangeable. A basic hive however will consist of a floor, a deep brood box, complete with frames fitted with foundation (or perhaps with drawn comb), two shallow honey supers, also complete with frames and foundation, a queen excluder, a crown board with holes to double as a clearer board and feeder board, a travelling screen, and a roof. In addition there should be in reserve for each hive (or at least for each two hives) a second deep brood box with frames and foundation. As extra equipment I would want to have one spare roof, floor and crown board. If you do not have this, what will you do when you take that swarm in the summer?

All this could be expensive if bought new. However the boxes, crown boards and roofs *may* be available second-hand. If you are worried about perhaps buying in disease, these items can be disinfected by carefully scorching with a blowlamp. Because of the risk of disease, I would *not* use old second hand combs or even frames in a hive freshly stocked with bees, but use these instead as excellent kindling for a fire. If you have some joinery skills it is perfectly possible to make satisfactory Smith boxes at home, and crown boards and floors are simple. Even roofs are not too hard to make. The new type of open mesh floors can also be made fairly simply, though the metal mesh for them needs to be bought. That is now not too expensive however. Cutting plans for most of the standard hive types are now available on the Scottish Beekeepers' Association's Internet web site at

`http://www.scottishbeekeepers.org.uk/`

You will also need one good feeder per two hives and Porter bee escapes or rhomboid escapes for the clearer boards. To space the frames you need an adequate number of metal ends or plastic ends, or Hoffman converter clips, unless you use Hoffman or Manley self-spacing frames. My advice is to avoid metal ends like the plague, or to get rid of them if you have inherited them! My own choice is to use Hoffman frames in the brood boxes and Manley frames in the supers. One mouse-guard per hive is also essential, and is a fairly cheap item.

In brood frames full sheets of preferably wired foundation are needed for straight and strong combs which permit satisfactory inspections. Because of the widespread growing locally of Oil Seed Rape in the 1990s, which yields quickly granulating honey in quantity, I used to find that it was rarely possible to extract honey from combs in the way which was usual in the 1980s. For that reason it became my practice, which you may decide to follow, to use *unwired* part sheets of foundation in honey supers, with a view to cutting out the combs in autumn, and either using the honey as cut comb honey, or else melting the honey out of the combs with *gentle* heat, before straining it off from the wax and bottling it, and then rendering down the wax. Moulds for casting sheets of wax foundation from your own wax can be bought, but are quite expensive. I have also found that it is possible with care to extract combs built on unwired foundation. Oil seed rape is now less widely grown than it was ten years ago, so the situation has changed again.

For queen rearing either a spare brood box may be used, or a special nucleus box bought or made. This might be an item on which you can at little expense try your joinery skill. It need not be very robust, as it is a fair-weather item which will not be used in winter.

Hive boxes of single-walled hives should not be painted because the damp from within sweats through the wood and causes the paint to blister. Perhaps some of the new porous types of outdoor paint may be better.

An alternative is to treat hive boxes with a wood preservative such as Cuprinol but **MAKE ABSOLUTELY SURE THAT IT IS NOT A BRAND CONTAINING INSECTI-**

CIDE AS A PROTECTION AGAINST WOODWORM. Remember that bees are insects! Thornes and the other beekeeping equipment dealers sell a kind which is suitable.

Hive boxes made of Western Red Cedar do not need treatment since they are resistant to the weather for many years without treatment, provided they are not allowed to remain damp.

2. **Protective clothing**

   Spend money on a good veil and hat/helmet combination that gives you confidence. Buy gloves and use them unless you want to try your bare hands among the bees for a change. A cheap decorating overall will do for a bee suit. Wellingtons you probably already have. I usually try to have a spare veil always with me. Sometimes a veil gets torn and a spare is useful, but more to the point, it is good to be able to show interested friends your bees, and also to get some help with lifting and transport from non-beekeeping friends. It is distinctly unfair to ask others to do without a veil what you would not do yourself! Some of my friends quite enjoy the "man from outer space" look.

