DISEASES, PESTS AND PROBLEMS by Amanda Millar 2017

Natural bee health and immunity

The mapping of the honeybee genome revealed that honeybees have only one third of the pathways associated with immunity compared with other insects. However, they have a number of physical and behavioural barriers to disease. They use antibacterial propolis within the hive and possess a unique symbiotic gut flora of at least 13 beneficial bacteria which assist in digesting pollen in the gut and may produce antimicrobial compounds and vitamins and other benefits but this is a very recent area of research. Beneficial crop bacteria (eg *Lactobacillus kunkeei* and other L. species) are passed from nurse bees to larvae and a help resist Nosema infection and possibly the Foulbroods. The Royal Jelly they feed their larvae contains antibacterial and antifungal compounds. They generate a fever when exposed to Chalkbrood fungus to try to kill it. Some exhibit hygienic behaviour and throw out diseased brood, or virus-infected adults. When adults are infected with some diseases or pesticides etc they may exhibit altruistic self-removal and voluntarily leave the hive to die elsewhere and avoid infecting the rest of the colony.

They also make use of special 'blood' proteins, waxed cuticle, self and mutual grooming, good queen mating with many drones, the age at which they perform certain tasks such as undertaking by older bees not the nurse bees in order to minimize disease transmission.

Most of these defence mechanisms depend upon the bees being well fed and full of protein rich fat bodies, containing vitellogenin, derived from good pollen sources, to be effective. Vitellogenin is a 91% protein/7% fat compound which is used to make royal jelly and worker jelly, is an antioxidant, is involved in the immune system and promotes longevity. Vitellogenin is passed from the queen to the eggs as an egg yolk protein and contains fragments of bacteria from the environments and this acts like a vaccination to the developing bees, priming their immune systems against certain diseases. In order to help our bees' immunity we need to avoid them damaging their protective cuticle (avoid overcrowding, shut indoors when being moved etc), ensure they have a good diet (pollen availability and variety), don't put crawling bees back in the hive, keep lots of healthy drones for mating and minimizing exposure to harmful chemicals.

Unfortunately periods of bad weather in summer (increasing in the last decade due to climate change) when large populations are confined indoors causes damage to hairs where viruses can enter, causing outbreaks of CBPV, sacbrood and dysentery which spreads disease.

Keep good records to enable changes to be noticed and be prepared to cull before they die to avoid spread both to other bees and to other pollinators as has been found with DWV and Nosema.

How to keep your bees healthy

- GIVE REGULAR INSPECTIONS – for food (honey and pollen), space, disease, queenright, swarming
- AVOID STRESSES – disturbance, pesticide spray, shortage of food, damp, cold, overcrowding, confinement
- RECOGNISE – healthy bee larvae, queen cells, diseases and be prepared to cull if badly diseased
- ROUTINE – hygiene and equipment sterilizing, regular comb changes, good records
- KNOW – where to go for further information – Beebase website, bee books, experienced beekeepers, local bee Division apiary meetings, courses and lectures, the web (need to be selective on web, Americans do things differently; seasons and bee strains differ in other parts of world, lots of rubbish is written by people on some forums and blogs). See useful links at end.

Things which shorten the life of bees:

- *Stress* - Nectar flow and processing syrup/fondant; rearing brood; unsuitable environment and poor weather
- *Low body protein* - from inadequate pollen supply and Deformed Wing Virus
- *Diseases* – Nosema, Viruses esp DWV, CBPV
- *Parasites* – Varroa, Acarine
- *Predators* - Wasps, hornets etc
- *Pesticides* – various sub-lethal effects, lose foragers prematurely, alters population balance in hive

Unnecessary stress can harm the bees. There is little we can do about the weather or unsuitable environment although planting pollen- and nectar-producing Spring and Autumn flowering plants can help. You might think you are doing them a favour by feeding them in the autumn with syrup "until they take no more down" or put fondant on all winter; you may actually be harming them unless they need it to prevent starvation. Assess their stores in Autumn and only feed what they need. Fondant is particularly stressful as they need water to process it, which necessitates risky flights outside in possibly adverse weather, or else they use metabolic water which shortens their lives.

Winter bees need to survive 6 months and then rear brood in the spring. As brood declines in autumn the proportion of pupae infested with varroa increases and there is a big increase in number of mites per cell and therefore the likelihood of that pupa dying increases and viruses are spread. It is imperative that varroa etc is controlled before the winter bees are produced so bees survive until the spring, or the colony will dwindle and die. The importance of treating for varroa in August cannot be overstated.

We have a responsibility to keep pests and diseases as low as possible in our bees, to help them and to reduce harm to our neighbouring beekeepers and reduce damage to other bee species which can be affected by diseases such as Deformed wing virus and Nosema ceranae. Also, unhealthy bees rarely produce much surplus honey and are more likely to die over winter.

Routine Sterilization and hygiene

Hygiene measures should include cleaning hive tools and gloves between colonies and apiaries in strong washing soda (in proportion of 1kg to 5 litres of water), sterilize boots regularly and hot wash bee suit with detergent regularly (after soaking in washing soda to remove propolis if necessary). Zip veil inside suit to protect it. If used, each hive should have its own cover cloths, regularly washed. Put tape round the part of the smoker bellows you hold, which can be replaced regularly, easier than trying to clean the wood.

Don't drop comb or scrapings of wax; put in container for recycling. Don't leave honey or syrup drips or supers uncovered, this will lead to robbing. Don't put hives in a row or drifting and disease transfer will be encouraged. Do not buy second hand frames, best to use new. All equipment should be cleaned and sterilized before using it on another colony. Any used equipment needs to be scraped free from wax and propolis eg with a paint scraper and play a blowtorch over the wood and metal parts so that the remaining wax and propolis boils but just before the wood scorches. The heat will destroy Nosema and Chalkbrood spores, EFB and viruses.

You should change brood frames regularly, (at least every 2 or 3 years) by rotation or better still use Shook swarm or Bailey exchange to do them all at once. In Scandinavia, Shook swarms are carried out routinely, annually. It can rejuvenate and greatly benefit a colony and they soon catch up. If one frame in a colony is dark, or has a bit of chalkbrood or spotty brood and the other frames of brood are fine then I would have no qualms about shaking the bees off that frame and recycling it, giving them a frame of foundation at the edge of the brood area.

Recycling frames – pull out wire (easier if you do not nail through loops), cut out the wax to recycle, scrape any remaining wax and propolis off the frames and scrub them in hot, strong washing soda using gloves and protecting eyes and clothes, or better still boil in washing soda to sterilize and remove any remaining wax and propolis. Boiling will kill Nosema spores, 60ºC for 30 mins, or 50ºC for 90 mins will kill Nosema. Protect floor, work surfaces and surrounding equipment from splashes as it may stain. Any brood comb from a colony which has died due to disease would be better burnt. Super frames can be used for several years providing not clogged with pollen or been used for brood rearing.

Polystyrene hives eg polyhives or mating nucs are more difficult to clean, but very carefully scrape off surplus wax and propolis then wash in warm washing soda to remove propolis and then bleach and rinse thoroughly and air dry. Plastic and polystyrene can be sterilized by soaking in a strong bleach solution (1 part bleach to 6 parts water) for at least 20 minutes before rinsing thoroughly. AFB spores will be killed by 20 mins bleach providing it is in contact so must be cleaned of wax and propolis beforehand.

Keep supers marked and restricted as far as possible to a particular hive, same with cover cloths; it reduces potential disease spread.
Change and clean floors, crownboards and boxes regularly, preferably annually at the first or second inspection in spring

Metal, eg ends, runners, queen excluder - scrape off the worst, then wash in concentrated washing soda. Don't leave metal in washing soda for long or it will corrode, a few hours is fine, then rinse thoroughly. Queen excluder – if metal, scrape off wax and propolis carefully (if holes are distorted the queen may get through), blowtorch to sterilize, but avoid getting too hot or zinc plating/resin coated wire may be damaged, if queen excluder is plastic, wash in hot water with strong washing soda after scraping.
Propolis is waterproof and will smear with hot water. To remove it use concentrated hot washing soda. For wiping propolis off door handles, telephones, floor tiles, hands etc. methylated spirits is unbeatable.

