Module 8 Study Notes

Introduction:

These notes have been prepared as part of my studies for Module 8.

As always comments are appreciated as with everything in beekeeping there seems to be as many variants to a topic as beekeepers discussing it ☺.

The reader is more than welcome to download a copy of the notes.

References:

The Honeybee Inside Out	Celia F. Davis
The Honeybee Around and About	Celia F. Davis
Guide to Bees and Honey	Ted Hooper
Beekeeping Study Notes (modules 5,6,7&8)	J.D & B.D. Yates
The Pollen Loads of the Honeybee	Dorothy Hodges
Honey Farming	R.O.B. Manley
Google	
BBKA Appendices to Syllabus	
Beecraft	
BBKA News	
MBBKA Study Group	
MBBKA Basic Course Notes	

8.1 the assessment and management of the quality of a colony for honey production; 4

8.2 the management of colonies for the production of oil seed rape (Brassica spp.) and ling heather (Calluna vulgaris) honey, the techniques involved in overcoming problems associated with extracting these honeys; 6

8.3 the management of colonies for the production of comb honey (sections and cut-comb) and its preparation and presentation for sale; 7

8.4 the properties of honey including specific gravity, refractive index, viscosity, hygroscopicity, electrical conductivity, reactions to heat and ageing; 8

8.5 the process of honey crystallisation including factors that affect its speed, crystal size, and the texture of the final product; 11

8.6 the preparation and bottling of liquid honey and set honey, including the requirements of the current UK statutory regulations relating to hygiene, handling, bottling, composition, labelling and weight of packs of honey; 12

8.7 the identification of pollen grains by their colour, size, specific shape and structure, using named examples, and an outline of the technique of melissopalynology to determine the floral source(s) and geographic origin of honey samples; 21

8.8 the nutritional value of honey to the honeybee colony; 27

8.9 the main constituents and physical properties of beeswax and propolis; 30

8.10 the commercial manufacture of wax foundation; 32

8.11 how foundation can be made on a small scale by the beekeeper including one method of wiring frames and embedding the wiring into this foundation; 33

Frame Wiring and Embedding 34

8.12 The production and use of pollen supplement and pollen substitutes 37

8.13 The assessment of the qualities of a queen and her colony and their subsequent management for queen rearing 38

8.14 The structure and changes in function of the exocrine glands throughout the life of the castes of the honeybee colony, and the implications this has for the management of the honeybee colony.................... 40

8.15 the management of colonies used for migratory beekeeping for both honey production and pollination services; 42

8.16 the use of honeybees as pollinators in orchards and fields of seed crops including arrangements to be made with the farmer/grower; 43

8.17 the management needed to cope with geographic localities, weather conditions and the timing of the flowering of forage plants; 46

8.18 methods of swarm control suitable for use in small and large beekeeping enterprises 47

8.19 the setting up, and management throughout the season, of an observation hive, and the uses to which it can be put; 48

8.20 the preparartion of a risk assessment and safety policy relating to handling, demonstrating and showing live honeybees; 50

8.21 methods of monitoring and seasonal management of the health of colonies; 52

8.22 the signs of disease and pest infestations of honeybees; the potential impact on bee health, the economic effect and how these diseases and pests impact on the management of the colony. 53

8.23 procedures related to good hygiene practices on matters of personal clothing, manipulations and equipment to prevent the spread of disease between colonies and between apiaries................................ 56

8.24 the development of hives and beekeeping equipment used in the United Kingdom (refer to list in Appendix): 57

8.25 the life histories of one selected species of each of the following found in the United Kingdom: solitary bee, social bee (other than Apis mellifera), solitary wasp and social wasp and their interaction with honeybees. 61

8.26 the history of beekeeping through leading contributors (listed in Appendix) to the knowledge of honeybees and beekeeping practices; 63

8.1 the assessment and management of the quality of a colony for honey production;

The management of the quality of the colony for the production of honey is driven by:

- Ensuring the colony is healthy
- Ensuring the population of the colony is balanced and of an appropriate size
- Ensuring that the colony does not swarm, thus depleting the population numbers

The assessment of the colony is carried out at regular points throughout the season in order to facilitate good monitoring of key aspects of the colony.

Health:

- Comprehensive disease inspections completed early and late in the season
- During each inspection the beekeeper is looking for signs of unhealthy bees such as:
    - Malformed workers
    - Deformed wing virus
    - Perforated sealed brood comb
    - mal formed larvae
    - sunken cappings
    - greasy looking cappings
- Up to 4 times a year varroa counts should be taken in order to monitor it's extent within the colony
- During inspections and throughout the season Integrated Pest Management techniques should be employed, including drone culling, icing sugar and most importantly open mesh floor

Population and colony expansion:

- In the spring the beekeeper is looking for expansion of the colony, using records the colony should be assessed to ensure it has grown since the previous inspection, key parameters for this are number of frames with bees on and number of frames with brood on
- The colony should be evenly balanced, ideally for every egg there should be 2 larvae and for every larva there should be 2 sealed brood cells, this would indicate the queen is laying consistently
- In the spring we would expect to see the proportion of brood to be high as the colony is expanding
- If weather poor may need stimulative feeding 6 weeks prior to main flow

Management of swarming:

- Throughout the spring, depending upon the year, late March through to July colonies should be inspected weekly (unless queen clipped then every 10 days) for signs of swarm preparation
- A swarm is a significant loss of colony population and therefore can affect the season's honey production
- If the colony shows indications of swarming (queen reduces lay rate, queen cups with royal jelly, queen cells with larva, reduced foraging, scout bees searching out new homes) swarm prevention/management should be implemented
- Ensure at all times that the colony has space

Inspection aide memoir

Every time a beekeeper inspects a colony answer these 5 questions:

- Is the queen present, either seen or signs of presence through all stages of brood
- Is it building up okay
- Are there signs of disease
- Does the colony have sufficient space
- Does the colony have sufficient stores

If the answers are recorded and monitored a key element of managing the colony for good honey production will be achieved.

8.2 the management of colonies for the production of oil seed rape (Brassica spp.) and ling heather (Calluna vulgaris) honey, the techniques involved in overcoming problems associated with extracting these honeys;

The principles for taking advantages of these crops are similar:

The beekeeper will build up the colony to be strong with a young and prolific queen, this can be accomplished by:

Feeding the colony pollen to encourage the queen to lay
Requeening with a queen of good stock
Uniting colonies to make a single big colony

The beekeeper will move the hives to close to the crop
The beekeeper will put on fresh supers once the flow has started in order to take advantage of the pure crop

Preparation

Oil Seed Rape is either sown in Autumn or Spring, Autumn sown crop requires the Beekeeper to build up the colony early through feeding sugar syrup and pollen from February. Spring sown crops and heather may not require feeding rather rely on normal build up as they come into flower later in the season.

Heather is a late flower (August/September) and can be a good second crop however as this coincides with the colonies preparing for winter, colonies may need to be united in order to ensure sufficient strength of colony. Colonies need to be “bubbling over” in the brood box, this can be achieved through reducing double brood to single brood or uniting colonies or both.

During the flow

For Oil Seed Rape the bee will fly up to 2 miles for the nectar
The colony can be moved to a suitable site close to the crop
Due to the special nature of the honey produced the hive should have fresh supers for the flow
Oil seed rape crystalises on the comb and very quickly at the end of the flow
Heather is Thixotropic and lends itself to cut comb and section honey

After the flow

As the colony will have built up to a strong state care should be taken to ensure there is sufficient forage, stores or feed available to maintain the colony. If there is a lack of forage the beekeeper can return the original supers with uncapped honey or feed medium syrup.

Oil Seed Rape, considerations

Stores rapidly crystallize

- Take off supers as soon as possible
- Keep supers warm when removed for extraction
- May need to blend honey with crop with better crystalisation

Colony can expand rapidly and be too strong after flow stops
Bees can become aggressive when flow finishes.
Winter stores of OSR will crystallize causing dysentery
Possibility of swarming hence regular inspections.
After removing crop check colony has enough stores until next inspection in case of bad weather

Heather, considerations

The Thrixotropic nature of Heather honey means that centrifugal extraction is not possible methods such as pressing and agitation are required to extract the honey.

8.3 the management of colonies for the production of comb honey (sections and cut-comb) and its preparation and presentation for sale;

The considerations for producing comb honey:

- It takes a lot of energy to make the wax necessary for comb honey.
- Must be strong steady flow.
- Colony must be strong and have significant number of young bees for wax production.
- The forage needs to be of quality such as not to produce readily crystallising honey.

The colony will be disease free, full brood chamber with all stages of brood with preferably a current year queen, if poor weather the colony strength should be fed 6 weeks in advance of the desired flow, the colony will already have a super of stores. The colony may need to be moved close to the desired forage.

Fresh sections or frames with starter strips or thin unwired foundation will be added in a super above the 1st super in order to avoid contamination from pollen and misshapen cells. If possible the super for comb honey will also have a super with stores above. The idea is for the bees to build consistent comb of honey from the preferred source of forage.

Further supers for comb honey can be added as the previous becomes fully capped.

Preparation for sale:

- When comb is fully sealed, remove it from the hive
- Cut out the comb completely around the wooden frame timber
- Lay it on its side on a draining surface over a tray, e.g. a Waldron Queen Excluder (wooden framed excluder)
- The usual container is 8oz/227g but any weight can be sold, cut comb with sharp knife or shaped cutter
- Leave the combs on a grid to allow loose honey to drain off and edges to crystallise
- There should be no evidence of granulation, fermentation, propolis, Braula or wax moth
- Store in fridge/freezer at <4°C
- Standard labelling rules apply

8.4 the properties of honey including specific gravity, refractive index, viscosity, hygroscopicity, electrical conductivity, reactions to heat and ageing;

specific gravity	1.4 (density at 20° compared to water at 4°C), this varies with water content With 18% water specific gravity = 1.4171 at 20°C
refractive index	Honey, 13% water content 1.504 Honey, 17% water content 1.494 Honey, 21% water content 1.484
viscosity	Honey's viscosity is dependent upon its water content, temperature and floral source: **Water Content (%)** – **Viscosity (poise)** at 25 °C 15.5 – 138.0 17.1 – 69.0 18.2 – 48.1 19.1 – 34.9 20.2 – 20.4 **Temperature (°C)** – **Viscosity (poise)** at 16.1% H_2O 13.7 – 600.0 29.0 – 68.4 39.4 – 21.4 48.1 – 10.7 71.1 – 2.6 **Floral Source** (examples) – **Viscosity (poise)** at 25 °C, 16.5% H_2O Sage – 115.0 Sweet Clover – 87.5 White Clover – 94.0
hygroscopicity	Because it is a highly concentrated "sugar" solution rich in fructose, honey can absorb water readily from the atmosphere.
reaction to heat	< 13°C will not ferment =<14° 18°=< will crystallise in best manner 35°C granulated honey becomes manageable 54°C honey liquefies 60-70°C honey pasteurises 100°C enzymes breakdown honey purified of disease (except AFB) for feeding to same apiary
reaction to ageing	Honey will darken, Diatase decrease, HMF increase, crystallisation will occur and possibly fermentation. timing of these is dependent upon storage temperature conditions
electrical conductivity	Conductivity is a good criterion of the botanical origin of. This measurement depends on the ash and acid content of honey; the higher their content , the higher the resulting conductivity. There is a linear relationship between the ash content and the electrical conductivity: $C = 0.14 + 1.74 A$ where C is the electrical conductivity in milli Siemens cm-1 and A the ash content in

	g/100 g.

Relative density

This is the density (weight/volume) compared with the density of water.
Relative density varies with sugar content of the honey, so this property can be used to measure the sugar content. It also varies with temperature due to thermal expansion, so it should be measured at a stated temperature.
Most conveniently measured using a hydrometer.

Refractive Index

Refractive index is calculated from the angle of refraction (bending) of light as it passes into a material, due to the difference in velocity of light in honey compared to air.
Easily measured with a refractometer. Refractive Index should be measured at the stated temperature for the most accurate result.

Viscosity

A measure of the resistance to flow of the honey. The more treacly, the higher the viscosity.

- Viscosity reduces as temperature increases.
- Viscosity reduces as the moisture content increases

Viscosity measurement is not considered to be a satisfactory way to measure water content of honey accurately, but it is important in the handling of honey to appreciate the influence of temperature and moisture content on viscosity.
A simple method of measuring viscosity is by dropping a ball bearing into a jar of honey and timing he fall between two points. Calculate the viscosity from standard tables and formula.
Viscosity is often quoted in Poise.
Thixotropy is a time dependent shear thinning property which causes he honey to reduce in viscosity after stirring for a time. Ling heather and Manuka honey are two well known examples.

Hygroscopicity

Honey will absorb water from the air in a damp atmosphere (hygroscopicity)
Conversely, it will lose water in a dry atmosphere.
The property has implications for processing and storing.

Reaction to Heat

Heat is used in processing for ease of straining, to dissolve crystallised honey and reduce subsequent granulation, and to kill yeasts to prevent fermentation.
Honey will degrade at elevated temperatures over a period of time:

HMF content increases
Enzyme activity reduces
Loss of volatile oils, hence aroma loss
Darkening in colour

60°C for 45 minutes used to retard crystallisation
70°C used momentarily for “pasteurisation” to reduce yeast content and retard fermentation (Dyce Process)
60°C for two hours causes noticeable degradation.
Various simple sugars will combine to produce complex sugars (oligosaccharides) this is the caramelisation of honey where it darkens and tastes ‘nutty’. The process occurs rapidly above 100C.