3. **Tools for the hive**

   Buy a copper or stainless steel smoker and a good hive tool. Both are essential.

   You should be able to make for yourself a pair of cover-cloths out of old curtain material from a jumble sale (or your attic jumble!). Sew or tack two wooden battens (perhaps lengths of garden cane) into the ends. Cheap dish-towels are another possible solution.

   Hive carriers are a good buy if it will be necessary for you to move hives (and it is surprising how often that is necessary).

4. **Tools for processing honey and wax**

   In your first season, it will probably be simplest for you to go for cut comb honey. In this way you will have no need to consider a honey extractor, or any straining and settling equipment, and you will have no beeswax to process. An extractor is a major outlay, particularly now that stainless steel is the required material for its construction. Dunblane and Stirling Beekeepers have two for use by members. Some equipment for melting granulated honey out of the comb, and for then straining it off the wax and allowing it to settle before bottling is important if you have OSR honey to deal with when you wish to move on to larger scale methods.

   Be very careful not to let honey get too hot, and also not to keep it hot for any longer than necessary. Commercial honey producers are VERY careful about this, and there are recommended maximum temperatures and recommended maximum heating periods. Overheating causes honey to develop bad flavours as well as causing the level of the undesirable chemical hydroxy-methyl-furfuraldehyde (HMF) to increase. If this level is determined by analysis to be above 80 mg per kilogram of honey, then the honey is deemed to be unfit for human consumption! You may need to think carefully about what will work best for you. Much excellent and expensive equipment can be bought, if you think it is worthwhile for your scale of harvest.

- **D Acquiring the bees**

  There are four different ways to acquire bees, and I will enumerate them from dearest to cheapest, explaining how to start in each case.

  1. Buying a nucleus stock or package from a commercial dealer.
  2. Buying a full stock in a hive locally.
  3. Buying a nucleus stock locally.
  4. Acquiring a swarm — either from a local beekeeper who will probably want something for it, or by your own catching of a stray when it is FREE — but of unknown origin and disposition and a lucky break if you get one that is of a mild-tempered and hard-working strain.

1. A nucleus bought from a supplier is just like one bought locally and both are to be treated alike. A package is in essence an artificial swarm — though the queen may be caged when you get it. Treat it like a swarm, following the seller's instructions about the queen. Note however that in these days when varroasis is present throughout most of Britain and all of continental Europe, the availability of stocks of bees for commercial sale is very limited, and *you should definitely not bring into a Varroa-free area a stock from an area that is not guaranteed free from Varroa*. Save your money and get your bees locally.

2. If a full stock is bought, or inherited, then you save yourself the cost of buying a hive separately. Simply start the annual cycle according to the month. Spring is the best time to start as the stock has safely wintered and can be checked at a spring inspection before you buy. *"Caveat emptor"* — "Let the buyer beware" — applies.

3. If you acquire a nucleus reasonably early in the summer (and such a thing is unlikely to be available earlier as they do not winter well), it should build up into a strong stock by autumn, but will probably not yield much surplus honey in its first season. It will consist of 4 to 8 British Standard combs with honey, pollen, brood, bees and a *mated laying queen*. See her before you buy.

   The frames and foundation for the combs cost about £2.50 each (2009 prices) so it is reasonable to charge about £4.00 per comb to take account of the added value. Commercial suppliers charge much more, but probably can't be found now.

   The nucleus will come to you in a closed travelling box. The box still belongs to the seller and should be returned promptly. The contents are all yours once paid for.

   When the nucleus arrives, place the box on your hive stand, loosen the screws holding the roof on, put your veil on and open the doorway of the travelling box to let the bees fly. Then leave them to settle for an hour or so, or even for several days if the weather is bad.

   Then, when the weather is good, put on your protective clothing, light your smoker and go to them again.

   Lift the travelling box gently over to one side of the hive stand, and put the floor and empty brood box of your own hive on the stand.