Fumigate super frames of drawn wax in their boxes with acetic acid, after removing brace comb and excess propolis by scraping top and bottom bars and lugs. Remove metal ends first and if metal runners or wired frames avoid leaving more than 7-10 days with acetic acid or they will corrode. Acetic acid attacks metal and concrete. Metal runners can be protected by smearing with petroleum jelly beforehand, or remove them. Acetic acid kills most wax moth stages, Nosema and Chalkbrood. Ventilate for a couple of weeks before putting on a colony. Freeze comb for a week to kill all wax moth; Nosema is also susceptible to lengthy freezing. Wear gloves and protect eyes and clothes when using any of above cleaning products and dispose of waste bleach or washing soda sensibly.
See Beebase website for leaflets; Hive cleaning and sterilization and various fact sheets – but note they suggest caustic soda, this is not recommended – use washing soda which is safer.
http://www.nationalbeeunit.com/index.cfm?pageid=167

Drifting
When colonies are placed in rows facing the same way, bees tend to drift and enter other colonies, often down wind. This can spread varroa and diseases, cause discontent among the colonies and result in an uneven supply of nectar and pollen to them, with the upwind colonies losing bees and stores to those down the row. Point hives in different directions and have at least 6ft between hives to minimize drifting.

Robbing
This is when bees from one colony try to steal the honey from another colony. Small colonies are vulnerable and less able to defend themselves. It may be silent and difficult to detect, or aggressive robbing. Robbed bees become demoralised and small colonies can be robbed clean and starve in a few days. Great care is needed in July/Aug at the end of the nectar flow to prevent this. Robbing spreads disease and varroa and wasps often exploit the chaos. Avoid robbing by adjusting the entrance to suit the size of colony. They rarely need more than a 4 inch wide slot and nuclei can have an entrance, one or two bees wide to help them defend it. Reduce with a wooden block or sponge/foam especially during a nectar dearth. Block any gaps between boxes which wasps exploit. Avoid leaving bits of comb around or spilling syrup, and wash inserts after icing sugar dusting is undertaken, keep supers covered at all times with cloth or spare crown board and minimise the time hives are open. Seal up any dead colony and don't feed swarms, artificial swarms or nucs for couple of days. Italian bees are notorious for robbing. Start any necessary feeding in the evening as it causes excitement, although topping up rapid feeders is not a problem so long as no syrup is spilled, and if returning extracted supers put them back in the evening.

In the event of robbing happening, you may notice more activity from certain hives than is normal for time of day or weather and comb debris or pupal husks may be seen on alighting board or ground. Dust bees with a little flour at the entrance to see which colonies are involved (it is more difficult to tell which the robbed or robbing colony is). Reduce entrance size down to one or two bee widths. Move a robbed colony to another apiary but if it is demoralised it may continue to be robbed. Spray robbing hive entrances with water; they may go home then. If robbing spilled comb or a super which has been left open it is important to leave a bit of comb

so they think they have finished it all off and then go home, otherwise they will fan out looking for it and attack other colonies. Robbing of a dead colony can select for highly virulent mites because a) the mites have killed or weakened a colony sufficiently to be robbed, b) in the wild, low colony density usually means mites which have killed a colony will die with the colony, but in an apiary robbing ensures successful transfer of these mites to another colony.

PARASITES

Acarine

Acarapsis woodii mites live in main thoracic trachea. A female enters, lays eggs, piercing walls of trachea to feed on bee 'blood'. Trachea goes brown and brittle. Shortens life of bee, mites migrate to other bees, via bees, not transmitted via comb. A high infestation leads to the death of the colony in winter. No outward signs. Old books suggest crawling bees but this is caused by paralysis viruses, mites might be a vector or increased stress may brings out virus. Little in the SE, on a good flying year there are fewer infested bees. Get a microscopic examination if many winter deaths. Sample several bees. Some varroa treatments eg Thymol may help but currently there is no approved specific treatment. Avoid robbing and drifting and destroy a colony if badly affected. A brood break may disrupt infestation as only young bees are infected. Bees affected by other problems, such as varroa or bad weather keeping bees in the hive; increases the risk of bee to bee transmission.

Varroa

Introduced into UK in 199l. Parasite originally confined to *Apis cerana* but transferred over to *A. mellifera* and has spread all round the world since about 1949. Only Australia and a few islands such as the Isle of Man are free of it. Initially it caused widespread losses as beekeepers had trouble adapting to the new management methods, and many gave up beekeeping. Varroa can kill a colony in 1-2 years. Now no truly wild bees are thought to live in UK, escaped swarms from managed bees survive for a few years, die out and are recolonised by new swarms.

Mites breed inside the capped cells of brood. A fertile female mite, mature shiny red, enters just before the cell is capped, feeds on the larva and lays a male egg followed by 4-5 female eggs. She favours drone brood as the longer development time enables more mites to mature. Immature mites are white or grey. The male mates with the females in the cell then dies, any mites not mature when the bee hatches; die. In worker brood an average of 1.7 to 2 mites are mature and move to other cells; in drone brood 2-3 mites emerge. Depending on circumstances, mite numbers can double every 4 weeks, increasing 12 – 800 fold in a year. This means treatments need to be carried out every year. The most critical time is in autumn when mite populations are high and adult bee and brood populations are declining. Varroa can then infest a high proportion of brood which should become the winter bees, sometimes with several mother mites per cell; causing brood damage or death. In winter when little or no brood is present the mites live on the mature bees and can survive 5 months and can be carried to other colonies on bees, a process called phoresis.

Most colonies needs treatment or sooner or later will die. It is a vector for Deformed Wing Virus (DWV), Acute Bee Paralysis Virus, Kashmir Virus, Israeli Acute Paralysis Virus, Slow Paralysis Virus, Sacbrood virus, Black Queen Cell Virus and Bacteria (*Serratia marcescens*). Varroa causes stress to bees so they become vulnerable to other problems eg European Foulbrood, Chalkbrood, Stonebrood, resulting in a combination of problems called Parasitic Mite Syndrome. In 2016 it was found that there is a mutual symbiosis between varroa and DWV. DWV suppresses the immune response enabling varroa to breed more successfully causing an escalating negative effect on the bee health and can lead to colony loss. If the Relative Humidity of the brood nest is high 79-85% only 2% of mites can reproduce successfully, if there is a lower humidity of 59-68% RH the 53% of mites can reproduce offspring. If the brood is reared at temps below 34.5ºC it takes longer and more varroa have time to mature, at higher temperatures varroa reproduction is reduced. Using insulation over the crownboard in winter may help the bees maintain a higher brood temperature.

Even if the autumn treatment has been effective, it is important to monitor in October and November as it is still possible for the colonies to have a late invasion of mites if a colony (feral or mis-managed/neglected) collapses nearby and your bees rob it out or they abscond and join your bees. This has happened on several occasions to me in recent years. It is too late by then for conventional treatments and too early for Oxalic (December) however icing sugar treatment (see below) is effective and does not disturb the bees too much.

I said most colonies need treatment. There is increasing evidence that some feral colonies in trees are surviving a long time although this may be because they are much further from other colonies, but also because they may be in smaller cavities and swarm more often thus having a brood break. Research is being carried out into 'hygienic bees' eg at University of Sussex LASI, which can cope better with disease by removing infected or varroa infested bee brood. Some people have stopped treatment and bred from bees which survive and after about 20 years their bees are surviving without treatment. See Swindon honeybee conservation group website and YouTube https://www.youtube.com/watch?v=DUFDXl8VGvs and the experience of Clive and Shan Hudson https://beemonitor.org/2016/07/20/has-varroa-lost-its-sting/ A lot of colonies are required to select for resistant bees and considerable losses are to be expected in the early days.

