Introduction:

These notes have been prepared by myself as part of my studies for Module 7. I have found god crossover with both Modules 5 and 6 which I am studying at the same time. In parallel I have be doing the BBKA correspondence course for the model and have tried to ensure these notes are consistent with those of the course.

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:

<table>
<thead>
<tr>
<th>Book Title</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Honeybee Inside Out</td>
<td>Celia F. Davis</td>
</tr>
<tr>
<td>The Honeybee Around and About</td>
<td>Celia F. Davis</td>
</tr>
<tr>
<td>Guide to Bees and Honey</td>
<td>Ted Hooper</td>
</tr>
<tr>
<td>Beekeeping Study Notes (modules 5,6,7&amp;8)</td>
<td>J.D &amp; B.D. Yates</td>
</tr>
<tr>
<td>The Biology of the Honey Bee</td>
<td>Mark L. Winston</td>
</tr>
<tr>
<td>The Anatomy of the Honey Bee</td>
<td>R. D. Snodgrass</td>
</tr>
<tr>
<td>Queen Breeding and Genetics</td>
<td>Eigil Holm</td>
</tr>
</tbody>
</table>

BBKA website
MBBKA Study Group
MBBKA Basic Course Notes
Module 7 Study Notes

The Candidate shall be able to:

7.1 give the principles of the selection of breeder queens and drones; .................................................................3
7.2 describe a system of record keeping used in the assessment of queens and their progeny; .................4
7.3 give a detailed account of methods of queen rearing suitable for a beekeeper with 5 to 10 colonies and methods more suitable for larger scale queen rearing operations; ........................................5
7.4 give an outline account of a method of instrumental insemination and assess the role this technique could play in honeybee breeding; .........................................................................................8
7.5 give a detailed account of methods of queen of queen introduction, the principles underlying the processes involved, the precautions to be taken, and attendant difficulties in relation to different strains of bee and colony condition; ...........................................................................................................12
7.6 describe the setting up of mating nuclei and any precautions that need to be taken; .................15
7.7 give an account of the subspecies and strains of honeybee commonly used by beekeepers in Europe with particular reference to their appearance and behavioural characteristics; ...............16
7.8 give an account of important aspects of the behaviour of honeybees, in relation to breeding programmes; ..........................................................................................................................................................20
7.9 show an understanding of Mendelian genetics, particularly the inheritance of one gene with two alleles, and the concept of multiple alleles; ........................................................................................................21
7.10 give an outline account of inheritance in the honeybee; ..................................................................................22
7.11 describe the genetic basis of sex determination in the honeybee including parthenogenesis; ....23
7.12 give an account of mitosis and meiosis showing an understanding of the unusual nature of meiosis in the drone honeybee; ........................................................................................................24
7.13 describe in detail the reproductive system of the queen and drone with an outline account of sperm and egg production; ..............................................................................................................................................26
7.14 give a detailed account of the mating behaviour of honeybee queens and drones including the roles of pheromones and the concept of drone congregation areas; .........................................................29
7.15 describe the causes of drone laying queens and laying workers and ways to recognise the presence of these in a colony; ........................................................................................................31
7.16 describe ways of dealing with colonies with laying workers and drone laying queens; ..............32
7.17 describe the signs of queenlessness and how this may be confirmed; .....................................................33
7.18 give a detailed account of methods of marking and clipping queens and the advantages and disadvantages of these practices; ...........................................................................................................34
7.19 to distinguish between queen cells produced under the emergency, supersedeure and swarm impulses; ..................................................................................................................................................37
7.20 give an account of the problems inherent in cross breeding subspecies of honeybee; ..........38
7.21 give an account of the advantages and disadvantages of inbreeding and out breeding and how it can be assessed; .....................................................................................................................................................39
7.22 give an account of the effect of pathogens and pests on bee breeding. ........................................40
7.1 give the principles of the selection of breeder queens and drones;

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 production 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

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.

Breeder queens should be selected from the best performing colonies in terms of performance against the beekeepers desired characteristics.

The breeding method also determines the principle of selection, these methods include:

- Pure breeding, developing a pedigree of a pure bred bee by ensuring only queens and drones of same breed mate
- Cross breeding, bees from different lines are bred to produce desired characteristics
- Line Breeding, selecting best colonies for breeding queens and drones
- Combination Breeding, introducing new strains into a single line to enhance characteristics, Br. Adam method best example.
7.2 describe a system of record keeping used in the assessment of queens and their progeny;

There are two aspects to the record keeping, the first is to mark and number each queen and her progeny in order to record the life and history of the queen, the second aspect is to employ a record card that regularly scores the required characteristics.

At each inspection the beekeeper will score the colony on the desired characteristics:

- Docility, 5 for no smoke and no stings, 1 for aggressive and sting easily
- Swarming, 5 no queen cells with eggs, 1 for swarming
- Tranquility, 5 very quiet, 1 busy and many bees in the air
- Disease resistance, 5 no varroa treatment or signs of bee disease, 1 for severe disease

The card below shows standard colony record plus queen assessment.

<table>
<thead>
<tr>
<th>Apiary Hive No:</th>
<th>Queen history:</th>
<th>Queen update:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Queen</td>
<td>Queen Cells</td>
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<tr>
<td>(Wk)</td>
<td>(Yr)</td>
<td>(Yr/No.)</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Once in the season the colony should be scored for:

- Honey Production, 5 for >50% than apiary average, 1 for <50% of apiary average
- Colony Build-up, subjective score
- Varroa resistance, 5 for no treatments, 1 for treatment of heavy infestation

At end of season average all weekly scores, no score should be below 3 with minimum of 5 for docility.
7.3 give a detailed account of methods of queen rearing suitable for a beekeeper with 5 to 10 colonies and methods more suitable for larger scale queen rearing operations;

Small scale queen rearing (Demaree method)

**Preparation**

4-5 weeks prior to breeding starting build up 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.

**Split the colony**

First find the queen and isolate her.

Rearrange the brood frames with all unsealed brood in one box, flanked by sealed brood and a frame of pollen.

In other brood box fill with remainder of frames, position on hive stand and reintroduce the queen.

Place supers above queen excluder on this box, followed by a second queen excluder and the box with unsealed brood, topped off with crown board and roof. If originally there was only one super add a second and if required feed top colony.

Young bees will be drawn up to the top brood box and due to lack of Queen Substance create queen cells.

**Divide into Nuclei**

After 10 days there should be sufficient queen cells for the needs of the beekeeper.

The top brood box should have sufficient queens, bees and stores to be split into 3 – 4 nuclei additional stores, sealed brood and bees can be added to the nuclei from the bottom colony as necessary.

The queen cells may need to be cut out from frames and stapled to brood frames in order to distribute appropriately, ideally there should be two queen cells per nucleus.

Excess cells can be employed in min-nucs or nuclei made up from other colonies in the apiary.

**Variations**

If the breeder queen is to come from a different colony at the time of splitting insert a marked frame of eggs from the colony with the preferred queen and when dividing into Nuclei destroy all queen cells not on the marked frame.