   Now smoke the nucleus lightly and remove the lid of the box. Carefully lift the combs from the travelling box one at a time, and place them in the same order in the brood chamber of your hive. Give them one or two extra frames of foundation and then a dummy. Fill the space beyond the dummy with crumpled rags or newspaper so the bees don't start to build wild comb there. Bump any bees remaining in the travelling box down on to the tops of the frames in the hive. Put on a feeder. Give them a feed and cover the hive appropriately ending with the roof. Close the entrance of the hive to about 2 cm (1 inch) using a strip of foam rubber, and leave them alone for a week.

   Check their development weekly, and as they expand to cover the new frames, give them more frames one or two at a time till the brood box is full. Feed as necessary but do not over-feed or the combs they build will get clogged up with stored sugar syrup and the queen will have no room to lay. At the same time gradually widen the entrance as the strength of the guard bees gradually builds up.

   Ultimately you may be able to give them a super or at least a "cap" for a limited honey harvest.

4. If you acquire a swarm or a package, follow the instructions on hiving a swarm given earlier, or if you prefer simply bump the bees down through an *empty* super on to the tops of the brood frames in your prepared hive, let them settle directly into the brood box and remove the super. Then feed them generously until they have good drawn combs, and check their development as for a nucleus. Note that even in mid-summer it is probably a good idea these days to treat any newly-hived swarm with acaricide strips against *Varroa* for the full six

week period, since there will be no brood being capped for a full eight days, and no supers on the hive, and in this way you can ensure that they do not build up a heavy infestation in their first season.

Once you have acquired bees, you are a beekeeper, and the bees themselves will be your best instructors if you watch and interpret what you see in the light of what you know. All the methods and ideas I have presented are workable ones and will give you a good practical start, but be prepared to read books, to listen to and watch other beekeepers, and then to try different methods for yourself. In this way you will gradually find the regime that suits you.

Chapter 8

Dealing with the crop of honey and beeswax

8.1 Section honey

The simplest form of honey crop to deal with is that in which the bees have stored the honey in small wooden *sections* a little over 10 cm (4 inches) square, holding about 400 grammes ($\frac{3}{4}$ lb) of honey each. To use these, a section crate must be bought to sit inside or take the place of a super, and the sections must then be fitted inside it with each row of three separated from its neighbour by a tinplate (or plastic) divider. Before the sections, which are purchased flat, can be used, they must be folded up and fitted with starters of thin wax foundation. To prevent the wood breaking when you fold it, damp the outsides of the folding joints. Be sure you insert the foundation the right way with pairs of opposite parallel sides of the hexagonal cell bases lying *vertically* and not *horizontally*, and points of the hexagons at the top and bottom, not at the sides. As the sections are square, it is merely a matter of inserting them the right way in the crate if they are fitted with full sheets of foundation. However if you use starters of part sheets, make sure you cut the wax the right way so that the cell bases have the proper orientation when the starter is hanging from the top of the section.

At harvest, the sections are simply removed from the box, have any propolis carefully cleaned off, and are ready for sale or use. They are probably more saleable than any other form of honey. Tidily wrapping them in clingfilm keeps them clean and enhances their appearance.

There are three reasons why they are not universally used. The first and least important is that all the beeswax from the crop is lost, or at least is eaten with the honey. However beeswax is a rather specialised item with a limited market, and limited uses by the beekeeper and in the home, so this loss might be tolerated.

The second is that they involve purchasing extra equipment — crates and dividers — and are themselves expensive and wasteful as they cannot be re-used. The premium price obtainable however would compensate for this.

The third reason is the deciding factor. Bees HATE them. They dislike the confinement in small separate units apart from the queen and their sisters. They are often very reluctant to enter them and start storing honey there. If the season is poor, they sometimes refuse point blank. Sometimes an old section in the crate with some honey in it will entice them up to start, sometimes not.