Electrical conductivity

How easily the honey will pass an electric current. Usually measured in milli Siemens /cm. It is a good indicator of the amount of free acids, proteins and mineral salts contained within the honey. Blossom honeys should have less than 0.8 mS/cm whilst honeydew and chestnut honeys should have greater than 0.8 mS/cm. But there are exceptions. The conductivity measurement is easy, fast and needs only inexpensive instrumentation. It is widely used to distinguish between honeydew and blossom honeys and also the characterisation of unifloral honeys.
Electrical conductivity is directly related to Ash content and quicker method of determining Ash content.

8.5 the process of honey crystallisation including factors that affect its speed, crystal size, and the texture of the final product;

Honey at lower temperature is a super-saturated solution of sugars and crystallisation is the glucose forming crystals. The fructose in the honey stays in solution.

Feature	Value	Comment
Granulation	<10°C slow >30°C none	Stops altogether below 4°C
	13 - 17°C	Fastest crystallisation, Hooper says 16-18°C to get crystallisation going and Davis says 14°C for best results
	Glucose/Water ratio	Higher ratio quicker granulation
	Glucose/Fructose ratio	More Fructose slower granulation (rape high glucose)
	Viscosity	Higher viscosity less granulation, crystals cannot move easily
	Nuclei promote granulation	Crystals form round impurities
	Stirring	Speeds up granulation
	Speed	Faster granulation smaller crystals and smoother honey

8.6 the preparation and bottling of liquid honey and set honey, including the requirements of the current UK statutory regulations relating to hygiene, handling, bottling, composition, labelling and weight of packs of honey;

A good option is to fine filter honey before storage so as to give options of choice of honey style at bottling time.

Assuming that the honey had been stored in a crystallised state, the process is:

- Scrape top of honey to remove alien materials
- Heat to 50°C until liquid and clear (can take between 1 and 3 days dependent upon amount and type of honey)
- Strain through fine filter (0.5mm mesh)
- Leave to settle, to remove air bubbles and remaining alien material to rise to surface (can be 1 – 2 days)
- Clean surface with cling film, to remove remaining alien material
- Clean, sterilise and dry jars and lids
- Bottle into pre warmed jars
- Heat to 60-62°C for ¾ to 1 hour in water bath after securing lids to remove final crystals and pasteurise

The honey should be heated for the minimum time in order to preserve the enzymes, volatile oils, odours, Diatase and HMF levels.

In commercial production the honey is quickly heated to 72°C and rapidly cooled in order to remove remaining crystals and pasteurise the honey.

Soft Set honey should be smooth and spread like butter, when a section is taken from a jar the cut shape should remain firm.

To create **Soft Set** honey follow the above instructions with the following adaption's; warm to 32-35°C and stir in a manner not to break the surface and introduce air bubbles

Allow to settle and then jar.

If the crystals are still not to liking of the beekeeper, the honey can be **Seeded** first liquefy the honey by heating to 50°C

Honey from a source with appropriate crystallisation is heated to 35°C and blended with the liquefied honey after it has cooled.

The honey used for **seeding** is usually 5-10% of the total weight.

Lucie Chaumeton and Geoffrye Hood have written an excellent summary of the relevant statutory regulations which can be found here.

There is some regulation on nutritional content labelling, the vast majority of UK Beekeepers are exempt from the regulation. To find out more go here.

There are two Acts of Parliament affecting Honey preparation for sale:

Food Hygiene and Safety Act 1990 with 6 Statutory Instruments

- Food Premises (Registration) Regulation 1991 (superceeded by Regulation (EC) No 853/2004)
    - Premises registration does not apply if the production is small quantities and
        - Primary production is for private domestic use
        - The domestic preparation, handling or storage of food for private domestic consumption
        - The direct supply, by the producer, of small quantities of primary product to the final consumer or to local retail establishments (within 35 miles of producer) directly supplying the final consumer
    - Small quantities has not been defined for honey products
- Food Safety (General Food Hygiene) Regulation 1995
    - Food business includes preparation even if not for profit and hygiene includes measures to ensure safety and wholesomeness of food
    - Requires adequate safety procedures are identified, implemented, maintained and reviewed
    - Requirements for handling and preparing food including; premises have adequate space, clean, ventilated and appropriate lavatories and hand washing facilities.
    - Specifically; all surfaces should be sound and easy to clean and disinfect, outside windows must be inspect proof, windows closed during operation, two sinks with hot and cold water (one for hand washing and the other for food washing), ventil;ated lobby between extraction room and toilet, equipment employed must be clean and where necessary disinfected
    - While processing honey suitable clean protective clothing should be worn, no exposed cuts/wounds and no one should be suffering from any kind of illness
    - Honey should be stored in a hygienic environment isolated from parasites, pathogenic micro-organisms, or decomposed or foreign substances
- Food Labelling Regulations 1996
    - Defines labels to be words and images
- Food (Lot Marking) Regulation 1996

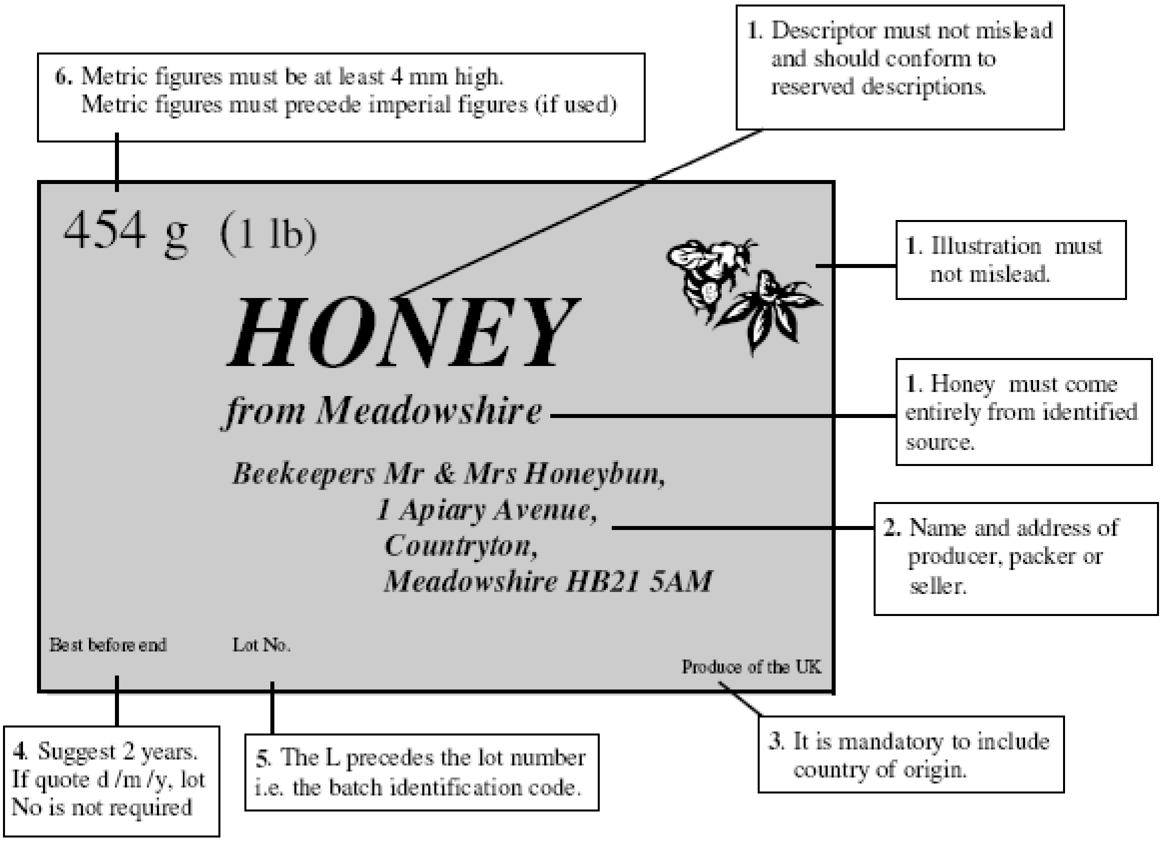
  - All foods must have lot marking indication, either specific identifier beginning with L or Best Before including day and month

- Food Safety and Hygiene (England) Regulation 2013
  - Lists relevant authorities and process for enforcement of Food Safety Act 1990
- Honey (England) Regulation 2015
  - Defines descriptors, labelling requirements and composition of honey, see below

Weights and Measures Act 1985

- The Weights and Measures (Quantity Marking and Abbreviation of Units) Regulations 1987
  - Converted UK to metric system
- The Weights and Measures (Packaged Goods) Regulations 2006
  - Defines metric units, font size for weights, abbreviations and tolerances
- The Weights and Measures (Food) (Amendment) Regulations 2014
  - Honey should be sold by net weight, exception chunk and comb honey

Sample label



Module 8 Study Notes

Labelling

The label should indicate:

1. The description of the product,

2. The name and address of the producer (within the EU)

3. The country of origin

4. A ‘best before’ date

5. A lot mark

6. The weight

1. Description of product.

This must be one of the following reserved descriptions:

- Honey
- Comb honey
- Chunk honey
- Baker’s honey intended for cooking only
- The word ‘honey’ with any other true description, e.g. Honeydew honey, Pressed honey, Blossom honey
- The word 'honey' with a regional, topographical or territorial reference

If there is any reference to a particular plant or blossom (either pictures and words), the honey must have come wholly or mainly from that blossom or plant - i.e. the honey must be characterised by that blossom or plant. If reference is made to a geographical origin the honey must come wholly from that place.

2. Name and address of producer, importer, packer etc.

Sufficient information is needed in order to trace the producer by an address within the EU.

3. Country of origin.

Honey must be labelled with the country/ies in which the honey was harvested. This may be a member state of the EU. If produced in England should be ‘Product of the UK‘ must be IN ADDITION to the address. Also acceptable blend of EU honeys, blend of EU and non-EU honeys and blend of non-EU honeys.

4. “Best before” date.

Honey lasts for many years but an appropriate durability or “best before” date must be given. Two years is reasonable. If “best before” date specifies day, month and year a lot number is not required.

5. Lot Number.

A lot means a batch of sales units of food produced, manufactured or packaged under similar conditions. It enables problems to be traced.

The lot number is preceded by the letter L to distinguish it from other indicators. The number may be a short code comprising letters and/or numbers identifying the appropriate batch. It is prudent to have small lot sizes.

The beekeeper is required to keep a record of each batch with its provenance and destination and retain this for the shelf life plus 6 months.

Lot numbers and "Best before" date are not needed for direct sales at farmers markets or at the door.

6. The weight.

From April 2008, honey can be sold in any weight, (including the traditional UK ones). Imperial units can be added after the metric ones but must not be in larger type and there must be no other print between them.

The abbreviation for gram is g and for kilogram is kg. An s must not be added. There must be one type space between the numerical value and the unit or its abbreviation.

Printing of labels

Printing must be clearly legible and permanent. Labels should be fixed to the side of the container.

The lettering must be

- 3 mm high for weights between 50 and 200 g,
- 4 mm high for weights between 200 g and 1 kg
- 6 mm high for greater weights

Only the weight declarations have to be a certain size.

The criterion for the size of all the other statutory information is that it must be easy to understand, clearly legible, indelible, not interrupted by other written or pictorial matter and in a conspicuous place such as to be easily visible. The information given on the label must be true in every respect and in no way misleading.

Module 8 Study Notes

Legal descriptors

Reserved descriptions	Specified honey product
1a. blossom honey or} 1b. nectar honey}	honey obtained from the nectar of plants
2. honeydew honey	honey obtained mainly from excretions of plant sucking insects (Hemiptera) on the living part of plants or secretions of living parts of plants
3. comb honey	honey stored by bees in the cells of freshly built broodless combs or thin comb foundation sheets made solely of beeswax and sold in sealed whole combs or sections of such combs
4a. chunk honey or} 4b. cut comb in honey}	honey that contains one or more pieces of comb honey
5. drained honey	honey obtained by draining de-capped broodless combs
6. extracted honey	honey obtained by centrifuging de-capped broodless combs
7. pressed honey	honey obtained by pressing broodless combs with or without the application of moderate heat not exceeding 45°C
8. filtered honey	honey obtained by removing foreign inorganic or organic matters in such a way as to result in the significant removal of pollen
9. baker's honey	honey which is - (a) suitable for industrial uses or as an ingredient in other foodstuffs which are then processed; and (b) may - (i) have a foreign taste or odour, (ii) have begun to ferment or have fermented, or (iii) have been overheated

Note 1: The description "honey" may be used for specified honey products specified in column 2 of items 1a, 1b, 2, 5 and 6 of Schedule 1.
Note 2: Where the specified honey product specified in column 2 of item 9 is used as an ingredient in a compound foodstuff, the reserved description "honey" may be used in the product name of that compound foodstuff.
Note 3: Except in the case of products specified in column 2 of items 7 and 8 a specified honey product may additionally be described by –
(i) its floral or vegetable origin, if the product comes wholly or mainly from the indicated source and possesses the organoleptic, physico-chemical and microscopic characteristics of the source;
(ii) its regional, territorial or topographical origin, if the product comes entirely from the indicated source; and
(iii) its specific quality criteria.

Organoleptic properties are the aspects of food or other substances as experienced by the senses, including taste, sight, smell, and touch, in cases where dryness, moisture, and stale-fresh factors are to be considered.