The **Miller Method** when the breeder colony has been built up prepare a brood frame with foundation cut into V’s. Place a Nucleus box next to the hive and within it place 1 frame of stores (pollen and honey), one frame of sealed brood with the breeder queen, the prepared starter frame one further frame of stores. After 7 days in host colony destroy all queen cells, take the starter frame from the Nucleus, shake off the bees and trim the frame to expose eggs or very young larvae, insert in middle.
of brood. 6 days later examine the starter frame and cull badly placed queen cells. After a further 4 days divide queen cells among nuclei and reunite original queen with the remainder of the colony.

**Points to note**

Some variations talk about culling all queen cells in top box after 4 days and introducing eggs from bottom box then to ensure fresh eggs or larvae of appropriate age.

If nuclei made up prior to dividing from other colonies check for queen cells before dividing the breeder queen cells.

**Medium and large scale queen rearing (Ted Hooper method)**

**Preparation**

As above build up a strong colony of bees across two brood boxes.

Choose the queen from which the new queens are to be bred.

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.

**Variations**

Rather than introducing a frame of larvae and leaving it to the bees to choose which to develop into queens, requiring the beekeeper to cut out the sealed cells for onward hatching grafting of larvae can be employed.
A special frame of queen cups is prepared, see picture, a frame of larvae is selected from the breeder queen, the artificial queen cups are primed with diluted royal jelly and larvae transferred to the cups.

The frame is introduced into the cell builder colony as above. Again frames can be introduced every 4 days. This method produces a cell that is easier to introduce into mating nucs.

If the beekeeper is not keen on grafting a cup kit can be employed. The breeder queen is contained within the cupkit for up to 24 hours where she will lay her eggs in the cups, the cups at larval stage are transferred to cell building frame and introduced to the cell building colony, this method ensures the growth of the larvae is achieved without disturbance from the beekeeper.
Module 7 Study Notes

7.4 give an outline account of a method of instrumental insemination and assess the role this technique could play in honeybee breeding;

Instrumental insemination enables the bee breeder to control the mating process with known genetic material which is essential in both pure strain and cross breeding. Instrumental insemination should yield 100% success rate independent of weather and other environmental considerations.

Outline of method:

- 5 – 6 weeks prior to insemination ensure drone breeding is started
- When queen 5-6 days old and drones at least 16 days old collect semen from at least 8 drones, dependent upon number of queens to be mated
- Centrifuge semen and load into syringe.
- Queen is removed from nuc placed in tube which is then covered with backing tube, queen will back into this with one dorsal emerging from end, place over CO₂ flow to anaesthetise
- With two specially designed hooks open sting chamber, first ventral then the dorsal hook which is crucial for the depression of the vaginal fold.
- Micro-syringe is placed within the entrance of the vagina and 5 – 8 µl is expelled, there should be no spilage, if there is the vaginal fold has not been depressed.
- Queen is returned the nucleus after a second exposure to CO₂ and after 2 days should start to lay

Extract from Dr P Schley Bee Equiment website given below as a neat practical description of the method, full description given at www.besamungsgeraet.de

Drones and Queens

To obtain semen, drones should be at least 16 days or older and in healthy condition. The age of virgin queens and drones at the time of insemination is important as they must be sexually mature. Virgin queens should be 6 to 9 days old at the time of insemination. Queen inseminated younger than 4 days old have high mortality and queen inseminated after 12 days tend to store less sperm.

Eversion of Drones

Drones must be healthy and sexual mature to obtain semen. The drone is easily stimulated by hand in a two step process, the partial eversion and the full eversion. A partial eversion is sometimes obtained by simply holding the drone by the head and thorax and teasing the abdomen. Further stimulation is usually necessary. Crush the head and thorax of the drone, holding this dorsally and ventrally. Sometimes it is also necessary to apply gentle pressure to the tip of the abdomen to stimulate the eversion. During partial eversion, the abdomen will contract and expose the cornua (horns) of the endophallus. Pressure should not be applied to the anterior or sides of the abdomen at this stage and care must be taken not to crush the abdomen.
The partial eversion must be completed to expose the semen.

To obtain the full eversion, apply pressure along the sides of the anterior abdomen with the thumb and forefinger. Squeeze the abdomen laterally starting at the anterior base of the abdomen and working toward the tip by rolling the fingers together in a strong and steady motion. This pressure forces the endophallas inside out to expose the semen. The semen is a creamy marbled colour on a bed of white mucus. Take special care to avoid contamination of the semen.

Semen Collection

Before semen collection and between each drone draw a small air space followed by a small amount of saline solution to fill the taper of the glass tip. It is essential to separate the semen from the saline to prevent dilution of the semen.

Hold the ejaculated drone in your left hand and focus this near the syringe tip under the microscope. Expel the saline in the taper of the tip to make contact with the semen on the drone’s endophallas. Be sure to maintain the air space between the semen of the first drone and the saline. After making contact, skim the semen from the more viscous mucus layer. Avoid placing the tip of the syringe in the thick mucus layer. Care must be taken to avoid collection of mucus as this will plug the tip. To avoid drying of the semen at the tip, collect a small amount of saline in the tip of the syringe between drones.

Avoid the collection of air in the column of semen. Push out the air space and small amount of saline in the tip onto the semen of the next drone to make contact for collection. Repeat this process to collect the quantity of semen needed. Each queen should be given 8 microliters (8mm3) of semen or about 10 mm length in the glass-tip. This should take about 5 minutes to collect.

Placing the queen in the holder

Place the queen into the cylindrical backup tube. When she reaches the end of the tube with the small hole she will backup into the holding tube held next to this. The holding tube with the queen fits on the queen holder of the instrument which is connected to the carbon dioxide line. The tube must be turned so that the back of the queen is on the right side. The queen is ready for insemination when she is motionless.

Opening the sting chamber

Both hooks may be used simultaneously to open the sting chamber of the queen. If the abdomen is tightly closed the ventral hook may initially be used. For the beginner, a pair of forceps can also be used to open the queen allowing placement of the hooks.
Position the ventral hook by securing this in the natural small notch on the tip of the queen’s abdominal segment. The sting hook is then brought over and lowered to thread the sting. Now use the sting hook to lift the sting structure up and over to the right. When the hooks are properly positioned the tissue will stretch to form a large triangle. Within this triangle is a smaller “V” of wrinkled tissue defining the vaginal orifice and location of the valve fold which is not readily visible. The vaginal orifice is located on the connecting line between the hooks. With some practice, the process takes only a few seconds. Beginners should appreciate to use the pressure grip forceps to grasp the sting.

The opened sting-chamber

Preparation of the Queen Bee in the Holding Tube

Basically, the same type of technique is used worldwide to position and anesthetize the queen. To the right of the insemination device – from the inseminator’s point of view – there is a sting hook or mounted forceps (grasp from the queen’s posterior side), located to the left of the ventral hooks (hooks from the underbelly-side). With the help of these hooks, the sting chamber is opened and the vaginal opening is exposed for insemination.

The holding tube containing the queen and the insemination syringe must be properly aligned. The queen is positioned with her dorsal side to the right and abdomen protruding from the tube, several segments. If there is too much tension pulling to either side, the alignment is distorted and tissue loses elasticity. To prevent this and avoid overstretching, the ventral hooks is not pulled widely. It is very important to lift the sting area evenly.