Monitoring - Mesh floor

10%+ of mites drop through the floor and are lost, and increased ventilation reduces damp problems in winter and reduces chalkbrood levels too by reducing Carbon dioxide levels. The numbers of mites found on the insert under the mesh floor also enables monitoring of mite numbers. In theory the drop is related to total population although this is not always the case as you can easily prove by monitoring on a monthly basis. Factors such as hygienic behaviour, level of activity, quantity of brood, season, weather etc. affect the drop. Best to count the mites after the insert has been in 7 days and calculate the average daily rate; a one day monitoring is too inaccurate to be meaningful. Some floors come with plywood inserts on which it is more difficult to see mites, and may distort when surplus sugar is washed off. I suggest it is painted with white gloss paint or better still obtain yellow or white plastic Correx sheets which can be cut to size. If mice droppings are found on the insert they have probably removed many mites, especially in winter; recheck and put something at back to prevent mice. Only put the insert in for monitoring or treatment. Otherwise it is a magnet for wax moth and mice.

Monitoring – Drone removal

Remove drone pupae at pink eye stage using uncapping fork, count proportion of pupae infested with mites (not the total number of mites), best to use 50 or so drones, calculate percentage. (See Beebase website for varroa calculator) http://www.nationalbeeunit.com/public/BeeDiseases/varroaCalculator.cfm?
And Managing varroa booklet http://www.nationalbeeunit.com/index.cfm?pageid=167

Monitoring – Icing sugar dusting

(see details below). Dusting has been found to remove about 30% to 50% of the phoretic mites (ie those clinging on to the bees). The majority (80%) of the mites fall within an hour of the dusting and after 24 hours the drop is back to the normal background mite drop. Research indicates that a powdered sugar dusting gives a quicker, more accurate, estimate of mite level in the hive than either natural mite fall or washing 300 bees in alcohol (which kills the bees too).

Varroa Treatments

Whatever treatment you choose to do, it is best to do all the colonies in an apiary at the same time, because drones move freely between colonies and will redistribute varroa if one left untreated.
Initially chemical impregnated strips 'varroacides' (Apistan and Bayvarol) were used successfully to knock the mite population back to low levels, with 95% + efficacy, but used only after the honey was removed as it can contaminate honey. However, the prodigious breeding rate of mites meant that by 2001 cases of resistance were found. Another wave of bee losses occurred in the following few years while beekeepers adapted to new treatments. Now the best method seems to be Integrated Pest Management (IPM), a combination of chemical and biotechnical methods as no one method seems to be better than 90% now. For example a typical IPM method avoiding hard chemicals might be: Apiguard starting in August for 5-6 weeks, Oxalic acid in

December/January, mesh floor throughout the year. Then if not doing a shook swarm or artificial swarm, 2 or 3 icing sugar treatments each in spring and late summer as well will keep the level of mites down well. All chemical treatments, including organic acids have the potential for developing mite resistance and should be rotated.

Icing sugar treatment

How does it work - the fine powder causes the mites to lose their grip, it also promotes bee grooming and more get knocked off to fall through the mesh floor. It only affects phoretic mites, not those in the brood cells. 30% to 50% of phoretic knocked off each dust application.

Application: The easiest way to apply it is to dust it on the top bars of the brood box where most of the phoretic mites are, but no need to dust the honey supers above the queen excluder, as research indicates varroa tend to stay in or around the brood area on nurse bees. Use 125g (1/4lb) icing sugar per brood box then brush any sugar on the top bars into the seams. (See http://scientificbeekeeping.com/ Biotechnical Tactics II, for good pictures). Use a sugar shaker, or stainless steel flour sieve/shaker. There is no need to take out each frame and dust it. Not technically approved as mite treatment, but harmless to bees.

When – any time of the year, especially good in honey flow when no chemicals can be used, (apart from MAQS formic acid), probably does not work well when they are in a tight winter cluster and rather disturbing but I have done it successfully on mild November and December and February and March days when the temp is over 8 degrees C, or the bees are flying. Also do it whenever there is a brood break and the mites are mostly on the bees and at their most vulnerable to this treatment, eg do on a swarm or artificial swarm.

How often – If you think you have a high number of mites, for example more than 10 mites, 20 mins after dusting, you may need to dust again ideally at 5 day intervals for a month, and then reduce to once a month to keep levels low. Two or 3 dusts in the spring and 2-3 in the autumn will help keep on top of the mites. It only affects the phoretic mites and every day new mites are hatching so a one off dusting is only going to reach a small proportion of the mites, but as the mother mites only return to lay in cells after several days, doing a dust every 4-5 days for a whole brood cycle should really knock them down. Sometimes needs two brood cycles to get the mites to low levels again after a varroa invasion in the late autumn.

Type of sugar – Pure icing sugar, and if you can get it, with no additives like dicalcium phosphate or silicon dioxide or glycerine which may be toxic to bees, so avoid the fondant icing etc. Keep it dry. Some icing sugar now has corn starch in it, it is not as fine but after a year of using it seems no have no adverse effect on bees.

Important – It only works with a mesh floor. If you have applied sufficient it will come through onto the insert. Put the insert in before dusting, to collect the sugar and the mites, as it does not kill the mites, merely knocks them off. This needs to be disposed of away from the bees and the inserts washed and best not to put them back on the hive as any sweetness attracts wasps.

Things to improve its effectiveness – Keep top bars clean of burr comb, which would make it difficult to brush surplus icing sugar into the seams, burr also might cause bees to be squashed when the crown board is replaced. Have the sugar in the shaker all ready to dust as soon as the crown board is lifted, to prevent the bees flying up; then no smoke is required. Brace comb between frames can lodge the icing sugar and reduce the effectiveness, so cut this down with the hive tool first.

In autumn/winter dust at the warmest time on a calm sunny day about midday over 8ºC; as the flying bees may beard at the entrance for a few minutes grooming themselves before going inside and you would not want any which fly up to chill and be unable to return to the hive. In August to October wasps can be a nuisance so be careful not to spill sugar and only leave insert in for about 20 minutes or they will walk all over it and make it difficult to count. The gap at the back can be blocked with a cloth to keep them out. This is the time when mites invade so dusting is likely to be needed in September to November.

No need to dust the honey supers, only the boxes with brood in, but do all the boxes they are wintering on. If you run a brood and a half then unless you have identical spacing and all the frames are pushed to the same side it will not work well as it gets lodged on the top bars of the lower box if frames are not aligned. So if you have, for example, Hoffman below and standard spacers above; start by dusting the upper box, wait 5 minutes, then lift it off and rest on upturned roof or spare crown board (to catch any dusty bees which fall off) then dust the lower box, brushing the dust off the top bars, shut up hive and wait at least 20 mins. Alternatively put identical metal or plastic spacers on the Hoffman frames if you intend to dust on a regular basis so they match the upper spacing.

Avoid windy days when the powder blows away and wet or misty days when the powder will clog and reduce effectiveness. If it does not come through the mesh floor, then either the floor is blocked by debris and dead bees (eg in winter) or damp sugar, or insufficient sugar used, or the frames are not aligned and it is lodging on the top bars. It can attract ants and wasps on the insert and apparently it can stimulate robbing if there is a nectar dearth, so avoid spilling sugar and take anti-robbing precautions if necessary. There is minimum disturbance to the bees if the frames are not disturbed and you work quickly, I have had no problems when using it with a queen cell or virgin in the colony, and it is particularly effective in these circumstances as there may be little brood and the mites are mainly on the bees.