Compositional Criteria

1. The honey consists essentially of different sugars, predominantly fructose and glucose, as

well as other substances such as organic acids, enzymes and solid particles derived from honey collection.
2. The colour varies from nearly colourless to dark brown.
3. The consistency can be fluid, viscous or partly or entirely crystallised.
4. The flavour and aroma vary but are derived from the plant origin.
5. No food ingredient has been added, including any food additive.
6. No other additions have been made to the honey except for other honey.
7. It must, as far as possible, be free from organic or inorganic matters foreign to its composition.
8. It must not—
(a) have any foreign tastes or odours;
(b) have begun to ferment;
(c) have an artificially changed acidity;
(d) have been heated in such a way that the natural enzymes have been either destroyed or significantly inactivated.
9. Paragraph 8 does not apply to baker's honey.
10. No pollen or constituent particular to honey may be removed except where this is unavoidable in the removal of foreign inorganic or organic matter.
11. Paragraph 10 does not apply to filtered honey.

Composition of Honey

1.	Sugar content		
1.1.	Fructose and glucose content (sum of both)	blossom honey	not less than 60g/100g
		honeydew honey, blends of honeydew honey with blossom honey	not less than 45g/100g
1.2.	Sucrose content (Borago officinalis)	in general	not more than 5g/100g
		false acacia (Robinia pseudoacacia), alfalfa (Medicago sativa), Menzies Banksia (Banksia menziesii), French honeysuckle (Hedysarum), red gum (Eucalyptus camaldulensis), leatherwood (Eucryphia lucida, Eucryphia milliganii), Citrus spp.	not more than 10g/100g
		lavender (Lavandula spp.), borage	not more than 15g/100g
2.	Moisture content	in general	not more than 20%
		heather (Calluna) and baker's honey in general	not more than 23%
		baker's honey from heather (Calluna)	not more than 25%
3.	Water-insoluble content	in general	not more than 0.1g/100g
		pressed honey	not more than 0.5g/100g
4.	Electrical conductivity	honey not listed below and blends of these honeys	not more than 0.8 mS/cm
		honeydew	not less than 0.8 mS/cm
		strawberry tree (Arbutus unedo), bell heather (Erica), eucalyptus, lime (Tilia spp.), ling heather	not less than 0.8 mS/cm

		(Calluna vulgaris), manuka or jelly bush (Leptospermum), tea tree (Melaleuca spp.)	
		chestnut honey	not less than 0.8 mS/cm
		blends of chestnut honey except blends of that honey with bell heather (Erica) honey, eucalyptus honey, lime (Tilia spp.) honey, ling heather (Calluna vulgaris) honey, manuka or jelly bush (Leptospermum) honey, strawberry tree (Arbutus unedo) honey and tea tree (Melaleuca spp.) honey	not less than 0.8 mS/cm
5.	Free acid	in general	not more than 50 milli-equivalents acid per 1000g
		baker's honey	not more than 80 milli-equivalents acid per 1000g
6.	Diastase activity and hydroxymethylfurfural (HMF) content determined after processing and blending		
	(a) Diastase activity (Schade scale)	in general, except baker's honey	not less than 8
		honeys with low natural enzyme content (e.g. citrus honeys) and an HMF content of not more than 15 mg/kg	not less than 3
	(b) HMF	in general, except baker's honey	not more than 40 mg/kg (subject to the provisions of (a), second indent)
		honeys of declared origin from regions with tropical climate and blends of these honeys	not more than 80 mg/kg

Note 1: When placed on the market as honey or used in any product intended for human consumption, honey must not:

(a) except in the case of baker's honey, have any foreign tastes or odours, have begun to ferment or have fermented, or have been heated in such a way that the natural enzymes have been either destroyed or significantly inactivated.
(b) have an artificially changed acidity.

Note 2: No pollen or constituent particular to honey may be removed except where this is unavoidable in the removal of foreign inorganic or organic matter.

Module 8 Study Notes

8.7 the identification of pollen grains by their colour, size, specific shape and structure, using named examples, and an outline of the technique of melissopalynology to determine the floral source(s) and geographic origin of honey samples;

Melissopalynology is the study of pollen contained in honey and, in particular, the pollen's source. By studying the various pollens in a sample of honey, it is possible to gain evidence of the geographical location from the combination of the plants that the honey bees visited, although honey may also contain airborne pollens from anemophilous plants, spores, and dust due to attraction by the electrostatic charge of bees.

An outline of the technique would be as follows:

- Pollen is obtained by taking 10 g honey and mixing with 20 mls hot water.
- Mix and divide into two centriguge tubes and centrifuge for 10 minutes
- Pour off the liquid from the top of each tube and then pour the contents into one tube.
- Add water to the same level in the second tube and centrifuge for a further 5 minutes.
- Draw the supernatant off using a pipette and make up a pollen slide using warm Fuchsin gel and then magnify to x400 under a compound microscope.
- Compare the pollen grains viewed under the microscope with reference slides.

Generally, melissopalynology is used to combat fraud and inaccurate labelling of honey. Information gained from the study of a given sample of honey (and pollen) is useful when substantiating claims of a particular source for the sample. Monofloral honey derived from one particular source plant may be more valuable than honey derived from many types of plants. The price of honey also varies according to the region from which it originates.

Pollen analysis is often used in forensic work to show where people have been by identifying pollen on their cloths.

The species of plant from which pollen has been taken be identified through the combination of features of the pollen examined.

The **colour** of pollen collected by Honeybees varies by plant, time of day, weather and even by the flower within the species. Good examples of distinct colours are bright orange of the dandelion, black of the ornamental poppy and bluish green of the rose bay willow herb. Some flowers within the same species such as the purple loosestrife which can produce different pollen from emerald green to yellow in colour.

The **size** of pollen grains can vary from 6µm (forget-me-not) to 140µm (hollyhock), generally they are graded as:

Very Small	<20 µm
Small	20-30 µm
Medium	30-50 µm
Large	50-100 µm
Very Large	>100 µm

The general **shape** of pollen can be described by 7 categories:

1. Round e.g. crocus
2. Oval flattened, the appetures/furrows run across the grain, e.g. Mignonette
3. Oval elongated, the appetures/furrows run lengthwise e.g. Horse Chestnut
4. Triangular, e.g. Sycamore

Module 8 Study Notes

5. Long, e.g. Field Bean
6. Semi-circular, e.g. Bluebell
7. Irregular or multi-sided, e.g. Meadow foam

The **structure** of the pollen is described through the apertures and furrows on the surface of the pollen. The outer layer of the pollen comprises the hard and durable exine coating and the inner coating intine is much softer. The apertures are the points through which the pollen tube emerges on a receptive plant. The pattern on the surface of the exine enables the pollen attach to a compatible stigma.

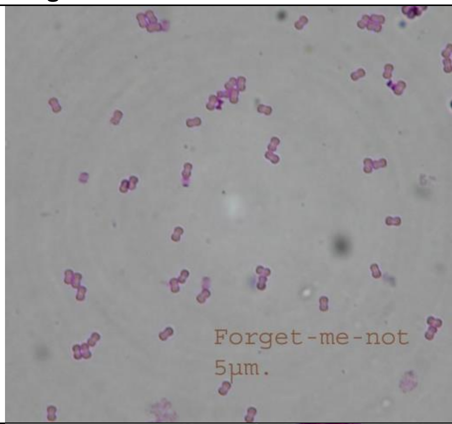
Pollen identification is based around the pollen grain features detailed in Rex Sawyer's Pollen Identification for beekeepers:

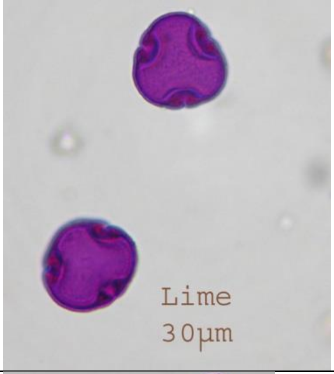
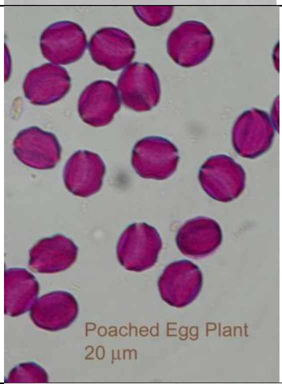
Size	1. Very Small <20µm 2. Small 20-30µm 3. Medium 30-50µm 4. Large 50-100µm 5. Very Large >100µm
Shape	1. Round or irregularly Round 2. Oval, flattened 3. Oval, elongated 4. Long 5. Triangular 6. Semi-circular or boat shaped 7. Multi-sided or irregular
Aperture Numbers	6 0 or indefinite 7 1-2 8 3 9 4-6 10 7-12 11 >12
Aperture Type	1. Pores only 2. Furrows only 3. Furrows with pores 4. United or irregular furrows may occur
Surface	1. Smooth or indefinite 2. Granular 3. Striate 4. Net or pitted 5. Isolated dots to spines or other projections
Exine, Section	1. Thin 2. Medium, no rods 3. Medium with spaced rods or beaded 4. Medium or thick with coarse external rods 5. Layer of close, thin rods 6. Long, thin spines 7. Large, broad based spines 8. Small or very small spines or warts 9. Other prjections
Other structural features	1. Grains compound or with air sacs 2. Thickened or projecting edges to apertures 3. Cap or streak on aperature 4. Granules or projections scattered on aperature 5. Intine swollen beneath aperatures 6. Intine thick or very thick 7. Cell contents granular
Pollen colour (fresh bee load)	1. White to grey 2. Brown 3. Red or pink

	4. Orange 5. Yellow 6. Green 7. Blue to black

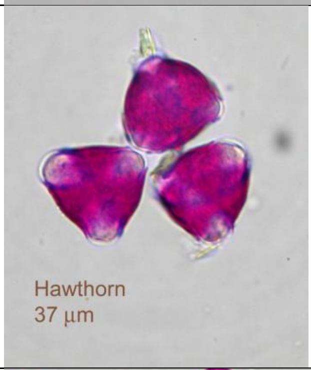
The only way to learn the feature classifications are to make a slide of a known pollen within the Rex Sawyer table and identify the features listed.

The following table gives examples of pollens and the associated Rex Sawyer Key:

	Latin name	Image
Forget-me-not	Myosotis arvensis 1,4/7,4/5,(3),1,1,-,5	
Dandelion	Taraxacum officinale 2/3,1/7,3,1,4/5,8/9,-,4	
Rape	Brassica napus 2,1/5,3,2,4,3,-,5	

Lime	Tilia petiolaris 3,2/5,3,(3),4,2/3,5,2/5	
Sycamore	Acer pseudoplatanus 3,2/5,3,2,3,2(3),-,1/2	
Poached egg plant	Limnanthes douglasii 2,4/7,(2),(2),2,1,-,1/6	
Crocus	Crocus aureus 4/5,1,1,2/4,2/5,1/8,6,4	
Willow	Salix caprea 1,1/2,3,2/3,4,3,-,4/5	

Module 8 Study Notes

Heather	Calluna vulgaris 3,7,3,3,1(2),2,1/2,2	
Hogweed	Heracleum sphondylium 3,4,3,3,2/4,3,-,5	
Rosemary	***Rosmarinus officinalis*** 3,1,4,2(3),4,2,-,-	
Hawthorn	Crataegus monogyna	
Hazel	Corylus avellana 2,2/5,3,1,1,2,2/5,5	

Module 8 Study Notes

Module 8 Study Notes

8.8 the nutritional value of honey to the honeybee colony;

Honey is the main source of carbohydrate for the honeybee, carbohydrates are used mainly for the production of energy, but may be converted to body fats and stored.

The principle contents of honey comprise:

Constituent	Typical Amount	Range
Carbohydrate	80%	78 - 86%
Water	17.5%	13 - 23%
Acids	0.5%	0.2 – 1%
Nitrogen	0.04%	0 – 0.13%
Ash	0.2%	0.02 – 1.03%
Enzymes	Not Stated	
Flavour and aroma constituents	Not Stated	
Breakdown Products	Not Stated	

Carbohydrates (sugars):

Taken together, sugars make up between 95 and 99% of the solids in honey.

They can be classified by their chemical complexity into four classes:

Monosaccharides (Fructose and Glucose, ratio F/G 1.2 except in Rape honey)	68 - 72%
Disaccharides (Sucrose 1-3% and Maltose ~7%)	8 – 10%
Trisaccharides (15 identified most important Melizitose)	1 – 5%
Higher Sugars (at least 2 indentified, contains 4 and 5 sugar molecules)	< 1%

Acids

Although acids comprise only about 0.5% of honey they have important effects:

- Reduce pH to 3.9
- Contribute to the stability of honey against micro organisms
- Contribute to the flavour of the honey

The main acid is gluconic acid which is formed by the action of the enzyme glucose oxidase. The reaction also produces hydrogen peroxide which is not sufficiently stable to remain for any length of time.

19 other acids have been identified, among which are formic acid, acetic acid, citric acid, lactic acid and oxalic acid.

Nitrogen

40 – 65% of nitrogen is in the form of proteins but there are some free amino acids. The proteins originate from pollen and from enzymes and other proteins introduced by the bees themselves.

The presence of proteins lowers the surface tension of honey and causes it to foam and produce scum. The higher concentrations found in ling heather and manuka honeys produce thixotropic effects.

Free amino acids react slowly with sugars at room temperature, more quickly at higher temperatures. This is thought to be a cause of honey darkening on storage or when heated.

Ash

The ash is the material left over when honey is heated to a high temperature and is caused by the presence of minerals. Potassium is usually the largest component but there are very many more.