The tip is moved to the right and slipped under the valve fold, then moved slightly to the left to bypass the valve fold. The tip is inserted into the median oviduct, about 1mm.

Injection of semen

Each insemination should be preceded with a small amount of saline. After the syringe is filled with semen and between each insemination, collect a small air space and 2µl of saline. This acts as a lubricant, allows you to test if the syringe tip is properly positioned and prevents drying of the tissues.

The leading edge of the glass tip should be positioned above and to the right of the “V” of wrinkled tissue. To bypass the valve fold a slight zigzag motion of the syringe tip is used. The tip is inserted 1/2mm, then moved slightly left, increasing the incline of the tip and inserting this another 1/2mm into the median oviduct. This is essential to move the valve fold to allow for passage of the semen.

The properly positioned syringe tip will slip easily into the median oviduct, without movement of the surrounding tissue. The semen can now be injected and should not leak out. If the tissue moves with
the syringe tip you have not bypassed the valve fold and the semen will back up. There should be no leakage of semen with a proper insemination.

Videoclips and Video

Susan Cobey (Davis, USA) works with the instrument 1.02 and my old perforated hook. Excerpts from the video by Susan you'll find at the following address:

http://www.youtube.com/watch?v=Csjy020fpyI
7.5 give a detailed account of methods of queen of queen introduction, the principles underlying the processes involved, the precautions to be taken, and attendant difficulties in relation to different strains of bee and colony condition;

Why Introduce a new queen?

Re-queening is the recommended solution to many beekeeping problems such as:
- Aggressive bees, followers, and other behavioural problems.
- Diseases such as chalk brood, acarine, stone brood
- Poor hygienic behaviour
- Poor productivity.
- Swarming; a colony headed by a young queen is less likely to swarm

Basic principles:
- Replace like with like; a laying queen is replaced with a laying queen.
- If another queen is placed in a colony of bees she will be attacked not only by the resident queen but also by the workers who recognise the alien by her scent.
- The colony should be in a receptive state; it must be queenless. The existing queen should be found and removed first.
- The new queen should then be placed in a sealed introduction cage which is put in the brood rearing area of the hive so the bees can familiarise themselves with her before she is released into the colony.
- Care should be taken not to stress the new queen. If she has come in a travelling cage, keep her there with her attendants until just before you transfer her to the introduction cage ready for insertion into the colony.
- If it is not possible to introduce the new queen within an hour of the hive being made queenless, further manipulations are needed before proceeding.

The Butler queen introduction cage

This is one such cage specifically designed for the purpose. It is made of 3 mm. wire mesh, formed into a rectangular sectioned tube approximately 90 mm. long and 20 mm by 13 mm. in cross section. One end is permanently plugged with a small wood block. Such cages can be home made or purchased from the appliance dealers. Similar plastic cages can also be obtained. The size of the mesh is important as the holes should be big enough for the bees to make contact with their antennae but small enough to prevent the workers getting to the queen and damaging her.

On arrival

It is best to introduce a queen to the new colony soon after she arrives but if this is not possible the travelling cage should be unpacked to allow ventilation through the mesh and two or three small drops of water placed on the mesh for the bees to drink. The cage can then be left in a cool ventilated cupboard for a day or two.

The travelling cage is unsuitable for introduction as it will be soiled with bee excreta and could transfer disease. Furthermore the attendants would antagonise the new colony. If the queen has been imported from abroad, the workers, cage and all packaging should be sent to the NBU for examination.

Transfer of travelled queen to introduction cage
Young queens not in lay are liable to fly! The safest place to open the travelling cage is therefore in a closed room with the windows shut. The queen can be picked up and put into the introduction cage, or gently coaxed into it while holding the cage against a window. Great care should be taken when handling a queen. She should only be picked up gently by the thorax or wings, and never grasped by her abdomen.

An alternative method is to open the travelling cage with the exit hole towards the light near a closed window and allow the bees to come out, placing the introduction cage over the exit hole when the queen is seen to enter the tunnel. She may be reluctant to oblige and patience is required.

In the field the transfer can be done inside a transparent plastic bag which can hold the travelling cage of bees, an introduction cage and the beekeepers hands. Many beekeepers do it inside a car with the windows closed, but make sure to block up ventilation slots below windscreen to prevent her dropping down inside! The queen can be kept in the cage using a wooden plug that fits the cage opening.

**Introduction**

Before introduction a plug of very stiff candy should be prepared by mixing a little honey with icing sugar. The honey must be disease free, do not use imported honey.

The queen-less recipient colony should be opened with as little disturbance as possible. The wooden plug on the queen introduction cage is replaced with a plug made of candy and the cage is supported horizontally between two brood combs in the centre of the brood nest amongst young brood. The queen will only be able to escape when the bees have chewed through the candy during which time they will have become accustomed to her scent. After introducing the queen in her cage the hive should be carefully re-assembled and not disturbed for nine days. At the next inspection remove the empty introduction cage and examine the brood combs carefully for eggs. It is not necessary to find the queen.

In conclusion, it must be noted that even in the most experienced hands Queen introduction can fail. There is no method that is 100% effective.

**Timing problems**

However if the colony is left queenless for 7-9 days emergency queen cells will be evident. If these are all removed the colony will be hopelessly queenless and may well accept the new queen directly from the cage. But, if left longer than this there could be one or more virgins resent which are difficult to catch and have to be removed. So be warned!

If you have just removed queen cells from a problem hive and you have a ripe queen cell in a well behaved colony preparing to swarm you could introduce this instead of a laying queen. Such queen cells should be protected using a spring type queen cell protector which can be spiked into a comb in the problem hive. Once again we are replacing like with like.

Because the laying worker produces its own queen substance one cannot introduce a new queen, however you can:

- unite the colony with a stronger queen right colony.
- remove the colony from the apiary and shake it out leaving the workers to find a new home (remembering to ensure no hardware left at the original colony site)
- As above but place a nucleus (dependent upon laying worker colony size) with queen or queen cell, a complement of bees and brood at the site of the original colony.

Views differ on the benefit of retaining the colony through uniting or housing in nucleus as the workers will be older and of dubious benefit to the new colony, however additional foraging bees can be viewed as a benefit during a flow.
Module 7 Study Notes

If re-queening has to be undertaken in the middle of the year it is much safer to establish the new queen in a small nucleus colony first.

Make up the nucleus from a healthy colony which could be the one to be requeened. At least two combs should contain plenty of brood preferably sealed and be well covered with bees but no queen. Put in another two frames of food and shake in more bees from a frame from the parent hive, again making sure the queen is not on the frame selected. Place the nucleus next to the hive to be requeened but facing in the opposite direction. Twelve to 24 hrs later introduce the new queen in an introduction cage. Feed with sugar syrup from a contact feeder but do not disturb for at least a week. When the queen is established and there is a good patch of unsealed brood the old queen that is to be replaced should be removed and the new colony in the nucleus united using the newspaper method.