Thymol treatments

The easiest and popular method is a tray of Apiguard placed on top of the brood, as soon as honey removed. Based on natural thymol, it is not thought likely the mites can become resistant as it works partly by stimulating increased grooming by bees so mites knocked off. Needs a 1" eke (spacer) between brood and crownboard to create space for tray. Mesh floor closed (ie insert in) and crownboard hole closed. Add new tray after 2 weeks, needs to be there 5-6 weeks total to cover 2 full brood cycles as it does not affect mites in sealed cells. Temperature sensitive, it relies on evaporation of thymol so in hot weather bees become distressed and may put queen off lay. If too cold, it will not evaporate enough. In ideal conditions at between 15 ºC and 25ºC, 90-95% efficacy can be achieved. So post treatment monitoring is important to be sure it was effective. ApilifeVar also uses thymol and other essential oils, it seems to be effective and thin enough for an eke not to be required, although it can make the bees bad tempered and the strips are rather fragile and crumbly, put on squares of paper to make it easier to remove at the end of treatment, it stains frames and the bees propolise over it.

Oxalic Acid, Formic Acid, Lactic Acid

These are acids naturally present in hives and plants in small quantities. Oxalic treatment must be done when brood is at minimum as it does not kill mites in the cells, eg late December. Gloves and eye protection against acid must be used. It works well with 80-90% efficacy. The only authorised oxalic acid product is API-Bioxal. Oxalic acid should only be used once in a bee's lifetime – remember queens can live a couple of years. See instructions on Beebase website. Research from Sussex University suggest most effective if any sealed brood is killed, scratched or removed the day before which can be disturbing to colony especially if weather cold. Oxalic is trickled between the brood frames or vapourised from below. It is possible the abrasive crystals of oxalic acid may damage bees' cuticle opening a way to viruses etc and small risk of queen loss. There is evidence it may harm beneficial bacteria and fungi.

Lactic acid has to be sprayed on each side of the frames during the active season and is more disruptive, however it can be used several time, but only gets the phoretic mites so best when broodless such as on a swarm. Two treatments remove 83-99% of phoretic mites removed. There have been reports of queen loss with organic acid use, especially with formic acid. The formic acid is now available as a pad (MAQS) which is placed over the brood frames, however if the colony is small it can easily be overdosed and harmed. It is also temperature sensitive to be used between 10 and 30 ºC, if too warm the bees can be harmed. The treatment lasts 7 days and can be used with honey supers on. There may be some brood mortality and may cause queen loss or supersedure (10%). The floor must be open with full ventilation. 60-80% effective.

Other products include Exomite (not very effective and distresses bees in my experience), Apivar (not legal in UK and Amitraz is a dangerous chemical). The USA permits very dangerous chemicals which we should never use and are not registered for use in UK, eg coumaphos (Perizin/Checkmite) which is an organophosphate and has been found to affect the bee's memory. Most treatments should not be used during honey flow except formic acid, so April to August is a problem. Icing sugar dusting is useful at this time, particularly effective when there is a brood break eg during artificial swarm or shook swarm.

Biotechnical methods.

Drone brood traps: put super frame in the brood, in summer bees will build drone brood below it, when capped, cut it off and destroy it (melt down). Mites preferentially enter drone brood to breed because it has a longer development time. This can only be done in summer when drones are being produced; however it will remove

drones essential for breeding, so people are going off this method. Up to 50% mite removal is possible. There are other more complex methods – Queen trapping (95% effective), artificial swarm, shook swarm etc which involve an extended break in the brood rearing (90% effective). All have drawbacks such as removing brood which might be needed for honey harvest and timing is critic, requiring finding queen etc, but at least do not require chemicals. See the Beebase leaflet Managing Varroa, for more details on these methods.

Natural Selection and Non-chemical
The best long term solution is to select bees resistant to mites and other diseases and those showing hygienic behaviour, ie they uncap and throw out diseased or infested pupae or groom the mites off, this applies to many brood diseases not just varroa. All beekeepers can do their bit by only rearing queens from their best, strongest, healthiest colonies. A total non-treatment approach (no hard or soft chemicals, organic acids, thymol, icing sugar, drone brood removal or brood break) could lose up to 90% of colonies and take 10 or more years to achieve results. Only suitable if apiary is isolated from other bees (3-5km) and have lots of colonies. Not suitable for inexperienced beginners with only a couple of colonies.

DISEASES

Checking for diseases
Before you can inspect for disease you need to be able to see the brood which means removing the bees on it. Remove the outer one or two frames with no brood on to give you space to move. Pick up the first frame with brood on, look for the queen, if she is there move her into a queen cage for safety with a few workers and put her in your pocket while you carry out the inspection. Take the frame, lower it half into the space created and give it a sharp downward shake. Most of the bees will fall off into the brood box. Inspect the frame thoroughly, replace it and move on to the next one. You should inspect most of the brood frames in this way. When you have finished don't forget to allow the queen to run in between two brood frames as you put the hive back together. If more than 20% of the cells in the brood area are empty then suspect some sort of disease.

European Foulbrood (EFB)
EFB is caused by the bacterium *Melissococcus plutonius.* The bacteria feed on food in the larval gut and starve the larvae. Larvae usually die before the cell is sealed. Affected larvae are seen in unnatural positions ('stomach ache'), colour changes from pearly white to cream and eventually dry to form a brown scale which is removable by the bees, resulting in uneven aged, patchy brood. In early stages, infected larvae have a melted appearance. Cell contents *do not rope.* **EFB is a notifiable disease.** If you think you have it you must contact your regional bee inspector, who will obtain confirmation using a lateral flow device, which can be purchased from bee suppliers. If confirmed, treatment with antibiotics by the BDO (Bee Disease Officer) may be used if the infection is light, a shook swarm method of treatment may be recommended, or destruction. The inspectors are very helpful and full of good advice. A shook swarm of the remaining colonies might be a good idea as the bacteria could be present with no symptoms. A standstill order will apply, preventing movement of colonies and equipment until the all clear is given.

American Foulbrood (AFB)
AFB is caused by the spore forming bacterium *Paenibacillus larvae* . The spores, which can survive for decades, contaminating the brood food, develop into bacteria that penetrate the gut wall and multiply in the larval body tissues. The larvae usually die from 'blood poisoning' after the cell is sealed. The brood has a patchy 'pepper pot' appearance with lots of spaces where diseased larvae have died. Cappings may appear moist, sunken and perforated. Initially the dead larvae are slimy then dry to form brown scales, which can be seen if the comb is tilted to the light. The scales are difficult to remove and are highly infective – spores have been known to be viable after many years. Diagnosis can be confirmed by the 'ropiness test': a matchstick is inserted into a suspect cell, twisted and withdrawn slowly. If AFB is present the larval remains will be drawn out as a brown mucus thread. **AFB is a notifiable disease** – the BDO will arrange for bacteriological confirmation. A standstill order will be put in place. If confirmed, the BDO will supervise the burning of bees and combs and the sterilization of the hive. Bee Disease Insurance (BDI), through BBKA membership, provides

compensation for destroyed frames. Do not feed foreign honey to your bees or honey of unknown origin, which may contain AFB spores. Swarms, drifting and robbing may bring AFB. You are not allowed to treat AFB with antibiotics. See Beebase website, leaflets: Foulbrood disease: recognition and control, for more detail.