Enzymes

Invertase (sucrase)	Used by the bees to breakdown sucrose into glucose and fructose. Some enzyme activity remains in the honey. The reaction is reversible, i.e. invertase can cause glucose and fructose to recombine into sucrose. This may be the reason why all honeys contain a small amount of sucrose.
Glucose oxidase	Breaks down glucose into gluconic acid and hydrogen peroxide and is one of the major factors responsible for the antibacterial properties of honey.
Diastase (amylase)	Breaks down starch to simpler compounds. Its exact function in honey is unknown but the enzyme is used by bees to breakdown pollen.

Enzymes start to breakdown at temperatures above 45°C

Flavour and aroma constituents

Many chemical compounds have been identified which are present in very small quantities but are responsible for giving honey its individual character. They mainly fall into 4 classes of chemical:

- Alcohols
- Aldehydes and ketones

- Acids
- Esters

The more volatile chemicals are lost quite quickly after the honey is removed from the hive and this is the main reason why the flavour of honey tends to reduce as it ages.

Breakdown products

The chemical composition of honey slowly changes over time. These changes are accelerated by heating. The most important breakdown product is hydroxymethylfurfural – HMF (formerly known as hydroxymethylfurfuraldehyde). Allowable limits in honey are 40 ppm (40 mg/kg).

Other breakdown products cause the honey to slowly darken.

Module 8 Study Notes

8.9 the main constituents and physical properties of beeswax and propolis;

Beeswax varies a lot, as does any product from the bees, depending on where it comes from, the weather and the time of year. It is mostly made of a substance called myricyl palmitate, which is a type of chemical known as an ester, but there are many other ingredients. These are the main four ingredients and approximate percentages:

esters 70%
alcohols 1%
acids 10%
hydrocarbons 13%

Beeswax Physical Properties

Beeswax is a water-repellent substance of firm but plastic consistency with a low coefficient of friction. It has a honey like odour and a faint characteristic taste.

Solubility	Insoluble in water
	Slightly soluble in alcohol
	Soluble in chloroform, ether and benzene
Colour	It is colourless as individual flakes and white when solid
Temperature	Melts at 62 - 64º
	Pliable at 32 - 35ºC
	Flashpoint 242 - 250ºC
Relative Density	0.96
Acidity	20
Reactivity	Reacts with Alkalis (used to make soap) and hard water (calcium)
	Use soft water to cleanse

Propolis

Propolis comes from exudates of some plants, in particular trees such as poplars and conifers. It can also come from flowers such as the Sunflower. The exact mix of over 150 or so constituents will vary by location but will generally comprise:

Module 8 Study Notes

50-55% resins and balsams
30% Beeswax
10% Essential and aromatic oils
5% Pollen

Physical Properties

Colour	ranges from yellow to dark brown depending on the origin of the resins
Temperature	25-45°C soft, pliable and very sticky <15°C becomes hard and at zero brittle >45°C more sticky and gummy Generally liquefies at 60-70°C although can be as high as 100°C
Antibacterial	The resins and balsams include components that demonstrate antibacterial properties, these components are generally soluble in water or alcohol

Module 8 Study Notes

8.10 the commercial manufacture of wax foundation;

Source of Wax

Wax is collected and traded by beekeepers for new foundation, this provides a good source of wax for commercial manufacture but is not sufficient for all UK needs. The UK imports most of its wax from China. All wax is tested prior to use, primarily for adulteration by petroleum based products which affect the properties of wax.

Cleaning and Filtering

Molten wax is mixed with Sulphuric Acid to remove staining and assist in the settling of impurities.

The wax is then filtered to remove the impurities through a paper filter or centrifuge

The final process is bleaching using hydrogen peroxide and benzyl peroxide at high temperature.

Foundation Production

Molten wax is first turned into continuous sheets of solid through several stages:

- A drum extracts wax and passes it through a die to create a course sheet of approx 1/8th inch
- The sheet is pressed and smoothed by passing it through rollers and reducing the thickness to 0.03 inch (0.75mm)
- The sheets are then milled and cut to produce the final foundation to the appropriate thickness and embossed cell size

Throughout this process a combination of heat, water and soap is employed to ensure the wax is managed to produce the final product.

Module 8 Study Notes

8.11 how foundation can be made on a small scale by the beekeeper including one method of wiring frames and embedding the wiring into this foundation;

Wax foundation is used to encourage bees to draw out comb to cover the full surface area of a frame.

Wax foundation provides a template for the workers to draw out the comb, ensuring that the comb ends up where the beekeeper wants it, the drawn comb fills the whole area of frame so optimum use is made of the space available and the size of the template dictates the use of the comb e.g. in brood for queen to lay worker eggs.

Foundation is a wax template mounted within a moveable frame in the hive, the template is embossed with the cell pattern that the beekeeper would like the bees to follow when drawing out the comb in the brood chamber of supers

this encourages bees to build the desired (worker or drone) sized cells in an orderly manner across the whole available surface

Facilitates easier manipulation and inspection of bees

Foundation can be specific to drone or worker cells being drawn out by the bees, this is done by using different cell size templates on the foundation

The foundation can be wired or unwired

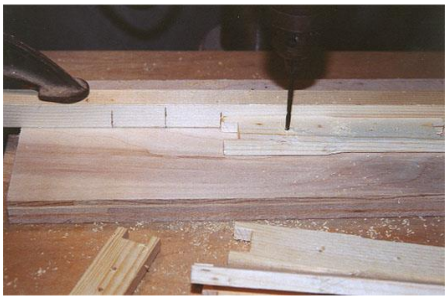
Home Production

Fill a large sink or other container with cold water
Place the hinged edge of the Press flat on a firm surface and slightly open the Press
Pour in the liquid wax until nearly full and squeeze shut, pouring away the excess wax
Put the Press into the water. After only 2-3 seconds, carefully open the Press underwater and remove the sheet of wax. This will need to be trimmed to the correct size.
Remove the Press from the water and stand it open on its edges to allow water to run off.
Give the Press a gentle rub with a kitchen towel to break up any water droplets. Alternatively the water could be made up of a soapy solution of washingup liquid which will prevent water droplets forming.

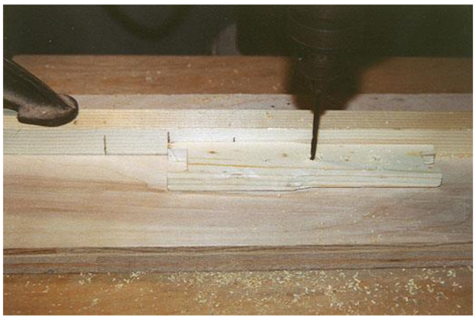
Module 8 Study Notes

Frame Wiring and Embedding

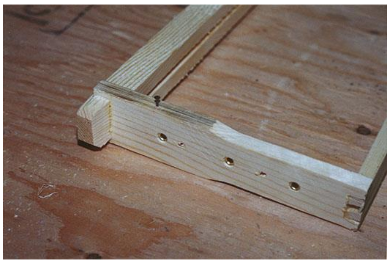
Excellent explanation and images from beesource.com



Begin by drilling 1/8" diameter holes centered in the end bars. 5 holes are drilled on 9-1/8" (deep) end bars, evenly spaced. 3 holes are drilled on 6-5/8" (medium) end bars, evenly spaced. A simple jig is made by using a scrap piece of wood and making marks on it that equate to the spacing of the holes to be drilled.



Once the holes are drilled, install brass eyelets into the holes. A setting tool can be purchased.



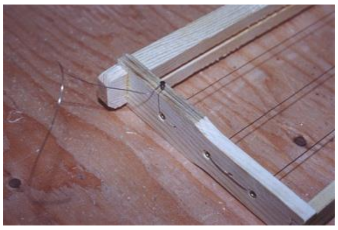
To install the wire, start by setting a small headed nail just above the top eyelet on one side of the frame.

One the opposite side of the frame, install a nail directly above the bottom eyelet, leaving both nails standing about an 1/8".

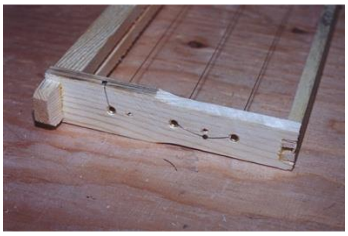
Module 8 Study Notes

Starting at the bottom, thread a piece of wire through the bottom eyelet (where the nail is) and across to the opposite side (bottom eyelet), up to the middle eyelet and through to the opposite side eyelet, repeating till you reach the top eyelet where the nail is. Cut the wire from the spool leaving a few inches extra on each end. Wrap the wire tab around the bottom nail a few times.

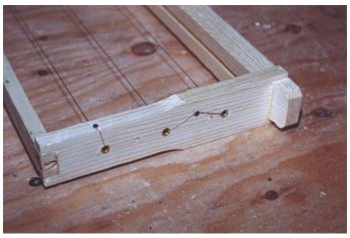
Drive the nail all the way in and break off the excess wire tab.



Pull the wire hand tight through all the eyelets, then wrap the end of the wire around the top nail several times.



Drive the nail all the way in and break off the excess wire tab. Stretching the wire with the nail between the eyelets, drive the nail through the end bars as shown.

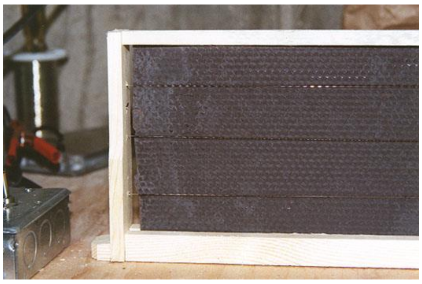


Repeat on the other side. This will take all the slack out of the wire.

Module 8 Study Notes

Various contraptions can be made to provide a low current to the wire. Battery charger, transformer, here a clothes iron.

Place the electrical clamps on the wire at each end. Insert a piece of wax foundation into the top groove, laying on top of the wires. Give the wire a few seconds electrical charge. You will see the wires start to melt right into the wax. Gently push the wax down onto the wires as they cool to make sure they are embedded.



Wires embedded into the wax foundation.

Module 8 Study Notes

8.12 The production and use of pollen supplement and pollen substitutes

Pollen supplement and substitute “patties” are used by the beekeeper to feed the colony in early spring in order to rapidly build up the colony for early crops such as oil seed rape. Pollen is the primary source of protein for the bees as well as the source of lipids, minerals and vitamins. Abundance of pollen is necessary and encourages brood increase.

If pollen supplement is to be produced a source of pollen is required, this is achieved by employing pollen traps at the entrance to the hive. Care needs to be taken in collecting pollen as if it is carried out for too long brood production declines and hence a poor honey harvest may ensue. Trapped pollen is generally air dried and stored in the freezer until required.

Pollen substitute does not as the name suggest include pollen.

Recipe for pollen substitute/supplement:

- Pollen Substitute
  - By weight 3:1:1 Fat free soya flour:Brewers Yeast:Dry Skimmed Milk, skimmed milk is optional
  - The dry ingredients are mixed with sugar syrup 2:1 to form patties and stored in sealed plastic bags to retain the moisture
- Pollen Supplement
  - By weight 3:1:1 Fat free soya flour:brewers yeast:dried pollen
  - Similarly the dry ingredients are mixed with sugar syrup 2:1

The patties are placed above the brood chamber covered in plastic sheet/greaseproof paper in order to retain the moisture.

Brewer's yeast contains all the essential amino acids, 14 minerals, and 17 vitamins. It is one of the best natural sources of the B-complex vitamins thiamin, riboflavin, niacin, B6, pantothenic acid, biotin, and folic acid. It is also high in minerals, including chromium, zinc, iron, phosphorus, and selenium. Brewer's yeast is also a good source of protein. It contains approximately 16 g of protein per 30 g of powdered yeast.

Brewer's yeast is made from a one-celled fungus called Saccharomyces cerevisiae and is used to make beer. It also can be grown to make nutritional supplements. Brewer's yeast is a rich source of minerals -- particularly chromium, an essential trace mineral that helps the body maintain normal blood sugar levels; selenium; protein; and the B-complex vitamins. It tastes bitter and should not be confused with baker's yeast, nutritional yeast, or torula yeast. All those types of yeast are low in chromium. Brewer's yeast has been used for years as a nutritional supplement.

Brewer's yeast is often used as a source of B-complex vitamins, chromium, and selenium. The B-complex vitamins in brewer's yeast include B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B9 (folic acid), and H or B7 (biotin). These vitamins help break down carbohydrates, fats, and proteins, which provide the body with energy.

Module 8 Study Notes

8.13 The assessment of the qualities of a queen and her colony and their subsequent management for queen rearing

The principles of selection of breeder queens and drones encompass defining the characteristics desired of the bees, the method of breeding (depends very much on scale and experience of operation) and record keeping to enable measurement of characteristics over time.

Each beekeeper may have a different idea of the perfect characteristics, but it is key to identify the ones that the beekeeper wishes to develop.
Key characteristics include:

- Dolcility, ideally no need for smoke or protective clothing through
    - Lack of stinging
    - Lack of aggression
    - Lack of tendency to follow beekeeper
- Disease Resistance, less treatment less colony disruption
    - Through hygienic tendencies, clearing out debris
    - Nosema resistance is a cleanliness thing
    - Varroa resistance through grooming
- Honey Production, every beekeeper is looking for a bumper crop
    - Bees must be able to produce large stores
- Thrift in the use of stores is key
- Swarming, reduced tendency to swarm
    - Swarm control is partly husbandry but some colonies will try to swarm when not necessary
- Tranquility, calmness on the comb
    - Eases inspections and manipulations
- Colony Build-up, larger colonies can produce more honey
- Early season build-up without swarming
- Continued growth in colony throughout season

These characteristics would be scored at each inspection of the colony through the use of a record card. The Nosema resistance would be measured by testing a sample of bees at the end of the season, all other characteristics can be measured throughout the season.