Some factors which may affect acceptance.

- Genetic differences like replacement of a lighter Italian queen with a dark N. European bee
- Colony stress due to lack of food, bad weather, robbing etc
- Time of year; it is easier at the beginning of the season in April or early May when colonies are not in their prime, or during September when colony activity is diminishing. In mid-summer when colonies are large and swarming may be imminent, direct introduction of a new queen often fails.
7.6 describe the setting up of mating nuclei and any precautions that need to be taken;

It is assumed here when we are talking about using mini-nucs for mating purposes.

Some principles:
- Young nurse bees should be employed
- If the queen has been with attendants she should be introduced in a cage
- Reduced entranced should be employed to reduce robbing
- Feed should be supplied as nurse bees will not forage

Preparation of mini nuc
- The mini nuc should have stores within the colony, candy is best, if syrup ensure there is a means to prevent bees drowning
- Bees will need water source to breakdown stores.
- The mini frames should be fitted with 2-3cm of foundation
- Separate feed from nuc by queen excluder

Collection of nurse bees
- From a suitable colony remove brood frame and hold away from colony for a few seconds to allow flying bees to depart then shake young nurse bees into a large plastic bucket
- Spray with water to prevent the bees climbing
- 2.5 decilitres of bees required per mini nuc, if late in season 4 decilitres to strengthen colony

Queen introduction
- If queen has hatched she can be placed on mini nuc floor, spray her if she climbs side
- Pour in nurse bees
- Ensure entrance closed to allow bees to acquaint
- Open when queen 5 days old

Options
- If queen cell, place in hair roller cage for protection and introduce into mini nuc
- If unsure that queen will be accepted pour bees into nuc and introduce queen within a cage with a plug (not too big as not many bees to consume)

Leave for 12 days
- Do not open during queen flying times 11-17:00
- Check for sealed brood
Module 7 Study Notes

7.7 give an account of the subspecies and strains of honeybee commonly used by beekeepers in Europe with particular reference to their appearance and behavioural characteristics;

<table>
<thead>
<tr>
<th>Subspecies/strains</th>
<th>History</th>
<th>Appearance</th>
<th>Characteristics</th>
<th>Traits</th>
</tr>
</thead>
</table>
| *Apis mellifera*      | **The Carniolan honey bee** is native to Slovenia and to some regions of the former Yugoslavia, southern Austria, and parts of Hungary, Romania, and Bulgaria. | **Appearance**                      | It is favoured among beekeepers for several reasons, not the least being its ability to defend itself successfully against insect pests while at the same time being extremely gentle in its behaviour toward beekeepers. | • Considered to be gentle and non-aggressive  
• Sense of orientation considered better than the Italian honey bee race  
• Less drifting  
• Not known for robbing  
• Tendency to swarm  
• Able to overwinter in smaller numbers of winter bees; honey stores are conserved.  
• Able to quickly adapt to changes in the environment rhythm of brood production very steep. Brood rearing is reduced when available forage decreases  
• Low use of propolis  
• Prone to diseases such as paralysis, acarine and nosema  
• Workers live up to 12% longer than other breeds  
• More prone to swarming if overcrowded  
• Low ability to thrive in hot summer weather  
• Strength of brood nest more dependent on availability of pollen  
• Unless marked the dark queen is difficult to find |
| carnica (Carniolan)   |                                                                          |                                    |                                                                                 |                                                                                               |
| **The Carniolan honey bee** is native to Slovenia and to some regions of the former Yugoslavia, southern Austria, and parts of Hungary, Romania, and Bulgaria. | **Appearance**                      | **Characteristics**                 |                                                                                 |                                                                                               |
| **The bees are about the same size as the Italian honey bee race, but they are physically distinguished by their generally dusky brown-grey colour that is relieved by stripes of a subdued lighter brown colour. Their chitin is dark, but it is possible to find lighter coloured or brown coloured rings and dots on their bodies. They are also known as the "grey bee".** | **Characteristics**                 |                                                                                 |                                                                                               |
| **The Carniolan bee has a very long tongue (6.5 to 6.7 mm, which is very well adapted for clover), a very high elbow joint and very short hair.** | **Characteristics**                 |                                                                                 |                                                                                               |
| *Apis mellifera*      | **The Caucasian honey bee** originates from the high valleys of the Central| **Shape and Size: similar to A. m. carnica** | **Slow to build up in the spring, does not over winter well.**                  | • gentle and calm on the comb  
• ardent brood production raising |
| caucasica             |                                                                          | **Chitin Colour: dark with**        |                                                                                 |                                                                                               |

17/2/2011
### (Caucasian)

- **Hair Colour:** lead-grey
- **Tongue Length:** up to 7.2 mm
- **Notes:** They are susceptible to Nosema. Over use of propolis and brace comb ideal for mountain winter climate but a nightmare for manipulations.

### Apis mellifera ligustica (Italian)

- **The Italian honey bee** originates from the continental part of Italy, South of the Alps, and North of Sicily.
- **Subspecies:** may have survived the last ice age in Italy. It is genetically a different subspecies than the subspecies from the Iberian peninsula and from Sicily.
- **Size:** The bodies are smaller and their over hairs shorter than those of the darker honeybee races.
- **Abdomen:** has brown and yellow bands. Among different strains of Italian bees there are three different colours: Leather; bright yellow (golden); and very pale yellow (Cordovan).
- **Tongue Length:** 6.3 to 6.6 mm
- **Mean cuticle index:** 2.2 to 2.5
- **Notes:** Show strong disposition to breeding and very prolific, excellent housekeeper (which some scientists think might be a factor in disease resistance), uses little propolis, excellent foragers, superb comb builder, covers the honey with brilliant white cappings, shows lower swarming tendency than other Western honey bee races, ideal for areas with continuous nectar flow and favourable weather throughout the summer, prone to drifting and robbing.
- **Other:** shows strong disposition to breeding and very prolific, excellent housekeeper (which some scientists think might be a factor in disease resistance), uses little propolis, excellent foragers, superb comb builder, covers the honey with brilliant white cappings, shows lower swarming tendency than other Western honey bee races, ideal for areas with continuous nectar flow and favourable weather throughout the summer, prone to drifting and robbing.

**Notes:**
- **Origin:**
  - Caucasus
  - Hair Colour: lead-grey
  - Tongue Length: up to 7.2 mm
  - They are susceptible to Nosema.
  - Over use of propolis and brace comb ideal for mountain winter climate but a nightmare for manipulations.

**Notes:**
- **Origin:**
  - The Italian honey bee originates from the continental part of Italy, South of the Alps, and North of Sicily.
  - The subspecies may have survived the last ice age in Italy. It is genetically a different subspecies than the subspecies from the Iberian peninsula and from Sicily.

**Notes:**
- **Origin:**
  - It is the most widely distributed of all honey bees, and has proved adaptable to most climates from subtropical to cool temperate, but it is less satisfactory in humid tropical regions.