The overcrowding in the brood nest when bees stay down in this way is only too likely to trigger off swarming, and many beekeepers therefore feel the game is not worth the candle, particularly if all you have at the season's end is a collection of unsaleable and unusable partly filled sections.

8.2 Honey in shallow frames

Until recently the commonest way of obtaining honey locally was in shallow extracting frames fitted like the brood frames with wired wax foundation.

Once the honey is sealed it is ready for harvest, and it is removed from the combs in a centrifugal honey extractor, so that the combs can be returned to the bees for re-use which means a much quicker second fill of the same super as the bees do not have to use time and honey in secreting wax to re-build the comb. It has been estimated (although I do not know how!) that bees use as much as 6 kg of honey to produce 1 kg of beeswax.

When extracting honey you should work in a warm room and with freshly removed supers. Combs kept for more than a day or two away from the hive are much more difficult to extract, particularly if they have been allowed to cool down.

Before extracting, the cappings must first be removed from the combs by cutting them away with a knife. I now use an uncapping fork, holding the comb on edge above a large bowl to receive the cappings, and working upwards. Special uncapping knives can be bought, and a pail with a batten over it having a nail sticking up from it on which the end of the top bar of the frame can be impaled is better than a bowl. The cappings in the pail or bowl are left for processing at the end. Remember to uncap *both* sides of each comb.

Make sure the extractor has a fairly evenly balanced load before starting to spin it (and of course make sure that it is clean and honey-tight before you begin).

With the small tangential extractors, spin gently to extract the bulk of the honey from the outer comb faces, but not enough to force the honey on the inner faces to burst the mid-ribs. Then turn the combs and spin fairly hard, turn again and finish the first face.

When the level of extracted honey in the extractor rises to near the bottom of the extractor cage, it is time to run it off from the tap through a coarse strainer into a settling tank or ripener.

Finally after finishing off the extracting, the mush of cappings and honey can be dumped into the strainer to let as much honey as possible drain from them. The washing water from the cappings when they are turned out from the straining cloth forms a good basis for a brew of mead if you like that kind of thing. When you are finished, wash all the equipment starting with *cold* water so that scraps of wax float away and do not melt and adhere to everything.

Next day the honey should be run off (ideally through a finer strainer) into jars or storage tins or pails from the settling tank. Honey jars in 2008 cost about 27p each or more. If you are going to sell honey in jars, then be sure not to under-fill them, not to spill honey on the outsides, and also to use commercially produced labels which state in the legally required type size the legally required particulars about weight etc. which now includes the name and address of the producer, and some form of batch number which will allow the producer to identify when and where the jar originated if there is any come-back from a customer. The country of origin (either UK or Scotland) must also be shown, and a "best before" date (which for the small producer can be printed as "Best before end. . . " allowing the producer to fill in a year two years after the bottling date (which is probably about right). The appliance dealers will produce labels for you at reasonable cost with the appropriate name and address particulars, but of course you must add your own batch number when you jar the honey.

Honey which has not yet been sealed by the bees is usually unripe with too high a water content to keep satisfactorily. It tends to ferment. Combs with more than a small area of unsealed cells should not be extracted, but should be returned to the hive for the bees to finish.

8.3 Beeswax

The wax cappings (and any other comb scraps but *not old brood comb*) should be washed in several changes of water, and can then be melted down satisfactorily in a double saucepan over boiling water.

N.B. DO NOT RENDER WAX BY MELTING OVER DIRECT HEAT OR YOU WILL SCORCH IT BLACK AND MAY EASILY SET YOUR HOUSE ON FIRE. IT IS HIGHLY FLAMMABLE.

The molten wax should be allowed to set, and afterwards the surprisingly dirty cake of wax removed from the saucepan where there will be a residue of washing water under it. Some of the dross can be scraped away and the cake then be allowed to dry. The dirty wax must then be carefully re-melted and strained though a pre-heated fine filter — I find kitchen paper is good. A carefully timed sojourn in the *cool* oven of an Aga does the job well, but avoid prolonged heating which scorches and darkens the wax. The clean molten wax can then be poured into a mould and allowed to set. Small moulds can be purchased giving cakes of about 25 g (1 oz) in weight. For larger cakes a pyrex bowl makes a good mould, but it is hard to get a large cake to set without cracking.