Chalkbrood

This is caused by the fungus *Ascosphaera apis*, is widespread and found in seemingly unaffected colonies, it often appears in the spring in expanding colonies when the adult population is at its lowest. The trigger is not completely understood, however optimal growth of chalkbrood occurs when the brood is chilled below 30ºC even for a short time and high carbon dioxide levels in the brood nest (and high humidity (87% RH) may have a small effect), such as may occur if there are insufficient bees to keep brood warm enough or to ventilate the colony of excess carbon dioxide (mesh floor helps here), and deficiencies of pollen are possible factors. It may also be genetic, in which case re-queening may help. The fungal spores are ingested by the larvae and germinate in the gut when the brood is chilled. Strands of fungus invade the larval tissue and the larva dies, frequently after the cell has been capped. The dead larva is chalky white at first, often with a yellow centre, and becomes very hard and loose in the cell (*mummies).* Additional black/grey spores may develop on the surface. Mummies are removed by house bees and can be seen outside the hive or on the insert. Chalkbrood mummies should not be confused with discarded mouldy pollen, which has coloured layers**.** Combs can be sterilized using acetic acid fumigation. As chalkbrood spores can survive 15 years, a colony with it would benefit from a shook swarm onto clean foundation and box. Avoid swapping equipment and frames between colonies and avoid manipulations causing chilling eg overwintering with empty supers, inappropriate spreading of brood. Adding insulation over the crownboard for winter might help reduce it, especially with small colonies. It is associated with Nosema (see under Nosema) and similar stressors promote outbreaks.

Stone brood

Stone brood is a fungus *Aspergillus flavus*, and *A. fumigatus.* Fortunately rare, it looks rather like chalkbrood, except the mummies are yellow/green or brown/green. Brood and adults are affected. It can cause respiratory problems in humans and birds.

Baldbrood

More than one cause; often the result of wax moth larva chewing cappings, this does not seem to affect bees, if you see a silken tunnel prod it with a hive tool and kill the emerging wax moth larva. However it may also be genetically based. When there are raised edges of cells, this could be a result of bees detecting a varroa infestation so they do not finish capping them.

Nosema

Nosema apis is a microsporidian that invades the intestinal tracts of adult bees and causes nosema disease (‘spring dwindling’). Nosema is also associated with Black Queen Cell Virus. It can be picked up when bees visit flowers previously visited by infected bees, Nosema is treated by shaking the colony onto clean frames and boxes. Beekeepers used to treat a hive with antibiotics, eg Fumidil B, but this treatment was withdrawn in 2011. Nosema can also be minimized by removing much of the honey from the beehive then feeding the bees on sugar syrup in the late autumn. Sugar syrup made from refined sugar has lower particle content than flower nectar which contains pollen, reducing the risk of dysentery.

In 1996, a similar type of organism to *Nosema apis* was discovered on the Asian honeybee *Apis cerana*; called *Nosema ceranae*. This parasite also infects the Western honeybee and has few symptoms but kills bees in a month or two and may be the cause of sudden unexplained colony loss. It is associated with other stress related diseases eg chalkbrood, and viruses. Spores can survive 2 years in faeces and up to 5 yrs in dead bees.

Acetic acid will sterilize supers used on the colony, a shook swarm and feed of pollen substitute may bring an ailing colony round. If the colony is weak a Bailey Comb change would be better. Some herbal supplements claimed to help prevent it eg Nozevit, Vita Green. Hygiene and regular comb change is the best prevention

Stressors promoting Nosema include moving bees, confining, small mating nuclei, periods of Queenlessness, poor nutrition, high density of hives in area, poor seasons, wet, damp, cold etc. Rural bees may be under less pressure from pathogens, especially Nosema, and live longer, possibly because urban sites are warmer and more crowded, allowing easier disease exchange.

Viruses
Acute Bee Paralysis Virus (ABPV or APV)
Israel Acute Paralysis Virus (IAPV) – linked with CCD
Chronic Bee Paralysis Virus (CBPV or CPV)
Kashmir Bee Virus (KBV)
Black Queen Cell Virus (BQCV)
Cloudy Wing Virus (CWV)
Deformed Wing Virus (DWV)
Sacbrood Virus (SBV)
Kakugo Virus (KV)
Varroa Destructor Virus 1

The CBPV and Deformed Wing Virus are becoming more common and can cause colony decline and loss.. Along with Sacbrood and BQCV they are the only ones with recognizable symptoms.
CBPV - Lack of coordination, trembling, cannot fly, crawling, dark, hairless, nibbled, refused entrance by guard bees, dead outside, paralysed on top bars, K wing. Trembling seen in bees after 5-6 days, die in about 10 days.
DWV - Crumpled wings and smaller when transmitted to pupa by varroa. Bees infected as adults show no outward sign but have impaired learning, reduced immune responses and die in about 12 days. Associated with winter mortality. BQCV and DWV are present in over 80% of US colonies tested. DWV is the virus most likely to be linked with winter mortality. In 2015 some bees were found to have a non-lethal strain B of DWV which is preventing the more virulent strain A from getting a hold and the bees have survived without treatment for a number of years. See more on the Swindon Honeybee Conservation Group website. Exciting news!
BQCV - Queen pupae die with symptoms similar to Sacbrood, and the queen cell may become dark, the contents black. Larvae more susceptible when blossom (esp almond, grapes and top fruit) is sprayed with pesticide enhancer Sylgard 307.

Confinement and overcrowding damages the cuticle allowing virus transmission. Too many colonies for the available forage leads to nutritional stress and lowered immunity. There is as yet little information on how long they can survive off a bee, but some viruses are spread by feeding, trophallaxis and it is spread via faeces, so hygiene and regular comb changes will help reduce viruses.
Varroa is important for the spread of several of these viruses eg DWV, BQCV, KBV, ABPV, SBPV so controlling varroa is essential. If badly affected the best course of action is to kill the bees and disinfecting the hive. Bumblebees are now also catching DWV and *N. ceranae*; this is most likely to be from flowers visited by honeybees. Local strains of honeybee have been found to be better adapted to their local strains of virus, so it is best not to import foreign strains of bee.

Sacbrood
Is a virus which affects brood, with symptoms being dead larvae in fluid filled skins and perforated cappings, transmitted by nurse bees and beekeepers swapping equipment between hives, drifting and robbing. Not usually common but very common in 2015, transitory in early summer, not virulent, can re-use combs after a few months when it becomes non-infective. No recognised treatment but shook swarm or requeen if bad, but this is not always effective, best to destroy affected comb. Spread by robbing, drifting, beekeeper using infected equipment. Nurse bees can contract is when cleaning out the dead larvae and then feeding other larvae. It can reduce their foraging days to a third and affect their ability to regulate temperature, they die young. It can be seen in collapsing colonies.

Amoeba
Amoeba may be the cause of Spring dwindling and dysentery. The organism is spread via faeces and results in a shortened lifespan. There are no outward symptoms but cysts may be seen at x400 under the microscope. There is no medication, but putting them on clean comb, sterilizing equipment and fumigating comb with acetic acid should help. Avoid exchanging comb, robbing, drifting etc.

Dysentery
Dysentery is not a disease as such but may be a symptom of several different diseases such as Amoeba, Chronic Bee Paralysis Virus, Nosema apis, poisoning, late feeding in autumn, granulated, fermented or under-ripe honey, impurities in stores, heather honey, a hard winter or wet summer so bees are confined indoors while active or when moving hives and they defecate in the hive, or around entrance. The dark brown dysentery is more worrying than yellow or orange spots. The dark brown dysentery is more worrying than yellow or orange spots.
Treatment - change comb (faeces spread viruses), feed clean syrup.

Ways to prevent the spread of brood disease

- Recognise healthy brood
- Be familiar with signs of brood disease
- Keep varroa levels low
- Sterilize gloves between colonies and between apiaries
- Regularly wash bee suit, hive tool, cover cloths, boots etc
- Avoid squashing bees; use gentle management
- Avoid stress to bees, eg pollen shortage, moving
- Never transfer comb between colonies without checking for disease
- Never bring in equipment or bees to apiary unless sure they are OK
- Never buy old comb
- Regularly replace old brood comb by artificial swarm, shook swarm or Bailey exchange
- Regularly sterilize boxes by flame, never re-use on another colony without disinfecting
- Fumigate supers and any stored comb with acetic acid
- Control robbing, cover boxes, don't leave comb or honey around
- Never feed honey from another source
- Control drifting
- Control overcrowding in colony and in apiary
- Inspect colonies at least in spring and autumn for brood disease
- If colony not thriving; suspect it and inspect it
- Cull badly affected colonies and disinfect the equipment
- If colony dies seal it up immediately
- Be suspicious of stray swarms, quarantine them if possible
- Each colony should have its own marked supers

http://www.msbain.co.uk/elbka/Diseases/Bee%20Diseases%20front.htm
Wikipedia website is quite good – Diseases of the honey bee
http://www.brightonlewesbeekeepers.co.uk Information sheets page for table of symptoms and diseases.