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**Module 7 Study Notes**

<table>
<thead>
<tr>
<th>Apis mellifera</th>
<th>The European dark bee was domesticated in modern times, and taken to North America in colonial times. These small, dark-colored honey bees are sometimes called the British or German black (or brown) bee, although they are originally from Britain to eastern Central Europe.</th>
<th>The bee can be distinguished from other subspecies by their stocky body, abundant thoracal and sparse abdominal hair which is brown, and overall dark coloration; in nigra, there is also heavy dark pigmentation of the wings. Overall, when viewed from a distance, they should appear blackish, or in mellifera, rich dark brown.</th>
<th>Hybrids have a defensive character and have the reputation of stinging people (and other creatures) for no apparent reason. Some colonies are very &quot;runny&quot; on the comb and so excitable that beekeepers consider them difficult to work with. This characteristic is not, however, one that has been traditionally associated with the dark bee breeds, which were previously known for their rather easy handling (though they have never been considered as placid as the Carniolan honey bee).</th>
</tr>
</thead>
<tbody>
<tr>
<td>mellifera (European Dark Bee)</td>
<td>heather honey before sealing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lehzeni (heathland bee)</td>
<td>nigra (black bee),</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- significant winter hardiness on few stores
- breeds at slower rate than other subspecies
- low tendency to swarm
- some lines are very gentle
- defensive against invaders i.e. wasps
- careful, measured "maritime" brood cycle
- strong drive to collect pollen
- high longevity of the worker bees and queen
- work longer hours than other bees
- produce beautiful comb and cappings
- excellent flight strength even in cold weather
- possibly hardiness against varroa
Module 7 Study Notes

Carniolan Bee

Buckfast Bee (common Hybrid)

Caucasian Bee

Italian Bee

European Dark
7.8 give an account of important aspects of the behaviour of honeybees, in relation to breeding programmes;

In breeding of honeybees the breeder is looking to improve one or more of the behavioural aspects of the bee line.

Key behaviours the breeder is concerned with in terms of the measured traits discussed in section:

- **Docility**
  - Defensive behaviour, the breeder is looking for bees that do not have a propensity to sting or follow
  - Aggressive behaviour, this is such things as buzzing the beekeeper or passerby, burrowing into gaps in clothing

- **Disease resistance**
  - Hygienic and house cleaning behaviour, helps to prevent the spread of disease within a colony, particularly Nosema and Chalkbrood
  - Grooming and mite damaging behaviour, these behaviours are distinct and seen as beneficial in the fight against Varroa
  - Honey Production

- **Foraging behaviour**
  - Bees need to be able to adapt to changing circumstances and collect stores well beyond the need of the colony

- **Comb building behaviour**
  - Without good comb building the colony is unlikely to be able store excess stores or have room for required increases in brood

- **Over winter frugality**
  - The colony needs to require as little stores as as possible for over wintering

- **Swarming tendency**
  - Swarming behaviour, a colony that tends to swarm is no good to a beekeeper looking for honey production

- **Tranquility**
  - Running behaviour, the breeder is looking for bees that do not run across the comb during inspections and manipulations
  - Clustering behaviour, bees clustering at the hive entrance or on the bottom frames during inspections is not a good trait
  - Calm behaviour, bees that carry on as normal during manipulation are a boon
  - Colony Build-up

- **Spring colony build up**
  - Related to swarming tendency and honey production is early build up to take advantage of spring flow and ensure a strong colony for the main flow

- **Brood adaption**
  - A behaviour that adapts the increase/decrease in brood production in relation to flow rate is seen as a good in terms of conserving stores and building up strength when required

Poorly regarded behaviour:

- **Robbing**
- **Excessive propolis**
- **Tendency to drift**
Module 7 Study Notes

7.9 show an understanding of Mendelian genetics, particularly the inheritance of one gene with two alleles, and the concept of multiple alleles;

There are two laws of mendelian:

First law – the law of segregation

The Law of Segregation states that when any individual produces gametes, the copies of a gene separate so that each gamete receives only one copy. A gamete will receive one allele or the other

Second Law – the law of independent assortment

The Law of Independent Assortment, also known as "Inheritance Law", states that alleles of different genes assort independently of one another during gamete formation

There are two basic types of cell within an organism, body cells (somatic cells) and reproductive cells (gametes). Body cells divide and produce replica cells in terms of structure and in particular the chromosomes. Gametes on the other hand half the chromosomes, resulting from a split (meiosis). When two gametes unite (sperm and egg) the result is a zygote and the gene pair (alleles) will reflect the forming of genes from two different chromosome structures.

An example of the 1\textsuperscript{st} law could be that cells with homozygous Alleles AA and bb would split to form gametes A, A, a, a, and b, b.

The uniting of heterozygous alleles demonstrates the second law. If original cells with alleles Ab and Ab formed gametes and united the possible results would AA, Ab, Ab and bb in equal proportion.

The second law shows how characteristics from a previous generation can be inherited and how homozygotic alleles can result from heterozygotic alleles.

Sometimes there can be multiple forms of a gene that controls a particular characteristic, this is multiple alleles or allelomorphic series. All instances of the gene reside at the same locus (position on the chromosome) but only one gene is used to form the alleles pair.
7.10 give an outline account of inheritance in the honeybee;

The genes that a honey bee inherits from its parent(s) determine all of its characteristics, however environmental aspects can dictate variations in behaviour. So for instance colour of a bee could be predicted however the behaviour of a bee as to what age it starts foraging will be dependent upon colony population and state of the flow. Behaviours including defence, disease resistance, hygiene and foraging are all controlled to a certain extent by genes, so inheritance of these behaviours is critical in breeding programmes.

Alleles have a dominant/recessive relationship, the table below demonstrates how the young inherit different genotypes (blend of genes) and phenotypes (physical appearance) based upon the genes of each parent. The example here is the orange colour gene which is recessive and the native colour dominant:

<table>
<thead>
<tr>
<th>Queen's genes</th>
<th>Drone's genes</th>
<th>Offspring's genes (genotype)</th>
<th>Offspring's colour (phenotype)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>CC</td>
<td>C</td>
<td>CC</td>
<td>C</td>
</tr>
<tr>
<td>Cc</td>
<td>C</td>
<td>50% CC</td>
<td>50% C</td>
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<td>50% Cc</td>
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<td>Cc</td>
<td>cc</td>
<td>c</td>
<td>c</td>
</tr>
</tbody>
</table>

Homozygous is where both genes are the same

Heterozygous is where they differ

Hemizygous is a drone which does not have a pair of genes

Notes, not all genes are clearly dominant or recessive and sometime several gene pairs control a specific characteristic.

All gametes from a drone are identical, but from an egg the genes will depend upon the pairs of the queen's chromosomes.
7.11 describe the genetic basis of sex determination in the honeybee including parthenogenesis;

Sex alleles within a bee are a series between 6 and 18, as long as the resulting pair in a fertilised egg is different a worker will result, if they are the same a diploid drone results. Diploid drones are eaten by house bees causing poor brood pattern. Under normal circumstances this situation should not occur as the queen will have mated with multiple drones from different colonies, however it may occur when she is mated via instrumental insemination with a related drone.
7.12 give an account of mitosis and meiosis showing an understanding of the unusual nature of meiosis in the drone honeybee;

Mitosis is the splitting of a normal diploid cell into two identical diploid cells.