Clean wax in bulk can be sold for not a very high price to the appliance dealers, or in part exchange for goods. It makes excellent *candles* and *polish*, and that can probably be sold for a better return. I now have a press for making foundation and have more wax for that purpose than I need. Making foundation is a rather slow process and needs a certain amount of dexterity if it is to be done successfully.

8.4 The problem of Oil Seed Rape

When Oil Seed Rape was a popular crop with farmers locally, honey yields improved greatly. It is a crop that bees love, and is of great benefit to beekeepers provided the farmers do not mis-time their insecticidal spraying. Its main drawback for the beekeeper is that it yields a honey high in the sugar called dextrose, which therefore granulates quickly into a very hard set honey when it cools down. If you try to spoon it out of a jar in this state without warming it up first, you will bend the spoon and crack the jar.

It granulates while still in the comb and even a small admixture of it will solidify a large amount of other honey. Honey set solid will of course not spin out in the extractor. There are three possible approaches.

First one can take supers very promptly off hives as soon as a reasonable proportion of the honey is sealed, and certainly before the super is completely filled. If it is quickly extracted at this stage, then the combs can be preserved, but any delay means that the battle is lost. If one succeeds, the extracted honey will again granulate before it is passed through a fine filter, so the best procedure is then probably to be content with only one coarse filtering, and then to stir the honey vigorously as it is setting. This breaks up the crystals and produces a fine soft granulation which is much easier to deal with. If it does set too hard, gentle heat will soften it again.

Second one can sell or use the honey as set honey in the comb, eating comb and all. This is a simple and straightforward solution, but not everyone likes eating beeswax.

Thirdly one can cut the combs out of the super frames, subject them to gentle heat ($25^0 - 30^0$ C, $80^0 - 90^0$ F) for no more than a few hours, mash up the resulting mess and strain off the honey quickly through a warm strainer before it sets again. Be very careful not to over-heat.

The last approach is the one I have usually used, and is the reason I no longer use wired foundation in honey supers. Until recently it also meant that all my honeycombs only lasted one season. It is wasteful of foundation, but in compensation has meant that I have had a plentiful yield of beeswax every year.

As local Oil Seed Rape growing has declined in our area since about the year 2000, I have found that the extractor can now come back into use to process a crop that has been mostly sycamore, lime and rose-bay willow herb honey. I am still using unwired foundation however, and can nevertheless spin the combs with care and then re-use them.

8.5 Heather Honey

Heather honey is a different story. It too will not spin out in an extractor because it is *thixotropic*, i.e., it is like a non-drip gloss paint. It forms a semi-solid gel until it is stirred, and then becomes liquid for a time, but re-sets again into a gel if it is left to stand.

One good way of dealing with it is to scrape the combs down to the mid-rib with a spoon or a special Smith scraper, wrap the resulting mush in a straining cloth — a pair of lady's tights is very effective — and press the honey out. A proper heather honey press is expensive but it is possible to improvise for this job if you are operating on a small scale. The residue after pressing can again be rendered down for wax. Dunblane and Stirling Beekeepers have two small heather honey presses for use by members, so many of our members get their heather honey pressed that way.

Of course heather honey *sections*, if you can persuade your bees to fill them, are almost worth their weight in gold!

Note: The heather honey described above is that from the common ling heather which yields nectar in August-September in Scotland. Bell heather and cross-leaved heath yield a very dark honey looking almost like treacle, but of a purplish colour. It is gathered a month earlier than ling heather honey. Unlike ling heather honey it can be easily extracted. These kinds of heather are not nearly so common as the ling heather, so if you want to try for them, you will have to enquire about a good site where these plants grow.

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