Killing a colony
If the colony has bad virus, chalkbrood, Nosema, or is too aggressive to approach or remains small and never builds up it is probably best in the long term to destroy the colony straight away rather than risk spreading the disease or maintaining the susceptible genes in the population. If the colony is not too aggressive and there is honey you wish to rescue then shake/brush the bees off each frame into a large bucket of water with detergent in. They will drown very quickly. It is time consuming as the flying bees will be in the air and will keep

returning to the colony. You need to get all of them if it is because of disease as any survivors will join neighbouring colonies. If the disease is really bad or they are very aggressive and it is imperative you kill them all, close up the entrance after they return at dusk, put the underfloor insert in and pour a cup of petrol in the crownboard hole and shut it up. You will not be able to salvage any honey or wax, and the frames will probably have to be burnt – with care! I have tried Acetic acid, so some wax and frames could be recycled, but it took 2 days before they all died, probably a lot of acid is required.
If it is EFB or AFB you will have to take the advice of the Bee Inspector for these notifiable diseases.

PESTS

Wax Moth species; lesser and greater – pest in stored comb, especially dark brood comb (more protein there) which they can destroy. Small colonies can suffer from them, also they damage woodwork when pupating. A strong colony will keep them down. They often pupate round edges of old frames in hive. Watch for larvae when examining bees, and their droppings on the underfloor insert. Acetic acid treat stored comb or freeze for a week. Strip down frames for recycling promptly, to avoid moths hatching. The larvae may cause 'bald brood' by chewing off the cappings exposing the pupae, usually in a line.

Woodpeckers will peck holes in brood boxes in winter and eat the brood and bees, once they learn they will teach their offspring. When equipment is damaged, holes let in mice etc and can cause loss of colony. Use wire netting round hive in winter, repair any holes promptly using wood, wood filler etc.

Mice in winter, they damage comb, bees hate urine smell, use mouseguard, or use an entrance slot of 8-9mm high; average mouse skull is about 11.5mm high. Alternatively nail frame pins at 9mm apart in the entrance block. The circular mouseguard holes tend to knock off pollen loads and makes it difficult for bees to remove dead bees through and can lead to a trapped colony, so the lower entrance or one with pins is probably better for the bees. They can also mess up the varroa monitoring by living on the insert. **Pygmy shrews** can eat bees on the outside of a cluster, decapitating them; use 6mm entrance block.

Wasps and hornets can be a huge nuisance in late summer, angering the bees; they can also rob out small colonies and nuclei and kill them. Put wasp traps out from June and traps from in early March should catch the queens emerging from hibernation (see details of Asian Hornet Trap below for bait).

Asian Hornet (*Vespa velutina*) Has been in N France for a few years and on 21st September 2016 was found in Gloucestershire. They attack colonies in a coordinated way and kill them. The native European hornet (*Vespa crabro*) also takes bees and can affect population of nucs and apidea and even kill them completely but is not as serious as the Asian. Put traps up in early March to catch queens. See Asian Hornet trap on:
http://www.nationalbeeunit.com/index.cfm?pageid=167
An entrance height of 5.5mm will exclude the Asian Hornet.

Ants get into feeders and eat syrup and get onto the crownboard and annoy bees, in wet summers they may move nest and eggs under hive roof where it is warm and dry. Apparently ants do not like cinnamon sticks, alternatively use water or oil or petroleum jelly barriers round hive legs, but bees might get stuck too. Ants can infest stored supers especially if stored wet.

Small Hive Beetle not yet in UK but was found in SW Italy in September 2014 and again in September 2015. It is devastating in USA, so do not import bees, we don't want it here. A notifiable pest.

Tropilaelaps mite, not yet in UK, smaller than varroa and more troublesome, but may be susceptible to winter cold and brood breaks. Notifiable pest: call Bee Inspector if suspected and collect samples.

Minor pests include Bluetits which tap at the entrance and take emerging bees, also spiders, toads, beekeepers. Woodlice, earwigs and slugs may be found under roofs.

PESTICIDES

More incidents are reported from inappropriate killing of bees in cavity walls etc, than mass killings from farm sprays in UK. Any bee destruction should have the access hole sealed to prevent other bees robbing poisoned honey and taking it back to their hives. Inform your local farmer of the presence of your bees and ask to be informed when he is spraying so you can shut up the bees by putting foam in the entrance the night before spraying, or move them away. The high profile of bees hopefully has made farmers more sympathetic now; it used to be a big problem. From summer 2016 a Spray Liaison scheme has been set up, see BBKA website.

Since the determination of the honeybee genome it has been found that bees are markedly deficient in the number of genes encoding detoxification enzymes and so are more vulnerable to pesticides etc. than other insects. In the United States bees are frequently killed by inappropriate aerial pesticide sprays. The big multinational chemical companies manufacturing these pesticides (Bayer, Syngenta etc) make billions on their sales and are understandably slow to admit their products might be the cause of any bee problems and their power gives them influence in high places. In early 2013 the EU EFSA declared there was enough scientific evidence for a precautionary ban on seed treatments using three Neonicotinoid pesticides (neonics) while more tests are done, but the UK government blocked this proposal to the disappointment of beekeepers, although later caved in under pressure but only for 2 years. Neonicotinoid survival in soil for at least 3 years means improvement is unlikely with only a 2 year ban which was due to be lifted in December 2015. But extended by the EU until end 2017, and an appeal by the NFU was rejected.

Beekeepers are becoming increasingly concerned about the sub lethal affects pesticides may be having on our bees and their link with the problems we are facing. Pesticides can weaken the colony by killing or otherwise affecting the foragers, altering the population balance, reducing adult bee longevity, having adverse effects upon the queen, brood, or nurse bees, reducing drone fertility, or by affecting bee behaviour. In addition, they could react synergistically with other toxins, fungicides, beekeeper-applied miticides, to suppress the bee immune response to pathogens. Any of these could conceivably result in colony dwindling, mortality, or collapse. Every month further scientific research is published with evidence that Neonicotinoids and other pesticides are doing just that. They survive several years in soil, contaminating the following crops; get into the water drops produced by plant leaves (guttation). Honeybees, bumblebees and solitary bees exposed to neonics experience problems with flying, navigation, reduced taste sensitivity, slower learning, impaired memory, reduced food collection and consumption, queen failure and reduced worker and brood survival, of honey bees, bumble bees and solitary bees. In combination neonicotinoids and coumaphos (an organophosphate mite treatment not permitted in UK) cause bees to suffer memory loss and learning reduction. Colonies exposed to Imidacloprid (a Neonicotinoid) or to Chlorpyrifos exhibit winter mortality, Imidacloprid also results in increased Nosema infection and reduced colony immunity. Honeybees and bumblebees have been found to become addicted to the nicotine-like compounds in neonicotinoids and return for more. More neonics (97%) are brought back to the hive from the field margin flowers than from the crop itself. There is evidence of increased population extinction rates of solitary bee species using oilseed rape in response to neonicotinoid seed treatment use on oilseed rape.

Testing samples from hives (wax, bees, pollen etc) in USA found pesticides in 91% with up to 39 different pesticides per sample (total pesticides 132), with potentially worrying synergistic effects. Some of these were in-hive miticides such as coumaphos and fluvalinate, emphasising the importance of using naturally occurring varroa treatments such as the organic acids and thymol rather than hard chemicals.