A diagram of a typical cell is shown above, note that chromosomes only become visible during replication, under normal circumstances they exist as chromatin material within the Nuclear membrane.

The process of Mitosis is given below:
The process of Meiosis is similar to mitosis except it involves two stages and results in 4 haploid cells, one of which survives to become a gamete cell in the process of reproduction. Prior to the first separation the homologous chromosome pairs connect in one or several places and cross over occurs with the exchange of material.

The first separation splits the pairs of chromosomes and the second splits the replicated chromosomes forming haploid cells. In Mitosis only separation of replicated chromosomes occurs and the chromosome pairs carry forward in the resultant diploid cells.

4 Haploid cells are produced, one survives and the other three degenerate (possibly becoming trophocytes).

Since a drone cell is already haploid the first separation does not occur, the spindle attempts to form but the nuclear membrane persists preventing completion. A second spindle forms at right angles and separates the replicated chromosomes resulting in 2 haploid cells, of which one survives to form a gamete.
7.13 describe in detail the reproductive system of the queen and drone with an outline account of sperm and egg production;

Queen Reproductive System

The reproductive system of the queen not only produces eggs it stores sperm and unites it with eggs prior to laying.

The key elements of the system are:

- ovaries, there are two ovaries, one on either side of the abdomen and attached to the ventral wall. The each ovary consist of 150-180 egg producing ovarioles (worker 2-12). The ovarioles produce up to a million eggs over the lifetime of the queen.

- oviducts, these are tubes that lead from each ovary to the median oviduct

- vagina, the median oviduct feeds into the vagina along with the spermatheca duct. Within the vagina is the valve fold which coordinated with the pump in the spermatheca duct unites sperm and egg.

- bursa copulatrix, this is the sting chamber from where the egg is laid within a cell

- spermatheca, is a spherical structure above (dorsal side) the vagina, within here the sperm from mating is held. The sperm travels down the spermatheca duct into the vagina. At the entrance to the vagina the valve fold presses an egg to the duct for fertilisation.

Egg Production

At the tip of each ovariole germinal cells divide and produce:

- Oocytes which become the eggs
- Trophocytes which provide nourishment to the oocytes, there are 48 trophocytes per oocyte.

The oocyte passes down the ovariole gaining size through the supply of nourishment from the trophocytes which diminish and finally disappear, yolk is added in the later part of the ovariole, the
follicle cells surrounding the egg form the covering (chorion). As the egg leaves the ovariole the final meiotic division occurs.

The egg emerges from the oviduct, is pressed to the entrance of the spermatheca duct by the valve fold, if sperm worker egg results, if no sperm drone egg results.

Drone Reproductive System

The drones reproductive system comprises:

- Testes, there are two testis which peak in size prior to drone emerging from cell, they shrink until the drone reaches full maturity at 12 days
- Vasa deferentia, small tubes that lead from each testis and lead to the seminal vesicles
- Seminal vesicles, the sperm reside here and are nourished until they are required
- Mucus glands, two small tubes enter the gland from the seminal vesicles, the mucus produced by the glands is not involved in the production of the semen rather the delivery. The mucus forms a thick mass when in contact with air.
- Ejaculatory duct, runs from the base of the mucus gland, near the entrance from the seminal vesicle to the bulb of the penis
- Penis, the penis (endophallus) resides within the abdomen of the drone, opening to the outside on A9 (the phalotreme) from the vestibule which is connected to the bulb by the cervix. Two horns (cornua) are attached to the phalotreme. The surface of endophallus has several plates (sclerites) on the surface

Sperm Production

The testis comprises a large number of tubes, the tip of which form the sperm cells, as they travel down the tube they divide to form spermatagonia, then form groups called spermatocytes which grow and divide into spermatids and finally change shape to form spermatozoa which emerge into the vas deferens.

The drone mates once and dies, so all sperm (spermatozoa) are released in one explosive moment. After the mounting of the queen the contraction of the abdominal muscles causes the penis to evert (go inside out). The muscle lining of the seminal vesicles and mucus gland causes the sperm and then the mucus to be expelled.

The endophallus breaks off, the drone dies, the sperm remains within the queen until endophallus is removed by next drone or worker on return to colony.
Module 7 Study Notes

7.14 give a detailed account of the mating behaviour of honeybee queens and drones including the roles of pheromones and the concept of drone congregation areas;

Mating Behaviour of the Queen

Queens mature and are ready to mate 5-6 days after emerging from the cells, queens are unable to mate 3-4 weeks after emerging. Workers will generally ignore a virgin queen although they will become more aggressive towards her as time goes by, this is seen as encouraging the virgin to go on mating flights.

When the queen emerges for her flights workers will gather at entrance and emit Nasonov pheromone in order to assist the Queen in orientation. Sometimes she will need encouragement by the workers to go on flight.

Ideal conditions for flights are:

- Mid-early afternoon
- Air temperature 20°C
- Little cloud
- Wind <25 km/hr

Queen makes one or two orientation flights prior to making up to 5 mating flights. Flights generally are on subsequent days but can be on same day.

Queen will mate with on between 15 and 20 drones over an average of 6 occasions, sperm from one mating is sufficient to fill the spermatheca but the inefficiency of the spermathecal duct means that the queen must mate multiple times ensuring sperm from different drones is mixed giving variety to the next generation. Mating occurs in Drone Congregational Areas.

Mating Behaviour of the Drone

The drone takes up to 12-14 days after emerging to reach maturity for mating, during this period they take daily flights (initially short but getting longer prior to mating).

Mating flights last no longer than 60 minutes but average 30 minutes, they take place early to mid-afternoon in optimum weather conditions as above.

Drone Congregational Area

Mature drones from surrounding apiaries (up to 6 km) will congregate in a Drone Congregation Area (DCA), the routes to the DCAs are known as flyways and are up to 21m high, the DCA is 10-40m above the ground. DCAs are always at least 100m away from the apiary. The fact that DCAs attract drones from a distance helps to ensure the cross breeding of Queens with drones from distant colonies.

The DCA is a mystery in that they exist in the same place each year, generally in sheltered but open areas at a height of 10-40m and a radius of up to 100m. Because drones do not survive the winter the DCA needs to be fixed by some method other than learnt knowledge, the theories include:

1. Topographical features - which drones assess by sight and other senses
2. Distance from apiary – usually greater than 100m
3. Magnetic effects – drones develop large quantities of magnetite in their abdomens, this could be affected by the earth’s magnetic field
Pheromones

A Queen will enter a DCA attracting the drones with the pheromone 9-ODA (9-oxodec-2-enoic) which the drones can sense up to 50m away. The drones form a “comet” below the Queen. The drones are attracted at close range by the a second pheromone from the tergite gland and the Koschevnikov pheromone released when the sting chamber is opened prior to mating.

Drones produce a pheromone with their mandibular glands during the first 9 days of their life, it is stored for use during mating process. The pheromone is used to attract drones and the Queen to the DCA.

Mating

When within sight of the queens behind the drone will catch the queen with all 6 legs, impregnate her and flips back breaking his endophallus, falling to the ground dying. The endophallus explodes releasing the sperm into the queens sting chamber.