The identification of these characteristics is not instantaneous or based upon a single queen. The characteristics should be measured of a period, at least one season (preferably 2) and compared across sister queens.

The queens that show the best combination of characteristics should be selected to be used for producing the next generation of queens, queens that do not match the specific criteria should be replaced.

A simple method of breeding new queens is given below:

Preparation

- 4-5 weeks prior to breeding start build up of the colony with the queen desired characteristics to be a strong colony by adding a second brood box of drawn comb and feeding as necessary.
- Ideally at the start of the process there should be brood throughout the two brood boxes and two supers with stores.

- When ready to start breeding, remove the queen from the large colony and put in a nucleus box with attendants and associated frames.
- On the stand place super, queen excluder and brood box above with 8 frames of brood around a frame of eggs and larvae plus a frame of pollen and stores. All the bees from the colony are shaken into the hive. Excess super and brood frames are redistributed around other colonies.
- This colony is now congested to overflowing and queenless so will start to make queen cells.

Breeding

- After 3 days remove all queen cells, shake all frames of bees to make sure none are missed.
- Add a frame of young larvae from breeder queen in centre of brood chamber (can be Miller shaped frame).
- After 4 days queen cells on this frame will sealed and a second frame of larvae can be added. Each frame of sealed queen cells should be removed after 10 days for insertion and distributed to mating Nuclei.
- Once the raising of queen cells has been completed by the colony the queen should be reintroduced from the Nucleus.

Scaling up

- If more queens are required this process can be continued from mid-May through to end of July. However additional frames of sealed brood will need to be added to ensure sufficient young adults to tend the larvae. The number of bees and congestion in the colony must be maintained at all times.

Module 8 Study Notes

8.14 The structure and changes in function of the exocrine glands throughout the life of the castes of the honeybee colony, and the implications this has for the management of the honeybee colony

Gland	Located	Function	Caste
Hypopharyngeal	Front of head	in younger worker produces component of brood food using protein drawn from haemolymph in older worker produces enzymes for processing nectar invertase (converts sucrose to glucose + fructose) and glucose oxidase to preserve honey Gorging on pollen can cause gland to revert to food production	W
Mandibular (pair)	Above mandibles	Young worker, production of brood food and royal jelly includes pheromone 10 HDA Mature worker, alarm pheromone issued by guard bees to ward off robbers and initiate stinging response from other bees 2 heptanone Queen, produces pheromones used in mating or part of queen substance 9ODA & 9HDA + others	Q W D
Tergite (renner-Baumann)	Edges of abdominal sternites 3-5	Queen recognition, contributes to Queen Substance, emitted through Queen grooming and retenue palpating her abdomen with their antennae	Q
Nasonov	Tergite A7	Location scent used when flying in swarm to attract other bees, marking the entrance to hive, marking source of water. Main components E-Citral & geranic acid	W
Sting scent gland	Quadrate plates	Alarm pheromone, attracts bees to sting site iso pentyl acetate	W
Sting acid (poison or verom gland)	Abdomen	Develops in older house bees, production of venom to be used in sting	Q W
Sting Alkaline (Dufour)	Sting Chamber	Generally unknown but assumed to: lubricate sting mechanism, neutralise remaining acid and in queen protective coating to eggs or egg adhesive for cell floor	Q W
post cerebal (pair)	Behind brain	Salivary, no reservoir, secrete directly into outlet ducts Only vestigial in drone, equal development in Queen and Worker	Q W D
Thoracic (pair)	In the thorax	Salivary, developed from silk gland in larvae, have reservoir	Q W D
Arnhart (tarsal glands)	5th tarsome of each foot	Location (footprint odour) in worker bee Constituent part of Queen Substance, queen emits factor x13 of rate of worker	Q W
Wax glands 4 pairs	Sternites A4-7	Wax production, develops in young up to 12 days	W
Koschevnikov	Sting chamber outlet	Queen recognition by workers and drones	Q

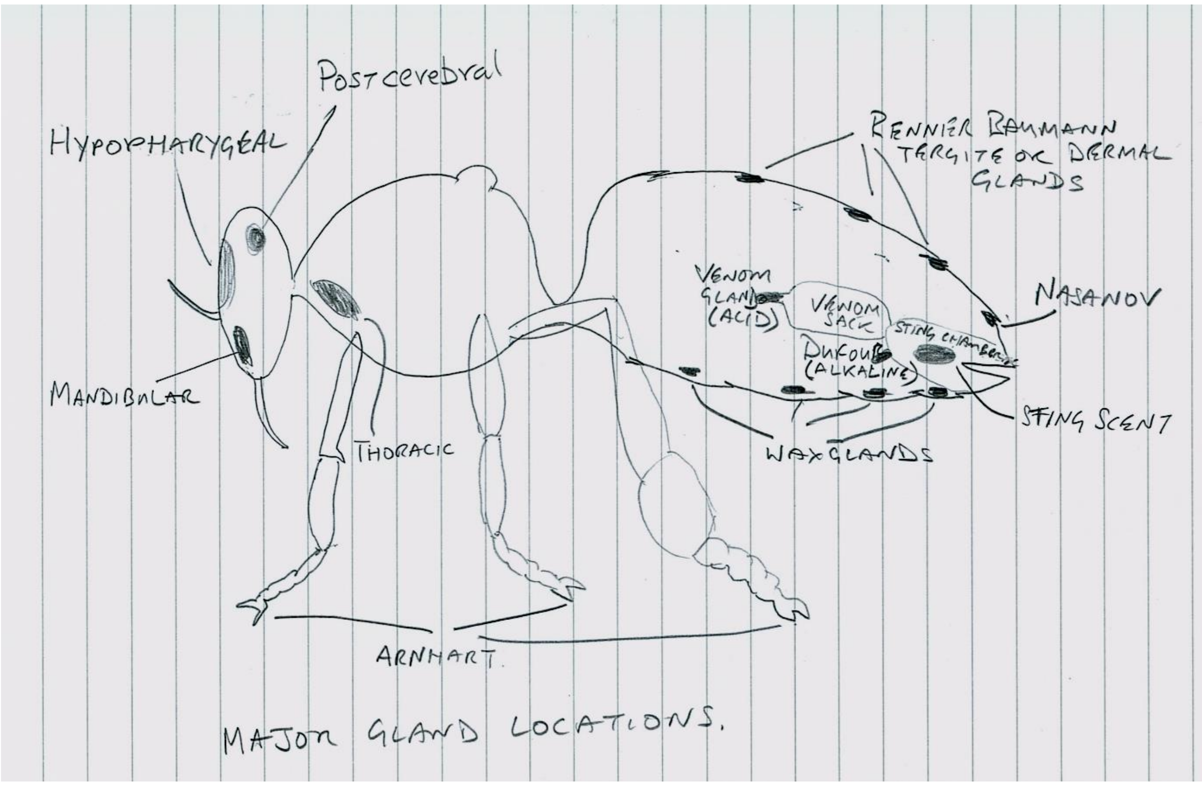
Module 8 Study Notes

Key Glands:

Queen
Mandibular, Tergite and Arnhart glands, all of which contribute towards Queen substance. Amount of queen substance produced by a queen reduces by a factor of two each year. These glands will be most productive in young queens from proven stock so the beekeeper should include queen replacement within their colony management. Indirectly the egg laying rate of the queen is affected by the level of stores (honey and pollen) within the colony, so the beekeeper needs to ensure the colony has good reserves at all times.

Worker
Hypopharngeal, Mandibular and wax glands. The development of the glands within the worker bee is dependent upon the availability of pollen as a food source. Hypopharngeal and Mandibular glands are required to produce brood food, an abundance of pollen can lead to rapid growth of the colony which is crucial in the spring. Young bees are necessary for feeding the young, wax production and honey making. Therefore the beekeeper needs to ensure a good supply of pollen in the spring and autumn, if necessary this can be through pollen supplement and substitute patties. Autumn pollen is crucial for the production of fat bodies in order for the workers to survive the winter.

Drone
There is no particular management of the colony for drone glands.



Module 8 Study Notes

8.15 the management of colonies used for migratory beekeeping for both honey production and pollination services;

There are several factors for consideration the management of the colonies:

- State of colony
  - Size
  - Brood cycle
  - Health
  - Nature
- Hardware
  - Suitability for moving
  - Spares
- Locations
  - Manage disease, robbing etc.

Foremost the colony should be healthy and disease free as moving bees around the country for production and pollination is an ideal way of spreading disease.

The colonies need to be large with a young queen and an abundance of foraging bees, in particular for pollination services there should be a significant amount of open brood in order to encourage the bees to forage for pollen. As some of the crops are likely to be early season, e.g. plum, the colonies will need to be encouraged to expand through feeding. The timing of the feeding is crucial as you want the colonies to be in the appropriate state prior to moving them to the production/pollination site.

The bees should be of a good nature and particularly for early crops have a trait for foraging in colder weather.

The choice of hive hardware should be appropriate to the role, a WBC for instance would be too heavy and large to employ, whereas a Smith hive was designed with migratory beekeeping in mind.

If the colonies are to be moved between different sites as the season progresses, it is likely that the beekeeper will need to replace supers between locations, harvesting one crop and putting fresh foundation for the next.

If a farmer has employed several beekeepers to pollinate a single crop the hives should be sited with consideration to the other temporary apiaries in order to minimise the risk of disease spreading through robbing and drifting.

Equalising brood in colonies for early pollination is done by some.

For heather crops it is usual to combine colonies to ensure plenty of foragers.

Module 8 Study Notes

8.16 the use of honeybees as pollinators in orchards and fields of seed crops including arrangements to be made with the farmer/grower;

Honeybees are excellent pollinators in that foraging bees will work a single crop until it is exhausted, the forager once it has established a good source will stick to that locale and plant.
Ideally the colonies would be distributed throughout a fruit orchard or around a seed crop in order to give a consistent level of pollination of the crop, this assumes we are working large fields and orchards.
The colonies should contain a large number of bees and be in the appropriate state before the crop to be pollinated comes into flower. This can be achieved early in the season through feeding of the colonies.
For pollination the colonies should have significant amounts of open brood in order to encourage the foraging for pollen.
You need to know the flowering periods and recommended colony density for each crop used. You need to bring the colonies in just as the crop starts flowering so the bees go to it and not something else. Once bees start on a crop they don't usually change until that crop is finished.

If a beekeeper is to supply pollinating services to a farmer it should be on a basis of a formal agreement which should include:

- Permission for hives on location
- Purpose of the agreement
- Restrictions on access, use of facilities etc.
- Facilities available to the beekeeper, e.g. parking
- Timing
- Crops involved
- Approximate number of hives
- Arrangements if multiple beekeepers on same crop
- Payment terms

The beekeeper should visit the site and agree with the farmer the hive locations before moving on site, for early season crops care needs to be taken in locating the hives to take into account weather conditions, e.g. late frosts.

The key elements of an agreement would be:
Parties and Scope of Agreement

- Farmer/Grower, contact details
- Beekeeper, contact details
- Purpose of agreement, in this case pollinate 40 acres of apples at ???? during the period of ????

Farmer/Grower responsibilities

- Provide access to the Beekeeper at requested times
- Give agreed period of notice of when bees should be on site
- Give agreed period of notice for removal of bees
- Provide facilities agreed with beekeeper, e.g. hard standing and clean water supply
- Abide by financial settlement as agreed with the Beekeeper
- Assume liability for Beekeepers colonies and equipment and indemnify the Beekeeper against 3rd party claims
- Not use chemicals on the crop without the approval and agreement of the Beekeeper

Beekeeper responsibility

Provide 60 colonies of bees (1.5 colonies per acre)

- Situate strong healthy colonies which are fit for purpose in the locations agreed with the Farmer/Grower in advance (groups of 4 to 8 at intervals of 500 feet) Each colony to have 6 to 8 frames brood. (National)
- Manage the colonies to the best advantage of the Farmer/Grower during the agreed period
- To resolve promptly issues arising from the colonies, such as swarming
- Abide by restrictions imposed by the farmer/grower such as time of access or routes of access

Agreement signed and dated by:

Module 8 Study Notes

- Farmer/grower
- Beekeeper
- Witness

Number of hives needed per unit area of crop pollination[2]			
Common name	**number of hives per acre**	**number of hives per hectare**	**number of bee visits per square meter/minute**
Alfalfa[3]	1, (3–5)	2.5, (4.9–12)	
Almonds	2–3	4.9–7.4	
Apples (dwarf)	3	7.4	
Apples (normal size)	1	2.5	
Apples (semi dwarf)	2	4.9	
Apricots	1	2.5	
Blueberries	3–4	7.4–9.9	2.5
Borage[4]	0.6–1.0	1.5–2.5	
Buckwheat[4]	0.5–1	1.2–2.5	
Canola	1	2.5	
Canola (hybrid)[4]	2.0–2.5	4.9–6.2	
Cantaloupes[5]	2–4, (average 2.4)	4.9–9.9, (average 5.9)	
Clovers[4]	1–2	2.5–4.9	
Cranberries	3	7.4	
Cucumbers[5]	1–2, (average 2.1)	2.5–4.9, (average 5.2)	
Ginseng	1	2.5	
Muskmelon[6][7]	1–3	2.5–7.4	
Nectarines	1	2.5	
Peaches	1	2.5	

Number of hives needed per unit area of crop pollination[2]			
Common name	**number of hives per acre**	**number of hives per hectare**	**number of bee visits per square meter/minute**
Pears	1	2.5	
Plums	1	2.5	
Pumpkins	1	2.5	
Raspberries[4]	0.7–1.3	1.7–3.2	
Squash[8]	1–3	2.5–7.4	
Strawberries[4]	1–3.5	2.5–8.6	
Sunflower	1	2.5	
Trefoil[4]	0.6–1.5	1.5–3.7	
Watermelon[5]	1–3, (average 1.3)	2.5–4.9, (average 3.2)	
Zucchini	1	2.5	

Module 8 Study Notes

8.17 the management needed to cope with geographic localities, weather conditions and the timing of the flowering of forage plants;

Geographic Localities

The general locality of a colony can determine the productivity of the colony, for instance if the colony is sited high in the moors with a single flow late in the season there is no use in building up the colony in early spring through extra feed. Larger colonies with no flow are more likely to swarm.