Symptoms of acute poisoning include:

- Sudden large numbers of dead bees outside the hive, possibly with extended proboscis,
- Regurgitating nectar,
- K wing, paralysis, abnormal behaviour,
- Bees crawling, trembling, spinning round (symptoms like CBPV).

- Loss of foragers will result in neglected brood.
- Contaminated foragers with abnormal behaviour will be repelled by guards.
- Most of colonies in an apiary will be affected and they may have a bad temper.

Symptoms of chronic, sub-lethal poisoning are less obvious but include:

- Higher mortality of adult and brood
- Delayed mortality (like CCD)
- Reduced homing ability
- Reduced foraging especially pollen
- Increased queen supersedure
- Synergistic effects with Nosema etc
- Greater susceptibility to Nosema etc
- Impaired memory and learning deficit
- Reduced drone fertility

To prevent this happening, let local farmers know you have bees nearby. Become familiar with pesticides likely to be used and levels of toxicity and application method; for example if the weather is cold when sprayed, it will not dry and the next day may lift and drift if warmer. Dusts are very hazardous and prone to drifting. If moving bees to a crop make sure the farmer knows what is unsafe for bees, advise of spray drift etc. Do not use banned or unauthorised miticides or acaricides in the hives and follow bee treatment recommendations. Have a 'safe' apiary over 3 miles away to move them too if necessary before spraying commences. Close up hives the night before, give them extra space (a super) ventilation, water and shade if closed up all day. If the bees are already out foraging when you learn of spraying, cover the entrance with straw or grass; the bees will fuss around it and will not go out to do much foraging.

If the bees have been contaminated, move hives away from sprayed area, remove excess supers containing contaminated nectar. Because of the loss of foragers you may need to feed colonies inside hive with 1:1 syrup. Be prepared to manage the colonies for queen failure or supersedure but do not requeen until the chemical is considered no longer active. Replace contaminated frames and in extreme cases shake bees into new clean equipment. Add frames of sealed brood from healthy hives if required. Take 3 samples of bees, each 300 bees and report with full details (weather, numbers of dead, pollen samples, map, date, crop etc) and photos to BBKA, National Bee unit, Wildlife Incident Investigation Scheme.

OTHER PROBLEMS

Mould – store supers dry (bees allowed to lick them dry after honey extraction) in cool dry place. If outer frames of small colony become mouldy over winter, recycle them as bees will not use them. Mouldy pollen is sometimes removed by bees and look a little like chalkbrood mummies. Replace with clean frames.

Queen loss – results in emergency cells. Queen loss may be caused by poor beekeeper handling when queen is squashed or damaged and bees reject her; varroa treatments eg formic acid or disease. Viruses can kill a queen if she is damaged by varroa. If bees make swarm preparations and the beekeeper removes queen cells, it will not prevent them from swarming and may leave no means of replacing the queen if/when they do swarm. If after a swarm or artificial swarm the virgin does not hatch (due to disease) or does not return from her mating flight then the colony has no means of replacing her and becomes hopelessly queenless. The old queen is often replaced in autumn if they have swarmed; if these supersedure cells are not recognized but removed by mistake the colony may become queenless. High disease load eg parasitic mite syndrome or CBPV may lead to loss of queen and replacement queen cells may be affected by virus eg BQCV. Poor weather may lead to a badly mated queen and the bees may try to replace a newly mated virgin a week later. If there is no queen, the bees may 'roar' for a bit after being inspected. Sometime weather or starvation puts queen off lay so no brood – feed.

Queen rearing problems – frequent supersedure of young queens (possibly due to pesticides or disease), if late in the year when few drones are around and weather not good, this results in poor mating. Poor mating may also be due to poor quality drones possibly affected by buildup of chemicals in environment, or not enough drones. Poor mating often happens in periods of bad weather and possibly when Nosema is present. If poorly mated, the queen may become a drone laying queen, or the bees may try to replace her quickly. If an unrelated or foreign strain of queen is introduced the pheromone 'language' problem may cause the bees to replace her with one of their own emergency queens. Virgin queens seem to mate faster in small colonies and mating nuclei than large colonies, which may take 3-4 weeks. If all the brood has hatched, and still no new eggs, give them a frame with eggs from another colony to prevent laying workers.

Drone laying queen – If the colony has more drone brood than expected for the time of year with one egg per cell in organised pattern with queen present; it may indicate a failing queen, or if only drone brood seen then a new queen may not have mated, the colony becomes smaller and workers older. Replace queen asap, if necessary give a frame of worker brood from a good colony to increase nurse bee numbers, remove any frames distorted with drone cells, or the replacement queen will lay drone eggs in them. The drone brood may be neglected by the depressed, aging workers and chill and die. Drones will be stunted. Look out for it at start of year if a late supersedure queen failed to mate properly.

Drone laying workers – Drone brood with multiple eggs per cell. Both queen and brood pheromones inhibit laying in workers; the loss of queen with no brood present may lead to laying workers. Cannot cure or merge as they will not accept a new queen. Move hive some distance away and when useful flying workers have joined nearby colonies then kill off the workers left in the hive (which will include the laying workers) using soapy water. If, as some books suggest, you shake them off in front of another hive, there is a strong chance they will kill the queen of the colony they join. If you shake them onto a sheet, the laying workers are quite able to fly to so problem not solved that way. Laying workers can develop in as little as a week after the last brood has hatched following queen loss. Prevent this condition by adding a frame of brood to queenless colony to keep them going until a queen can be found.

Larvae and pupae thrown out of entrance – Usually drone brood first; suspect disease, chilling, starvation or reduced worker population for some reason, eg pesticides. Adult drones are normally thrown out by the workers in autumn.

Chilled brood – especially small colonies or declining colonies; in a cold spring when adult numbers low, or manipulations causing removal of bees eg splitting colony or artificial swarms; starvation, or inappropriate spreading of brood; may cause brood to die from neglect. Usually seen on outside of brood nest first and drone brood, killing all stages; brood turns grey then black. Capped brood may be perforated as bees try to clean it out, and larvae and pupae may be seen thrown out in front of hive. Not infectious but can look like EFB. Avoid manipulations removing bees in cold weather and take care against spreading the brood or having small hives open too long. If it is a small colony, consider putting insulation on top.

Starvation - caused by poor beekeeping not checking they have enough stores in autumn or in 'June gap', taking off too much honey, poor or erratic weather conditions, long cold spell when cluster unable to move to new stores, or colony too small (isolation starvation). If still alive, spray bees with warm 1:1 syrup and feed.

Inadequate protein sources - not enough pollen variation to satisfy protein requirements. Colonies become weak and susceptible to diseases. More likely in spring and autumn, if recognised feed pollen substitute. Not a clear or obvious problem in southern England, but possible where many acres of monoculture are grown.

Small Colonies - sometimes, as a result of disease over winter for example, or a long brood break, the population can fall to a couple of seams. Below this critical mass they cannot maintain brood temperature and will rapidly dwindle further. This number of bees is OK in an insulated polystyrene mini hive but not a standard

hive unless insulated dummy boards are provided either side. If decline due to serious disease then cull, otherwise if queenright, provide insulation and food.

Aggressive colonies – Can be caused by many things, see Personal Health and Safety section, also genetics, being robbed or disturbed (mice, wasps, large mammals), shade, drips from trees, bad handling, too much smoke, powerlines(?), starvation, pesticides and disease, weather. Association between aggression and disease resistance but no link found with honey crop. Try to determine cause and rectify, if it persists then requeen. Inspect aggressive colonies last as can upset the rest from the pheromones emitted. Wash gloves and suit.

Theft – increasing problem with high value of hives and bees. Mark or brand equipment and keep hives out of sight.