A white plug is left at the entrance to the Queen’s vagina, this is called the “mating sign”. It is composed of a blob of semen, mucus and the remains of the endophallus. This is removed by a subsequent drone or workers on the return to the hive.

The queen can mate again on the same flight and on subsequent days, the preference is to mate with drones not from her colony. Not all sperm from a single mating is employed (although it would be sufficient to fill the spermatheca), sperm travels to the spermatheca via the oviduct.
7.15 describe the causes of drone laying queens and laying workers and ways to recognise the presence of these in a colony;

A laying worker is worker whose ovaries have developed to the extent that they can produce eggs, all workers have ovaries (they are a female caste) but normally the development of the ovary is suppressed by pheromones. The ovaries when developed comprise 2-12 ovarioles capable of producing up to 50 eggs per day. The development of the ovaries in Apis mellifera mellifera takes up to 3 weeks. There are generally laying workers in a queen right colony but the egg production is managed by policing, in a queenless colony the policing is less.

Within a queenright colony there are two key pheromones:
- 9-ODA
- Brood Pheromone

These pheromones contribute to the suppression of worker ovary development in the colony.

In a queenless colony with active laying workers, the laying workers will produce a queen like substance from their mandibular gland that in turn prevents other workers developing their ovaries.

Laying Workers might arise due to:
- In a colony about to swarm due an aging queen or overcrowding the queen substance distribution will be reduced causing laying workers to develop.
- A colony where the queen has gone off lay and there is no brood and hence no brood pheromone
- Queenless colony, after a swarm or where the queen has died. After a swarm a laying worker is unlikely to prevail until after all the brood has emerged.

A drone laying queen might arise due to:
- Unmated queen, the queen has failed to mate within 3-4 weeks of emerging from cell
- Queen runs out of sperm in spermatheca, the queen is unable to produce fertilised eggs
- queen has mated with closely related drones and produces diploid drones

<table>
<thead>
<tr>
<th>Sign/symptom</th>
<th>Drone laying Queen</th>
<th>Laying worker</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Similarity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brood</td>
<td>Only drones laid and worker cells employed</td>
<td>Only drones laid and worker cells employed</td>
</tr>
<tr>
<td>Drones</td>
<td>Small and abnormal</td>
<td>Small and abnormal</td>
</tr>
<tr>
<td>Bee Colony</td>
<td>High proportion of drones</td>
<td>High proportion of drones</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brood Pattern</td>
<td>pattern even and normal</td>
<td>pattern random</td>
</tr>
<tr>
<td>Egg</td>
<td>single egg per cell laid in bottom of cell</td>
<td>multiple eggs in cell some laid on the side of the cell</td>
</tr>
<tr>
<td>Queen</td>
<td>Queen present</td>
<td>no queen or queen cell present</td>
</tr>
</tbody>
</table>
7.16 describe ways of dealing with colonies with laying workers and drone laying queens;

Laying Worker

Because the laying worker produces its own queen substance one cannot introduce a new queen, however you can:

- unite the colony with a stronger queen right colony.
- remove the colony from the apiary and shake it out leaving the workers to find a new home (remembering to ensure no hardware left at the original colony site)
- As above but place a nucleus (dependent upon laying worker colony size) with queen or queen cell, a complement of bees and brood at the site of the original colony.

Views differ on the benefit of retaining the colony through uniting or housing in nucleus as the workers will be older and of dubious benefit to the new colony, however additional foraging bees can be viewed as a benefit during a flow.

Drone Laying Queen

Re-queen or unite (if less than 50% worker brood present) with another colony, prior to either remove the drone laying queen.
7.17 describe the signs of queenlessness and how this may be confirmed;

**Signs**

- No eggs, larvae or capped brood cells (though of eggs and larvae can mean virgin queen)
- Queen cells with larva and royal jelly
- Colony more irritable than usual
- When opening colony distinctive roar
- Bees seem less well organised on the frames
- Very few brood cells polished up ready for queen to lay egg
- Pollen in brood nest will be shiny from being covered with honey in order to preserve it
- Possibility of eggs from laying worker
- Stores not being built up
- Bees generally lethargic
- Colony size dwindles

**Method**

- Remove a frame of eggs and young larvae from another hive
- Shake off bees
- Close up frames and add frame of foundation to outer area of brood box
- Insert frame in middle of queenless brood box
- If after several days workers make queen cells, indicates queenless
Module 7 Study Notes

7.18 give a detailed account of methods of marking and clipping queens and the advantages and disadvantages of these practices;

First Catch the Queen!

Step by step (assuming right handed)

Using your right hand, pick the queen off the comb using thumb and forefinger to grip both pairs of her wings... as shown left.

Then point the forefinger of your left hand at your right shoulder, keeping your hand up towards your face at a comfortable distance for good vision. (Illustrated at right.)

Offer the queen towards the tip of your left index finger and she will grip it with all six legs. Now gently close the tip of the left thumb and the side of the second finger onto the queens legs. You may now release the grip of your right hand (left picture).

Dab on your marking paint or glue your numbered identification disc in place. Then while the paint dries... do the clipping operation.

Aim your left hand at an angle as if to miss your right shoulder then slightly lift the queen's right wing with the tip of the lower blade of the snipper, position the blade so that about one third of the wing will be amputated. After ensuring that there is no spare leg involved and that the blades are perpendicular to the wing surface... complete the cut. Do the marking first particularly if using fish glue, to attach numbered discs, which requires a slightly longer drying time than paint.
This gadget is known as a Baldock cage, it is simple to use and will not harm the queen providing that it is not pressed too heavily into the comb. When it is not in use, press it into a piece of expanded polystyrene foam (styrofoam) which will protect your hands from the sharp points and the prongs themselves from damage.

This method of marking is employed when an unmarked queen is in a full sized colony.

It is used with the prongs on the surface of capped brood, unfortunately a few pupae may be damaged by the prongs, but this is a small price to pay for a simple method.

The spacing between the prongs is large enough to allow workers to escape, but the queen has a larger thorax and thus is captive. She is immobilized by pressing the cage down until she is gripped by the soft and compliant mesh. When she is still it is an easy matter to dab on paint or cement a numbered disc to her. A few moments delay to allow the paint or cement to dry and the cage is withdrawn.

There are also coloured discs and numbered discs with coloured backgrounds. Grey is occasionally used instead of white. I have used quick drying silver paint sometimes, as this is very ‘visible’.

The discs are small and difficult to handle with clumsy fingers... A way to have them ready for the instant that you require them, is to put one end of a piece of thin tubing in your mouth place the end of the tube on the top surface of the disc then apply suction with your mouth. The disc will stay in position and can be allowed to dangle ready to be applied when you have dotted the adhesive on the queen.