Colonies that are in more northerly areas of Britain are likely to need bees of a more hardy nature and frugal of winter stores, so breeding of queens that can propagate these traits will be vital for the success of a colony and fruitful harvest.

Apiaries in the western areas of Britain are more likely to experience wetter seasons so choice of hardware suitable to these conditions is critical as dampness is an ideal vector for disease.

South Eastern England is more likely to have a semi arid climate so managing the supply of water to the colony and ensuring it is not continuously exposed to the sun and hence excess heat is a consideration.

Weather conditions

In locating an apiary one should take into account:

- The direction of the prevailing wind and ensuring it is not across the entrance to the hive, plus in exposed areas wind barriers are provided
- Avoidance of frost pockets is key to good apiary locations as frost can severely affect the colony build up in the spring
- Ideally the hive should be exposed to morning sun as its warming effect can induce the bees to early forage
- In areas with a record severe winters the beekeeper would do better to employ bees of a more hardy nature, bees with more of a Mediterranean heritage require more stores and larger colonies going into winter.

Flowering of foraging plants

The beekeeper needs to manage their colonies in order to take advantage of the forage when it is in flower, this means the colonies need to be big, strong, healthy and foraging before the plants come into flower.

For early crops the beekeeper may need to feed the colony, likewise in gaps between early and late season forage crops the beekeeper may need to feed.

For late season crops the beekeeper may need to unite colonies to enhance the foraging population in the colony since naturally the colony population declines over the summer.

Module 8 Study Notes

8.18 methods of swarm control suitable for use in small and large beekeeping enterprises

Small Beekeeper

Method	Description	Advantages	Disadvantages
Remove the queen	destroy all queen cells, remove the queen and re-queen	Queen quality is managed Honey crop not impinged No extra hardware	Colony size remains so could still be chance of swarming
	remove queen and destroy all bar two queen cells and leave colony to re-queen		Colony growth and crop disrupted New queen might not mate well
Artificial Swarm	Queen, fresh foundation, foragers and supers stay in place, brood and young bees moved to side	Honey crop maintained Can re-queen through uniting with "swarmed" colony if desired	Requires additional hardware (essentially 2 hives)
Shook Swarm using Taranov Board	Ramp placed in front of hive with 4 inch gap to hive. Bees on frames shaken onto sheet over ramp. Foragers return to hive and brood with 2 x Queen Cells, queen and young bees cluster under board. Cluster is the "swarm" which is hived.	Splits colony into swarm relatively easily Minimal hardware	Break in brood New Queen may not mate well
Snelgrove	Same as Artificial Swarm except the existing colony is placed above Snelgrove board above supers, flying bees are bled from parent to swarm colony.	Control over flying bees and maintain foraging activity less hardware required simpler to reunite	Timing is crucial
Demaree	Similar to Snelgrove except board not used, queen, frame of brood and new foundation in bottom box, QE, then supers and 2nd QE, original brood with QCs torn down, as brood emerges it will go down to bottom box	No special hardware required Simple No loss of crop	Only prevents colony swarming for 14-21 days, time to think!

Commercial beekeeper

The commercial beekeeper does not have time monitor colony and unlikely to have additional hardware. If swarm cells found spilt the colony.

Module 8 Study Notes

8.19 the setting up, and management throughout the season, of an observation hive, and the uses to which it can be put;

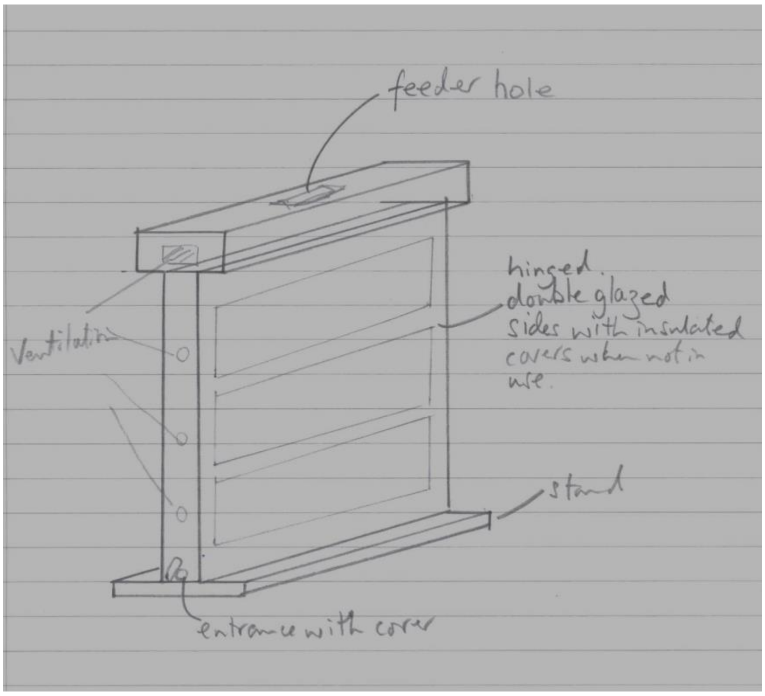
Setting up an observation hive is very similar to setting up a Nucleus Colony.
Key points relating to the colony that is to go into an observation hive are:

- The bees should be of a good nature as throughout the season they will be manipulated multiple times and sometimes in not the best of weather conditions
- The comb on which the colony will reside should be clean and uniformly drawn
- The colony should be small, but not too small
- The queen should be marked, young and well formed
- The colony must be disease free

The colony can be established by taking frames and bees from hives within the apiary:

- 2 frames of brood with good arch of stores (if observation hive 3 frame)
- 1 frame of stores
- Enough young bees to cover three frames
- Queen in an introduction cage

If no frames of stores available feed the colony as there will be no foraging bees.



Key points of the picture:

- Ample ventilation
- Secure and stable stand, if permanent display fixed mountings
- Entrance with cover for when on mobile show
- Feeding reservoir or aperture
- Double glazed hinged sides for access
- Insulated covers for use when travelling or not in use as OH

The colony is managed throughout the season in the same way as other colonies in the apiary, however there are special considerations:

- the colony size needs to be maintained below 5,000 in order to prevent overcrowding, too many bees does not make a good display in addition to the fact that overcrowding can cause swarming

- the number of brood frames needs to be restricted to 3 frames, this can be achieved by removing frames and replacing with fresh foundation
- levels of stores need to be monitored closely and colony fed appropriately with sugar syrup 1:1 and possibly pollen

The main use of the observation hive is education:

- at local shows it helps describe where honey comes from
- schools visits as part of the local association schools programme (fits in well with 1st school mini beast curriculum)
- monitoring the development of a colony, for instance showing the production of queen cell and eventual emergence if the observation hive is made queenless
- Permanent displays at museums & places where honey is sold.
- Taken to lectures & talks to show a small colony of bees

Problems for the honeybee:

- growth of colony is artificially restricted
- additional stresses from chopping and changing of frames
- transportation
- temperature variations (too hot or too cold) during a showing
- periods of up to 24 hours being enclosed.
- sometimes difficult to maintain ventilation throughout colony

Problems to the beekeeper:

- colony size needs to be managed
- what to do with the colony at end of season, usual option is to unite with another colony
- additional management in terms of feeding
- health and safety management when displaying the colony.

Module 8 Study Notes

8.20 the preparartion of a risk assessment and safety policy relating to handling, demonstrating and showing live honeybees;

The Risk Assessment in general terms must cover:

- what are the hazards
- who can be affected
- what can be done to avoid and manage the risks
- recording of actions and reviewing them

Hazards:

- Transporting bees to and from show
  - agricultural shows are generally held at rural locations may mean carriage of the bees over rough ground to a the marquee location
  - failure to secure the colony or an accident during transportation could lead to an escape of bees
- Proximity of crowds to demonstration and showing of the bees
  - in establishing where to site the colony for live handling demonstration consideration needs to be given to how to manage audience engagement as well as their safety
  - When showing bees in an observation hive similar crowding issues can occur
- Bees sting
  - Management of the environment to avoid bees escaping in the first instance
  - If a bee sting does occur how to handle it in a manner not to cause panic
- Bees escaping
  - Bees could escape through any of the above

Who is likely to be affected by these hazards:

- Beekeeper demonstrating live bees or showing them
- General public visiting the event
- Other stall holders nearby
- Children in play areas

What actions can be done to mitigate the risk:

- Colonies should be transported in a secure manner
- Site to which the colonies are to be delivered visited prior to event to plan location of equipment and bees, route to and from location assessed
- Stand for showing bees and the secure area for demonstrating live bees set up before the bees arrive
- Colonies employed should be of a good nature and less prone to sting
- Demonstrators fully dressed in protective clothing and any bees on clothing brushed off before leaving the secure area
- The netting employed to create the secure area for demonstration erected and examined for holes before the event and any flaws repaired
- Colonies sited on sheeting that can easily be thrown over the hives in order to limit bee escape should disaster strike e.g. hive is inadvertently knocked over
- Spare bee suit and equipment available for beekeeper showing bees in observation hive
- Hives sited such that they are clearly visible so as to prevent crowding around the hives
- Beekeepers in bee suits situated around the secure area to field questions, manage the audience and perform support if an accident occurs.
- Ensure all people who are managing the stand and demonstration are aware of the actions to be taken if someone gets stung
- Avoid leaving out items that may attract bees and wasps from the local area
- Create a tick list and brief all helpers before the event
- Make contact with the First Aid post at the show and make them aware that there are live bee demonstrations occurring at the event and agree the process is someone is taken ill after a sting

Module 8 Study Notes

Safety Policy Document

- We will provide adequate control of the health and safety risks arising from our beekeeping demonstration activities.
- We will consult with the events secretary prior to the show to agree a safe number of hives and a suitable location for them.
- We will ensure safe handling of the bees.
- We will provide adequate training of our beekeepers.
- We will prevent accidents to the best of our ability
- We will look after health and safety of all stewards with adequate refreshments & rest breaks.
- This policy will be reviewed and revised as necessary at regular intervals.

Signed:____________________________ (Chairman)
__________________________________(Date

Module 8 Study Notes

8.21 methods of monitoring and seasonal management of the health of colonies;

Colony Inspections:

- Inspect the colony regularly throughout the foraging season and record observations
    - All stages of brood and in appropriate proportions 1:2:4 (egg:larva:sealed brood)
    - Number of frames of bees and brood, is it growing
    - Health of bees on frame, e.g. is deformed wing virus present
    - Good brood pattern
    - Growth of colony and stores

Disease inspections

- Carry out disease inspections at the beginning and end of the season
- Take sample a bees and carryout nosema test count

Monitor for varroa 4 times a year

Observe activity at the entrance

- Is pollen being brought in
- Is activity commensurate with size of colony and weather
- Are there dead/dying bees around the hive
- Are dead larvae being brought out of the hive
- Are there “sick” bees walking away from the hive

At all times wear and use clean clothing, clean tools between use on different colonies and ensure all hive components are clean/sterile before use.

Use an Open Mesh Floor, not only as part of varroa management but also for improved ventilation as dampness is a vector to poor colony health

Spring

- Ensure sufficient stores, particularly of pollen
- Ensure colony protected from elements and damp free
- Replace brood comb in an appropriate manner to the size and strength of the colony
- Carry out brood disease inspection (checking for AFB & EFB and others)
- Carry out varroa count and act accordingly
- Carryout regular inspections
- Follow Integrated Pest Management for the control of varroa with the colonies

Summer

- Continue with regular inspections and IPM schemes (e.g. drone uncapping)
- Ensure colonies have sufficient space within hives
- Site colonies in order to avoid drifting and robbing, if it does occur manage the situation
- Ensure the colony always has sufficient stores

Autumn

- Carry out full disease inspection
- Ensure sufficient capped stores present to survive the winter
- Ensure hive components are fit for purpose to survive the winter
- Treat for varroa
- Ensure colony strong enough to survive the winter

Winter

- Establish protection against pests
- Monitor stores level through hefting hive, feed as necessary
- Keep air flows clear of snow
- Do not disturb the colonies

Module 8 Study Notes

8.22 the signs of disease and pest infestations of honeybees; the potential impact on bee health, the economic effect and how these diseases and pests impact on the management of the colony.

name of disease	type of pathogen *e.g. bacteria, virus, fungus, protozoan*	full scientific name of pathogen	stage of bee attacked *(larvae, pupa, adult)*	all diagnostic features
European Foul Brood	bacteria	Melissococcus plutonius	Larvae before capped	Un-natural position of larvae, yellowish-brown colour to dead larvae, gut visible through body, patchy brood pattern, urinary smell from secondary invaders, loose scales in cell. Positive identification may be made using lateral flow device.
American Foul Brood	bacteria	Paenibacillus larvae larvae	Larvae after capping	Sunken cappings, greasy looking, pepper pot brood pattern ,rotting smell, rough scale on lower side of cell, ropey thread on matchstick, proboscis of dead pupae protruding from bottom edge of cell, perforated cappings. Positive identification may be made using lateral flow device.
Amoeba	Protozoan	Malpighamoeba mellificae	Adult bee	round cysts in malpighian tubules
Chalk Brood	Fungus	Ascophaera apis	Larvae and prepupae	White mummified larvae, soft and crumble easily, pepper pot brood In bad cases black fruiting bodies chalks outside hive and pepperpot appearance of brood.
Nosema	Microsporidian Which is a fungus	Nosema Apis/cerana	adult	No obvious signs, dysentery associated with nosema. Colony may be slow to build up compared with others in the apiary, shortened adult bee life.
Acarine	Mite	Acarapis woodi	Young adult	darkened first thoracic trachea
Varroosis	Mite	Varroa destructor	all stages	Poor brood build up, poor brood pattern, dead mites on varroa tray, mites seen on larvae, bald brood
Chronic Paralysis type 1 syndrome	virus	Chronic Bee Paralysis Virus type 1 syndrome	Adult	Trembling wings and body, Crawling, bloated abdomen, huddled on top bar, dysentery, dislocated wings (K wing)
Chronic Paralysis type 2 syndrome	virus	Chronic Bee Paralysis Virus type 2 syndrome	Adult	Black shiny hairless bees ,black broad abdomen, trembling, crawling, nibbled by other bees, refused entry to hive

Sac Brood	Virus	Sacbrood	prepupae	perforated cappings , dead larvae pupae like a Chinese slipper. The cuticle is not shed on the fifth moult to prepupa and the prepupa dies in a fluid filled sac.