Climate change and weather – wet, windy, cold summers can lead to poor or failed mating of queens, inability to forage leading to starvation. If confined in hive this spreads viruses, nosema and acarine. There will be a reduced honey crop. If winters are warmer, certain pathogens previously killed by frosts may thrive. Synchronisation between other pollinators and their favoured plant flowering period becomes de-synchronised. Different honey bee races may alter distribution due to warming and come in contact with and exchange novel strains of pathogen not previously exposed to with neighbouring strains of bee.

Winter Losses

In winter 2014/15 the average UK winter losses were 14.5%. Winter 2015/16 losses were 16.7% ranging from a low in the north of 11% to 23.4% in the SE). In recent years the peak losses were in the very cold winter of 2012/13 with about 34% losses, to lowest in 2013/14 of 9.6%. In cold winters those colonies with high mite counts succumb more readily than in mild winters. The main reasons for colonies dying in winter are high numbers of varroa which weakens the immune system and transmits viruses and bacteria, DWV in particular is linked to winter loss. A new varroa-vectored bacteria was discovered in the US in late 2016; *Serratia marcescens* strain sicaria. This was found in 73% of winter-killed colonies in a sample. Other reasons for colony loss in winter include poorly mated queens in summer or late superseding, poorly mated queens, resulting in drone laying queens; queen loss leading to irreparable drone laying workers in spring. Inadequate pollen supplies, in terms of quality and quantity during the summer and autumn produces short-lived winter bees. Starvation because of shortage of honey/sugar syrup is a preventable cause of loss. Finally, damage by mice, woodpecker or overturned hives are small, preventable causes of colony death. Some people think it is good that some of the weaker, susceptible colonies are weeded out and die over winter, leaving stronger stock.

Colony Collapse Disorder

CCD is a little-understood phenomenon in which worker bees from a beehive of Western honey bees abruptly disappear, no dead are found, plenty of stores, often a queen and a few nurse bees and brood left. Little robbing occurs. CCD was originally found in Western honey bee colonies in North America in late 2006. European beekeepers observed a similar phenomenon in Belgium, France, the Netherlands, Greece, Italy, Portugal, and Spain, and initial reports have also come in from Switzerland and Germany, albeit to a lesser degree. No confirmed cases have been found in the UK. Possible cases of CCD have also been reported in Taiwan since April 2007. From 2006 – 2011 average losses of between 30 and 36% per year were reported in USA, 2011-2012 29%, 2012-13 45%, 2013-14 34%, 2014-15 42%, 2015-2016 44%.

The causes of the syndrome are not yet well understood. Hypotheses include environmental change-related stresses, malnutrition, pathogens (i.e. disease including Israeli acute paralysis virus and Nosema), mites, pesticides such as Neonicotinoids, radiation from cellular phones or other man-made devices (unlikely), and genetically modified crops with pest control characteristics such as transgenic maize. Some claim that the disappearances have not been reported from organic beekeepers, suggesting to some that beekeeping practices can be a primary factor.

Currently, it is believed there are four likely factors involved:
- pesticides eg Neonicotinoids such as Imidacloprid, Clothianidin, Thiamethoxam and Fipronil that may be having unexpected negative effects on honey bees;
- a new parasite or pathogen that may be attacking honey bees, such as the parasite *Nosema ceranae* and newly found viruses;
- a combination of existing stresses that may compromise the immune system of bees and disrupt their social system, making colonies more susceptible to disease and collapse;
- inadequate pollen availability, bees forced to survive on monoculture with no wild flowers.
Stresses could include high levels of infection by the *Varroa* mite; poor nutrition due to apiary overcrowding, pollination of crops with low nutritional value, or pollen or nectar scarcity; exposure to limited or contaminated water supplies; sub-lethal pesticide exposure and migratory stress. USA bees can be moved 10,000 miles in a year. In October 2010 research suggested that a combination of Insect Iridescent Virus IIV6 and *Nosema ceranae* may have a key role in CCD. In 2014, Neonicotinoids were again implicated. Although the UK does not have CCD, in the cold winter of 2012/13 33% of UK colonies died and 9.7% summer losses, in 2013/14 winter 9.6% died, in 2014/15 14.5% died, 2015/16 12% died. Some think it is good that some of the weaker, susceptible colonies are weeded out and die over winter, leaving stronger stock to reproduce.

Keeping bees Healthy

- Provide sheltered, dry hives
- Change comb regularly
- Gentle management, avoid squashing
- Quarantine swarms and new bees
- Sterilize equipment
- Clean gloves, hive tool between colonies
- Wash suit, boots etc regularly
- Keep varroa etc low
- Attention to nutrition
- Keep good records to recognise change
- Select for healthy bees
- Cull sickly colonies

Overview of general decline of all bee species and other pollinators

The current loss of honeybees and other native pollinators is thought to be due to:

- Loss of wild flowers; hedges cut too hard, verges devoid of wild flowers and weeds due to herbicides.
- Loss of habitat and forage; eg old crops like clover no longer available, modern hybrid flowers have little or no nectar and pollen from double flowers may be inaccessible.
- Introduced diseases from other species and countries; *Nosema ceranae,* varroa, small hive beetle, etc.
- Wild pollinators picking up emerging diseases of honey bees, eg DW Virus and Nosema
- Increased numbers of chemicals used in hives; miticides, unknown synergistic effects.
- Increase in chemicals in environment; herbicides, pesticides, fertilizers, water sources less pure.
- Pesticides; such as Neonicotinoids have lethal and sublethal effects causing colony decline and loss.
- Half of total decline of wild bees attributable to chemicals.
- Wild colonies destroyed, nesting areas disturbed; people afraid of them or intolerant.
- Invasive species; eg in US and Australia, Asian Hornet in southern Europe damaging natives.
- Air pollution; bees cannot smell flower fragrance.
- Climate change, warming reduces protein levels in pollen, weather affects disease and foraging.
- Loss of pollen host plants, out of sync with preferred plant species
- Billions of pollinating insects die on the roads annually

Leaflets and articles, websites

http://www.msbain.co.uk/elbka/Diseases/Bee%20Diseases%20front.htm (Bee Diseases)
http://www.nationalbeeunit.com/ (Bee diseases and their treatments)
http://www.bbka.org.uk/ (British Beekeepers Association)
http://www.bbka.org.uk/learn/general_information/information_leaflets_for_download
BBKA leaflets in Members section
http://www.brightonlewesbeekeepers.co.uk/ (lots of useful leaflets, handouts, record sheets, disease symptoms)
http://articles.extension.org/bee_health (Bee Diseases) USA website
http://www.biosecurity.govt.nz/pests-diseases/animals/varroa/paper/varroa-treatment-options.htm
http://scientificbeekeeping.com/ (lots on diseases, management, research etc)
http://www.dave-cushman.net/ Encyclopaedic index of topics, UK
http://www.beeculture.com/ Magazine of American Beekeeping, interesting articles, subscribe to Catch the Buzz; a regular email of articles, notes etc.
http://beesource.com/point-of-view/ interesting articles, USA
https://honeybeesuite.com/ a useful beekeeping blog USA
Beecraft magazine (subscribe through local Beekeeping Division). Join your local Division. BBKA membership comes with Division membership and insurance, BBKA news. Attend meetings, Conventions, Bee festivals
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/82643/Pesticides---reducing-damage-to-honey-bees-Primefact-148.pdf
http://www.clemson.edu/public/regulatory/pesticide_regulation/bulletins/bulletin_5_protecting_honeybees.pdf
http://www.bbka.org.uk/files/library/bees_and_pesticides-l019_1342859149.pdf
http://www.beyondpesticides.org/infoservices/pesticidesandyou/Fall08/pollinators.pdf

The links do not work for the following interesting pdf's so paste into browser:
http://www.xerces.org/wp-content/uploads/2012/03/Are-Neonicotinoids-Killing-Bees_Xerces-Society1.pdf
https://extension.entm.purdue.edu/publications/E-53.pdf