The tube cage, this is better when using the glue and numbered discs, as you can take the queen away from the hive and buzzing bees to mark her, with this cage you can also clip one wing at the same time. The cage consists of a 30 mm glass (or plastic) tube about 80 mm long with a 5 mm sq. elastic mesh stretched over one end and held in place with a rubber band, a 28 mm plunger covered on the top with a 9 mm thickness of soft plastic foam. To use it the queen is captured in the open end of the tube and the plunger inserted into the mouth of the tube, to hold her captive. Cover the brood box to keep the bees happy while you take the queen away to mark her, prepare the glue and disc then push the plunger up to trap the queen against the mesh with the dome of her thorax through a mesh hole to mark her. If you also wish to clip a wing, you can twist the plunger slightly and one wing tip will
poke through the mesh, cut off about 4 mm and the job is done. Withdraw the plunger about 25 mm the queen will walk about un-harmed wait a few minutes to let the glue or paint dry, pull the cover off the brood box place the tube along a seam between the frames, pull the plunger out, and let the queen walk out and down on to the comb.

Karl Jenter manufactures this plastic device that resembles a clothes peg, they call it 'queen pliers', which sound a little less brutal. This has soft sponge areas for gripping the queen's abdomen and small, stubby, transverse silicone rubber tubes that grip the sides of the queen's thorax. It is spring loaded and the ‘grip limit’ can be set using the thumbscrew.

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baldock Cage</td>
<td>Queen is not handled&lt;br&gt;Easy to use&lt;br&gt;Queen can be positioned for marking</td>
<td>Can squash queen if too much pressure applied&lt;br&gt;Need to have cage ready&lt;br&gt;Cage sharp can cause damage</td>
</tr>
<tr>
<td>Tube cage</td>
<td>Ability to manipulate the position of queen&lt;br&gt;Queen cushioned by sponge</td>
<td>Contact with queen&lt;br&gt;Mesh at end of cage plastic and can have sharp edges&lt;br&gt;Queen can be damaged by plunger</td>
</tr>
<tr>
<td>Queen held</td>
<td>Can be clipped at same time&lt;br&gt;Ensure queen is OK</td>
<td>Can damage queen&lt;br&gt;Workers can reject queen on her return</td>
</tr>
</tbody>
</table>
7.19 to distinguish between queen cells produced under the emergency, supersedure and swarm impulses;

Queens are raised in specially constructed queen cells. The fully constructed queen cells have a peanut-like shape and texture. Queen cells start out as queen cups. Queen cups are larger than the cells of normal brood comb and are oriented vertically instead of horizontally. Worker bees will only further build up the queen cup once the queen has laid an egg in a queen cup. In general, the old queen starts laying eggs into queen cups when conditions are right for swarming or supersedure. Swarm cells hang from the bottom of a frame while supersedure queens or emergency queens are generally raised in cells built out from the face of a frame.

As a general rule, queen supersedure occurs during the summer or early fall months and involves the rearing of only a few queen cells. Additionally, supersedure queen cells are more frequently positioned on the face of the beeswax comb rather than its lower margin. These circumstances are not always the rule and predicting the eventual outcome of a colony rearing queen cells is very difficult.

Swarming preparations begin when the queen lays fertilized eggs in the vertically oriented queen cups. Queen cups are constructed, often in great numbers, by the bees as colonies expand in the spring.

Emergency queen cells can be distinguished from the queen cells of swarming or supersedure because they originate from a worker cell. The horizontal orientation of the worker cells, selected for conversion to queens, is quickly changed to the vertical by enlarging the base of the cell and drawing the opening outward and downward. This usually means destroying the cell walls and removing the larvae of three to four cells adjacent to the modified cell.

- Swarm cells are large and generally on the periphery of the comb such as the bottom edge. They have been developed from queen cups.
- Supersedure cells are very similar to swarm cells and are also produced from queen cups but are generally fewer in number and on the face of the comb.
- Emergency cells are normally found on the face of the comb and have been drawn from worker cells, emergency cells are smaller than supersedure and swarm cells.
7.20 give an account of the problems inherent in cross breeding subspecies of honeybee;

The colony odour (pheromone composition) is very different between races (=sub-species) and hence queen introduction of a queen of one race into another race is difficult e.g. Amm to Aml. We know there are different dialects in the communication systems e.g. dances and chemicals. Bees of different races are different sizes so the act of natural mating may be difficult between some races.

Taking an extreme example tropical Apis Mellifera races are very different to temperate Apis Mellifera races.

Subspecies of the honeybee are well adapted to their particular environment and have distinct characteristics which in some cases if they can be merged with another subspecies may produce a better bee.

However there are issues with cross breeding:
- 1st generation (F1) crosses may yield good consistent results, however 2nd generation (F2) resulting from interbred hybrids can produce variable results e.g. bad tempered bees
- When cross breeding it should be done in a controlled manner (instrumental insemination) to ensure known lines mate, the wider distribution of resultant queens must be restricted until the characteristics are proven
- The hybrid queens when widely introduced will mate with local drones of unknown heritage and therefore unknown offspring characteristics
### Module 7 Study Notes

#### 7.21 give an account of the advantages and disadvantages of inbreeding and out breeding and how it can be assessed;

<table>
<thead>
<tr>
<th></th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td><strong>Inbreeding</strong></td>
<td>Known pure lineage</td>
<td>Can result in closely related bees mating</td>
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<tr>
<td></td>
<td>Ability to breed to enhance desirable characteristics of a line</td>
<td>Reduction of viable brood through production of Diploid drones</td>
</tr>
<tr>
<td><strong>Outbreeding</strong></td>
<td>Produce F1 Hybrids with desired characteristics</td>
<td>Pure line parentage required</td>
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<td>Initial breeding needs to be controlled on a small scale</td>
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The queens characteristics need to be monitored in order to assess the outcome of breeding:

The brood is examined for non-hatching eggs, this should not exceed 10-15%

Bad characters should be removed by selection, such as temper

Records kept of the breeding colony and assessed regularly against desired criteria
7.22 give an account of the effect of pathogens and pests on bee breeding.

Pathogens and pests can affect bee breeding directly or indirectly.

**Indirectly**

Any Pathogen or pest that weakens a colony reduces the ability of the colony to produce good queens.

Conversely colonies that comprise honeybees which have hygienic characteristics or are known to be resistant to pathogens may be less affected and hence the bee breeding is less affected.

A key indirect pest is varroa, it is a vector for viruses that reduce the lifespan of the adult bee and weaken the colony to such an extent in severe infestations can cause collapse. Deformed wing virus a symptom of varroa infestation affects both worker and drone bees, resulting in drones being unable to mate with queens. Workers with shorter lifespan are unable to forage and therefore the queen lays fewer eggs and hence less brood.

Also the control methods for Varroa include Drone cell culling which reduces the population of drones available for mating with Queens.

Pathogens that can cause the same affect include AFB, EFB, Nosema, Acarine, Amoeba, Chalk and Sac Brood.

**Direct**

Nosema can result in Black Queen Cell Virus and is associated with early supersedure of queens

Any pathogen can introduce stress in a colony and make the colony more susceptible to other pathogens. This is particularly noticeable, as you say, with varroa.

Breeding also stresses a colony because on occasions there will be no queen present in order to rear queen cells. If the beekeeper is not careful this could introduce pathogens.

Attack by wasps may stop queens being mated (as well as wiping out the colony)!