Virus	Association	Effect
CBPV type 1	Varroa, Acarine	• Trembling wings and body • Not flying – crawling on ground and up plant stems • Bloated abdomen (full honey sac) • Huddle on top bars – does not react to smoke • Dysentery • Dislocated wings (K-wing) • Deaths
CBPV type 2	Varroa, Acarine	• Black shiny hairless bees (appear smaller) • Broad abdomen • Affected Bees nibbled by other Bees – refused entry to hive • Trembling, not flying • Deaths
Acute bee paralysis	Varroa	• Weakening of the colony without signs of brood diseases and mites • Increasing numbers of dead or dying bees on the inner cover or front of the hive. Dying bees may be trembling and display uncoordinated movement. • Affected Bees are partly or completely hairless where the upper surface of the Thorax is especially dark • Older Adult Bees have a greasy or oily appearance while recently emerged Bees may appear opaque as if pigmentation of the tissue had not been completed prior to emergence • Rapid decline within a few days
Black queen cell	Nosema	• Turns queen cell black • Prepupa or pupa is yellow
Sacbrood	Varroa	• The moult at prepua to pupa goes wrong and the space fills with ectdysial (fluid) • Moult skin resembles Chinese Slipper • Changes from yellow to dark brown • Pupa dies. • Adult Bees can be infected when cleaning cell • Life shortened • Become foragers earlier • Stop feeding larvae • Rarely collect pollen
Deformed wing	Varroa, Tropilaelaps	• Damaged appendages, particularly stubby, useless wings

		• Shortened, rounded abdomens • Miscolouring • Paralysis • Severely reduced life-span (less than 48 hours) • Typically expelled from the hive
Slow paralysis	Varroa	• Collapse late in the year
Filamentous	Nosema	• Causes haemolymth to go milky
Y	Nosema	• No reported symptoms
X	Amoeba	• Shortens life • Colonies die in spring
Cloudy Wing	None known	• Wings go cloudy • Bee dies

Potential impact of these on bee health

Chalk Brood: May be minor disease or more serious. Normally there is little impact on bee health
Varroa: May be very serious if not properly controlled. If associated with viruses then the colony is likely to die.
Nosema: Shortens adult bee life span, this can lead to the demise of a colony very quickly
EFB: May take a couple of years to kill a colony, but colony will gradually dwindle & die. May spread to other colonies.
AFB: colony will collapse
Bald Brood: Rarely has any impact on the health of a colony.
Sacbrood: Usually a minor disease with little impact on the health of a colony.
Amoeba: does not seem to affect the colony detrimentally
Acarine/CBPV: can lead to colony collapse

Economic effect

Poor honey stores and hence poor harvest
If AFB loss of equipment and colony and honey.
EFB If a shook swarm is done early in the season there may be little loss of honey.
Bald Brood: Unlikely to be any economic effect.
Varroa: If not controlled may lead to colony collapse and consequent loss of honey.

Impact on the management of the colony.

Beekeeper will need to take appropriate action for instance Shook swarm for Nosema, Artificial swarm for Varroosis, effectively the colony will need to be rebuilt with the potential loss of honey production during the process.
Chalk Brood: Keep strong colonies but requeen with a different strain more resistant to Chalk Brood.
Acarine: No treatment available, but requeening may help.
Nosema: No treatment currently available
EFB: Shook swarm or OTC treatment by Bee Inspector.

Module 8 Study Notes

8.23 procedures related to good hygiene practices on matters of personal clothing, manipulations and equipment to prevent the spread of disease between colonies and between apiaries

a) personal clothing

Bee suits should be cleaned throughout the season (at least once a fortnight) and definitely cleaned before visiting another apiary, do not use perfumed detergent.
Disposable gloves should be used
Gloves cleaned between hives using soda crystal solution
Boots cleaned regularly with soda crystal solution
Have a different set of clothes for each apiary.

b) manipulations

avoid killing bees during manipulations
any wax or other item removed from hive should be put directly into a container for removal away from the apiary
cover supers during inspections to avoid robbing
do not leave used frames, wax, hive parts or tools around in the apiary
if feeding, do so in a manner to avoid robbing
feed all colonies in an apiary at the same time
replace brood combs every 2 to 3 years
replace failing queens
avoid overstocking an area

c) equipment.

Clean tools between hives
Smokers should be cleaned regularly in soda crystal solution
Equipment being removed should be cleaned/scorched and stored in a bee tight environment
fumigate combs with 80% acetic acid
Never leave spare equipment around in the apiary
Never transfer elements between hives without first cleaning (uniting is an exception) but check disease free first
Storage of equipment should take into account the potential spread of disease and pests e.g. wax moth.
Separate set of equipment for each apiary when possible.
Don’t buy second hand equipment.

Module 8 Study Notes

8.24 the development of hives and beekeeping equipment used in the United Kingdom (refer to list in Appendix):

a) development of hives

The development of the modern hive really has its roots in the 17th century, up until that time hives in the UK mainly comprised the use of the skep made initially from woven wicker and latterly from straw. The skep was difficult and costly to harvest honey as well as not appropriate for colony inspections as we know them today. Although going back to Greek times there is evidence of the employment of top bars and supers with skep like hives.

In 1756 Rev Stephen White began to produce a Collateral Hive, where the concept of a brood box and supers was adopted in a lateral manner i.e. the supers sat either side of the brood box. Thomas Nuit claimed that his design of a Collateral Hive in 1832 was invented without the prior knowledge of similar designs dating back over 200 years. His design was popularised through his publication Humanity to Honey bees. The design included features that supported his concepts of bee behaviour such a thermometer to assist in the monitoring of the brood and super temperature as well as bees preferred to travel laterally with honey loads rather than vertically.

French scientist René Antoine Ferchault de Réaumur was one of the first people to build a glass walled observation hive in order to assist in the biological research into bee behaviour, Francois Huber a Swiss scientist developed Réaumur's design to produce a leaf hive where individual frames could be observed. The hive was not commercially produced and an exact date of use is not known although it is mentioned in an article published in 1806. Huber is credited with documenting "beespace" which has influenced the design of all commercial hives we know today.

In 1819 Robert Ker designed the Stewarton hive, hexagonal in shape it comprised brood and supers stacked vertically as well as moveable top bars. The hive employed wider bars in the shallower super which produced deeper cells discouraging the queen from laying in them and therefore producing purer honey. The brood box was deeper than the super and the system of moving slats assisted in the process of uniting colonies.

In 1851 Langstroth revolutionised the design of the moveable frame hive and commercialised its production, the majority of hives in use today are based upon his design and understanding of beespace. Nearly 10 years after the publication of the Langstroth patent Thomas Woodbury designed the square Woodbury hive with 10 frames and internal measurements of 14 ½ inches and a depth of 9 inches, clearly a forerunner to the British National Hive.

Module 8 Study Notes

In 1880 T W Cowan produced a double walled hive employing thick square wood sides, the later William Broughton Carr design in 1890 proved more popular and in many ways is the seen as the classic British Hive. The WBC appealed to the amateur beekeeper because it could utilise cheaper materials such as fruit boxes for the brood and super boxes.

Charles Dadant emigrated to America in 1863 to grow grapes, this venture was abandoned in favour of beekeeping. He was accredited with importing the first Italian bees into America, however his greatest legacy is the Dadant Hive sometimes called the super Langstroth with more and larger brood frames but in the style of a Langstroth hive.

At the height of the debate for the standardisation of the British brood frame Samuel Simms a bee farmer proposed a 16 x 10 inch short lug frame which was housed in what is now known as a Commercial Hive, this hive is popular with commercial beekeepers as it is capable of housing larger colonies.

W. Smith from Peebles in Scotland around 1947 produced the Smith hive which is a short lug version of the British standard frame, this hive was seen as better for transportation by the bee farmers working the heather.

In 1968 Bill Bielby tried to revive a hive design adopted by the Greeks with the Catenary Hive, the name taken from how a chain hangs when suspended between two points. The hive has a curved inner lining to the brood box and top bars from which the bees draw comb in a natural manner. The top dimensions of the brood box match those of the British National so that standard queen excluders, supers etc. can be employed.

The British Modified National beehive could be viewed as a compromise, it is a single walled hive built around the standard deep (Kent frame based 1882) and shallow (Sussex frame based 1885'ish) frames. The Ministry of Agriculture designed in 1920 the first British National hive as an evolution of the Simplicity Hive a development of the Woodbury and Simms designs. The design was incorporated into BS 1300 in 1946 and modified in 1960, hence the title of British Modified National as we have it today. The BS1300 standard no longer exists.

b) equipment used in the United Kingdom

In 1865 Abbé Collins invented the queen excluder, believed to be a slotted zinc excluder it enabled beekeepers to ensure the queen did not try and lay in the supers, thus improving the purity of the honey produced.

Moses Quinby invented in 1875 what is attributed to be the first bee smoker, it was driven by the beekeeper blowing into a pipe held between their teeth, later a bellow was added. Mr T.F. Bingham 20 years later enhanced the design, both smokers produced cold smoke by passing air over the source. The smoker commonly used today was developed by A.I. Root around this time, the main difference being the air is blown through the source generating hot smoke.

The Porter bee escape was invented by E.C. Porter in 1891, the design has not changed since that date, although the materials may have improved. The principle is that young workers curing the honey need to go to the brood box to receive more nectar, they pass through a hole with springs that allow the bee to pass but cannot be opened on the return route. Thus isolating the bees from the supers. Requires a flow of nectar and warm weather to be successful.

William Broughton Carr introduced in 1887 the tin plated metal spacers for frames in order to provide the appropriate space between frames, this was followed by the Hofmann Self Spacing frames in 1889, the Hofmann frames have a V on one side and square shoulders on the other thus helping the beekeeper when releasing a frame. R.O.B. Manley invented the Manley frame for the supers to prevent the frames rocking and crushing bees whilst the hive is being moved.

In 1857 J Mehring a carpenter from Austria invented a method of producing sheets of wax foundation with an octagonal pattern for Langstroth frames, the method employed a dipping a mould in wax. In 1896 E.B. Weed invented a method of imprinting foundation on a continuous roll of wax, this method is very similar to that utilised today. The use of patterned foundation enabled beekeepers to achieve straight drawn comb. Captain Hetherington is credited with inventing wired foundation.

Major Von Hruschka in 1865 invented the first centrifugal extractor to handle Austrian 10 x 10 inch frames. T. W. Cowan was the first to use steam to separate wax and honey. The advantage of the Hruschka method was that the frames could be re-used whereas the Cowan method destroys the comb.

The Miller feeder invented by Dr C.C. Miller, it was a top feeder of the same dimensions as the hive that allowed bees to safely come up to feed from syrup either side of a central baffle. Mr. Harrison Ashforth improved the design by moving the baffle to one end of the feeder allowing bees to clear all the syrup within the feeder.

Dr Colin Butler was responsible for the Butler cage, a safe method introducing a queen to a colony, it comprises a mesh (big enough for worker antennae to pass but not for bees to harm the queen) permanently sealed at one end and open at the other end. The principle of the successful use being the distribution and acceptance of the new queen's pheromone.

L. E. Snelgrove introduced the Snelgrove Board in 1934 as a means of swarm in his book Swarming – It's Control and Prevention.

Module 8 Study Notes

Module 8 Study Notes

8.25 the life histories of one selected species of each of the following found in the United Kingdom: solitary bee, social bee (other than Apis mellifera), solitary wasp and social wasp and their interaction with honeybees.

Tawny Mining Bee (Andrena fulva)

Adult emerges from hibernation in the Spring, having hibernated throughout the winter. They will mate, the male dying on mating. The female then sets about making a nest. The Tawny Mining Bee seems to prefer to nest in sandy soil in lawns, borders or pots, sites are recognisable by mounds of soil like worm castes. The nest consists of a single tunnel with approximately 5 branches, one for each egg. The tunnel will be 20-40 cm long and the entrance about the size of a 10p coin. Females do sometimes construct nests close to each other, and a nest may be re-occupied year after year if undisturbed.

Like the other female solitary bees, she sets about making egg cells: in each one she lays an egg and provides both pollen and nectar on which the individual larva can feed. Each individual egg cell is made, provisioned, then sealed up before the next cell is made. She will usually lay about 5 eggs. The adults are active for 6 – 8 weeks of the year, and the new adults that emerge will need to hibernate over winter.

Bumblebee (Bombus terrestris)

Only queen bumblebees survive the winter, after hibernation they will emerge as the days get warmer and longer and she will forage on nectar and pollen before searching out a nest site. This feeding activates the development of the ovaries, the queen having mated the previous year. An ideal nest site is something like a disused mouse nest or similar hole.

The queen will make a couple of wax cells and fill with nectar and pollen, these are to sustain her and feed the young larvae. She will lay 8 to 14 eggs and incubate them. The eggs hatch in 6-8 days and feed on the provisions, after 10 – 20 days they go through a series of larval moults, spin a cocoon and pupate, emerging as adults two weeks later.

The new young adults will now forage and the queen will become the sole egg layer, the colony expands to 300-500 bees. Up until the colony reaches full size only female workers emerge, now both male and young queen eggs are laid, males are unfertilised eggs in larger cells. Males will leave the nest, mated queens will remain laying down fat reserves in preparation for hibernation. As winter draws closer the new queens will leave the nest in search of a location to hibernate. The old queen, males and workers die before winter

Solitary Wasp (Pseudepipona herrichii) – rare but found in heaths of south Dorset

The mated female only hibernates during winter. In late spring early summer the female excavates a nest by burrowing in the light sandy soil. The first cell 2 – 4 cm beneath the surface is polished with saliva and the egg is laid. The cell is then provisioned with live larvae of the Tortricidea family of moths 8 -10 to each cell, having being immobilised by the sting of Pseudepipona herrichii. The cell is then sealed and another cell prepared in the

same burrow, the female cells will be below the male cells, males will hatch first.
The eggs will hatch after 2 – 4 days into a larvae larval stage lasting 5 – 7 days feeding on the stores provided and moulting as it develops into a pupa. Cocoon spinning and pupation takes about 3 – 5 day, the imago emerging after another 15 days, the male first. Mating occurs and the male dies leaving the female to hibernate starting the cycle again.
There is no contact between parents and offspring.

Social Wasp (Vespula vulgaris)
As with the Bumblebee only the mated young queens survive the winter through hibernating at individual sites. The lone queen emerges in the spring/early summer and feeds on nectar and pollen which activates her ovaries. She searches out a nest site and builds the core and 20-40 cells into which she lays fertilised eggs. The nest is made from chewed wood. After 5 days the larva emerges and fed on insects including caterpillars, after 12-18 days the larva spins a cover to its cell and pupates emerging 10-15 days later.
The young workers are sterile and take on the role of foraging and nest building whilst the queen concentrates on egg laying, in July/August, male and queen cells are prepared. The brood is abandoned in September, the old queen, males and workers die before the winter. The young mated queens hibernate over winter on fat stores taken on in the winter.

There is no interaction between the honeybee and solitary bees, solitary wasps and social bees. However adult wasps feed on nectar so in the Autumn as the young queens prepare for winter and the sources of nectar are declining wasps are likely to try and invade honeybee hives in search of food.

Module 8 Study Notes

8.26 the history of beekeeping through leading contributors (listed in Appendix) to the knowledge of honeybees and beekeeping practices;

Outline of beekeeping practices:

Swarm Control	Snelgrove, Taranov, Pagden	Each of these methods named after the beekeeper that first used them employ a system based upon the same principle which is to separate the queen and foragers from the young and brood in order to maintain the overall colony population and honey production. Giving the Beekeeper the opportunity to manage the situation without the loss of bees in a swarm.
Queen Rearing	Miller, Doolittle	Miller and Doolittle popularised methods that had been previously used for the production of queen cells in a natural way but consistently, manageable and from a known queen. Doolittle grafted larvae into artificial queen cups and Miller employed a shaped comb.
Two Queen System	G Wells	The theory behind the two queen system is that it produces more than twice the honey of two individual colonies, good for getting maximum honey from a short season crop. The original method had two colonies above each other in double brood boxes with supers above, later methods separated the colonies with supers
Bailey Comb Change	Dr L Bailey	This method of comb change used the natural instinct of bees to employ fresh foundation for brood rearing and for the queen to go up. An ideal method for comb change and it is believed a colony after a Bailey comb change is stronger and more productive
Moveable bar combs	George Wheeler	In 1682 George Wheeler wrote about how the Greeks used bars across the top of skeps upon which comb was drawn and honey laid down. The bees maintained a space between the comb and side of the skep, enabling the bars with comb to be removed and examined.
Bee Space	Rev. L. Langstroth	The concept of beespace had been known for some time, see Greeks above and documented by Huber. Langstroth was the first person to significantly commercialise this knowledge with the patented design of his hive with moveable and manageable

		components.

Outline of the foundation of leading beekeeping organisations

1873	British Bee Journal and Bee-Keeper Advisor begins publication and exits today as part of BBKA News, founders were W. B. Carr, T. W. Cowan and C. N. Abbot
1874	British Beekeepers Association is formed and today comprises 66 local Associations with over 20,000 amateur beekeepers, founded by T. W. Cowan and C. N. Abbot
1880	E. H. Taylor founded by T. B. Blow was an beekeeping supplier.
1949	IBRA (initially BRA) founded by Dr Eva Crane is a publisher focused on disseminating information relating to Apiculture. There are three key publications Journal of Apicultural Research, Bee World and Journal of ApiProduct and ApiMedical Science
1964	BIBBA founded by Beowolf Cooper for the conservation, restoration, study, selection and improvement of the native and near-native honey bees of Britain and Ireland (Apis mellifera mellifera).

Short notes on the introduction of beekeeping equipment

Queen excluder	First employed in 1865 the queen excluder revolutionised the method for separating the brood from stores, paving the way for honey production through extraction rather than through use of Sections (which was the preferred system at that time)
Smoker	It had been known from Egyptian times that bees could be managed by smoke, the bellowed hand held smokers available from 1875 opened up a simple and focused method of application still in common use today
Bee escape	The porter bee escape has remain unchanged since its first introduction in 1891 and again is in common use today, albeit with modern materials.
Frame spacing	The WBC (1887) tin plated spacer frame attachments and the Hofmann (1889)self spacing frames gave beekeepers a simple method of ensuring that correct beespace is maintained with the hive.
Wax Foundation	The introduction of foundation manufacture assisted the beekeeper in optimising the use of space within the hive for brood/honey production as well as helping to maintain order in the colony
Wired Frames	With the advent of larger brood frames (Langstroth, Simmins) support of the foundation was required. Likewise with centrifugal extractors there was a need to support the super frame during extraction.
Extractor	The introduction of the first centrifugal extractor in 1865 (note same year as QE) enabled beekeepers to extract honey from comb and return empty drawn comb to the hive saving

	bee energy.
Feeder	Miller was an early proponent of feeding bee colonies and as the largest producer of comb honey in the USA in the late 1800s developed the feeder to bulk feed his colonies.
Queen Introduction Cage	The butler cage enables new queens to be introduced into a colony slowly, permitting the pheromones to mingle and the colony to accept the queen.
Swarm Control Board	The swarm control board permits the beekeeper to manage the swarming process without loss of bees or honey production. The main advantage of the board is that it saves on hardware as other methods require additional hive equipment.

Outline of bee strains introduced into UK

Ligustica:

T.W. Woodbury is credited with importing Italian bees from Switzerland in 1859, although there are reports that importing had be going on since 1819. The Italian bees were favoured by british beekeepers because of their high productivity. Woodbury bred new queens for delivery all over England.

Carnica:

Rev W. C. Cotton imported the Caniolan bee in 1870, which was after his return from New Zealand.

Cyprian:

T.B. Blow is known to have imported the Cyprian bee in 1887, although there are records stating is was in the UK 5 or 6 years earlier. The bee had a reputation for ferocity

Development of Buckfast Bee:

Bro. Adam bred the first Buckfast bee in 1917 following the "Isle of Wight Disease" which destroyed much of the UK bee population. With an isolated mating station and queens from all over the world Bro. Adam made it his life's work to produce the perfect bee (as well as honey production of course).

Summary of texts by influential authors

Rev Charles Butler	Feminine Monarchie (1609)	Definitive beekeeping reference for the next 250 years, 1st structured book on the management of bees kept in skeps.
Rev W.C. Cotton	My Bee Book (1842)	Written before leaving for New Zealand, practical advice on beekeeping, particular mention of making bees semi conscious rather than killing them when harvesting honey.
F. R. Cheshire	Bees and Beekeeping (1886)	Popular scientific work
Dr T.W. Cowan	British Beekeeper's Guide Book (1881)	Pocket sized book used as practical reference by beekeepers. 19 editions published

Module 8 Study Notes

W. Herod-Hempsall	British Beekeeping Guide Book and other texts (1928)	Volume 1 of a three Volume set is dedicated to TW Cowan, encompasses bee produce, war time beekeeping, simplified beekeeping for the cottager and smallholder. Complete set called Beekeeping New and Old described with pen and camera.
A.I. Root	ABC of Bee Culture (1877)	Still in print today and continues to be updated, probably most published bee book. Covers general practices and advice in beekeeping.
Rev L Langstroth	The Hive and the Honeybee (1853)	Still in print today it describes his observations of bee space and illustrates his patent for removable frame hive.
Dr J Free	Social Organisation of the Honeybee (1977) Pheromones of Social Bees (1987) Insect Pollination of Crops (1970)	Books reflect work at Rothamsted and have become classics in the beekeeping world.
Brother Adam	Beekeeping at Buckfast Abbey (1971) In search of the best strain of bees (1983) Breeding the honey bee (1987)	Books reflect his work as Beekeeper at Buckfast Abbey over a period of nearly 80 years.
Dr Eva Crane	Honey – a comprehensive study (1975) Archaeology of beekeeping (1983) Bees and beekeeping: science, practice and world resources (1990) The world history of beekeeping and honey hunting (1999)	Wrote over 180 books and texts on apiculture, the Honey – a comprehensive survey remains the most significant review on the subject. The later two encyclopaedias reflect the knowledge she gained through a lifetime in beekeeping.
E. B Wedmore	A manual of beekeeping (1932)	Comprehensive & Authoritative Guide to all aspects of Beekeeping. Reprinted 9 times.
R.O.B. Manley	Honey Farming (1946)	Reflects his experiences as at the time the biggest

		commercial beekeeper in UK with nearly 1,000 colonies.
Ted Hooper	Guide To Bees and Honey (1979) The illustrated encyclopaedia of beekeeping (co-author)	Classic reference manual for all aspects of beekeeping.
Dr M Winston	The Biology of the Honeybee (1987)	Excellent readable reference manual on behavioural and biological aspects of the honeybee.
K von Frish	The Dance Language and Orientation of Bees (1965 German edition)	This book details his discoveries relating to the efficiency of honey foraging and the related communication through dances.
M Lindauer	Communication among social bees (1961)	Reflects his work on dance language and use of polarised light by bees as a form of compass.
J Gould and C Gould	The Honey Bee (1995)	Looks at the history of beekeeping, describes the life cycle of honey bees, and discusses their foraging, flower learning, perception, and navigation

Three eminent beekeepers:

R.O.B. Manley (1888-1978)

Following the devastation caused by the "Isle of Wight disease" to native bees but not to carnica and ligustica colonies Manley began breeding Italian bees becoming a very influential beekeeper through his development of commercial honey farming methods.

Although he did not like the taste of honey in 1948 he was the first person to manage 1,000 colonies in England. He invented the Manley frame system and promoted the practice of feeding colonies as part of preparations for winter. Manley propagated the idea of using thymol in syrup intended for winter feeding in order to prevent fermentation and growth of mould. This practice is also effective in suppressing Nosema and is likely to become popular again with the demise of Fumidil B.

Brother Adam (1898 – 1996)

Born Karl Kehrle he was sent at the age of 11 to Buckfast Abbey where he joined the order and became Brother Adam. He joined the beekeeping team at the Abbey in 1915, in 1916 30 out of the 46 colonies succumbed to the "Isle of Wight Disease" starting him on his life long mission to breed a productive and disease resistant strain of bees. This different approach to that of Manley ensured that he too was an influential beekeeper of his time because of his knowledge and experience in breeding Honey bees.

In 1917 he created his first Buckfast strain, 1919 saw Brother Adam being promoted to being in charge of the Abbey Apiary. In 1925 the remote mating station in Dartmoor was established as part of his cross breeding programme.
From 1950 and for more than a decade he continued to improve the Buckfast bee with crosses from bees originating in Europe, Near East and Africa.
He was elected to the Board of the Bee research Association in 1964. In 1992 he resigned from his post at Buckfast Abbey and died in 1996.

Ted Hooper (1918-2010)

He started beekeeping as a hobby but learnt his trade working for 5 years with Rowse Honey farms in Hampshire, working with more than 500 colonies.
In 1962 he became a lecturer in Apiculture at Writtle Agricultural College in Essex where he remained until retirement in 1984. He was County Beekeeping Instructor during this period so visited many local Associations. He was President of the Essex Beekeepers' Association from 1983 until 1999. He was also President of the British Beekeepers Association for 1991 and from 1982 until 1989 he was chairman of the BBKA Education Board. In 1989 he was chairman of the BBKA executive committee.
In 1976 his book "A Guide to Bees and Honey" was published and it became the "Bible" of many beekeepers throughout Britain and the world. It has been translated into over twelve languages and has sold over 100,000 copies worldwide.