A Simple and Proven Method of Queen Breeding

Beekeepers can improve productivity by taking greater care of their queens. By the end of this article on queen breeding, we hope to have injected you with the breeding virus. In order to this we are going to adopt a purposefully straightforward almost textbook style: one method for everyone, from the hobbyist with thirty hives to professionals with over 2000 colonies. Specialized books on the subject often give you three possible ways of carrying out a manipulation accompanied by five variations on the same theme. No such thing here, we want to instruct not confuse, and this is especially true for beginners. We are going to show you a single technique, which of course you will be able to adapt later to suit your particular conditions and environment.

Captions:

1. Permanent open starters + 1 hive to supply frames of ripe brood
2. hives for supplying ripe brood for finishers
3. vertical finishers
4. mating nucleus hives with five standard frames, in groups of four
5. drone hives, the others are placed in an 800 m "flooding" around the breeding apiary

Before making a start perhaps we should consider the purpose of breeding queens. For the fun of it, of course, but more importantly to increase honey production. However, the surplus honey produced by bees is not only due to selective breeding, as we shall see in the following section.

Factors influencing productivity in beekeeping (Honey production in the hive)

1) The beekeeper

- character - sense of observation, organization, handyman
- beekeeping training and contacts with colleagues
- time available
- careful choice of beekeeping technology in the apiaries and honey house
- experience

2) Blossoms and flowers

- for maintenance
- for production: nectar bearing, pollen bearing or both nectar and pollen bearing

3) Climatic conditions

- humidity
- rainfall
- wind
- temperature (minimum & maximum + variations between night and day)
- sun

4) Honeybees

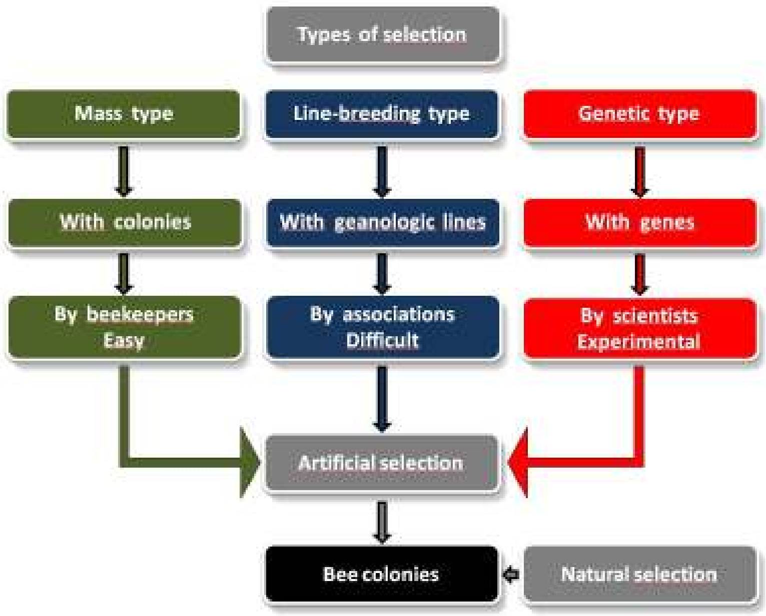
- selectively bred (productivity, hardiness, docility, life expectancy)
- populous
- healthy

5) Equipment

- choice, standardization and state of apiary equipment
- renewal and number of frames of foundation
- choice of honey house equipment

We are able to actively influence all the above points except for the climate. Queen breeding, our main concern in the following pages, not only perfectly controls point 4 but also has an indirect influence on points 1 and 5, because without a minimum of knowledge, organization and standard frames, there is little hope of success.

Before undertaking a breeding program, you have to know how to select stock. There are three types of selection: "mass" selection (I take the best bees, multiply them and use them to replace the weakest), "line-breeding" (I identify several lines or even races cross breed them and continue to follow through with their descendants) and finally "genetic" selection (but we'll leave this branch to scientists and geneticists).



Everyone uses mass selection whether they are aware of it or not. It is okay, as long as you do not make the mistake of mixing two weak colonies together or even worse placing a weak with a strong one and letting nature take care of the queens' fight for supremacy. In the following chapters, we are going to adopt an easy approach to line-breeding, no half-measures. There are three traps to avoid:

1) Errors of identification. Which hive produced what, when and where? Solution: numbering each colony and keeping records.
2) Inbreeding. Any large-scale multiplication of a single line, whether for males or females, outside an area visited by migratory beekeeping, runs the risk of impoverishing the stock's genetic pool and as a result obtains the exact opposite of the desired effect.
Solution: use at least four or five strains, biological exchanges with

fellow beekeepers, buy "elite" queens every now and again from professional breeders.
3) Mistakes made in qualifying strong lines.
Two cases of cause and effect

- the drifting effect: in an apiary set out on straight lines, numbers in the external hives are artificially pumped up by a variable percentage of drifting foragers from the central hives, the results are therefore completely false. Solution: break away from straight lines, lay out the hives in V-forms, squares or big circles and use the hive stands and facade colour to help the bees distinguish their entrance.
- apiary effect: a storm causes heavy rains in an apiary, situated ten kilometres from another, and as a result its heather harvest is cut by half, this being independent of the quality of the colonies true worth. How can we be sure of choosing the best colony or colonies from the two apiaries?
  Solution: with a little elementary mathematics we can seriously limit the inherent perversity of this situation. You simply need to record for each hive, not the number of kilograms harvested, but a figure representing the average harvested of each apiary minus the amount harvested by each hive. Let's call it "the adjusted production figure" or more simply the "*adjusted figure*". Hives with an *adjusted figure* of zero are not useless just average. Those with a negative *adjusted figure*, -7 for example, have harvested 7 kilos less than the apiary's "average" hives. Lastly, the hive that shows the highest positive *adjusted figure* will be the best in the apiary. Don't forget: it's not the hive with the best harvest on a given honeyflow which contains the best stock but the one which achieves the highest *adjusted figure*. To clarify, this means, for example, that a hive which gathers 25 kg and has an *adjusted figure* of 15 is better than a hive with a harvest of 40 kg but an *adjusted figure* of 2. This method proves an even better measure if taken over several honeyflows. The effects of swarming, whether artificial or natural, also need to be taken into account by adding +5 to the adjusted figure of the hives concerned.

By using this method to observe and record our hives over several seasons, we are able to fulfil the first of the four groups of criteria for selective breeding. That is:

1) Honey productivity

- storage instinct
- life expectancy of workers

- bee population adapted to region
- well-timed laying (end and start)

2) Purity of races

- virgin queens
- drones
- controlled hybridization of pure races

3) Hardiness

- tolerance to disease and parasites
- cost effective during winter

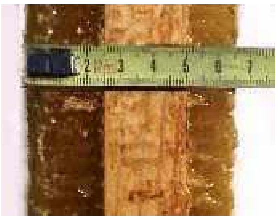
4) Behaviour

- docile but developed defensive instinct
- good breeders (queen and brood)
- remaining on the frames
- requeening by bees without swarming
- cleanliness ("cleaning" instinct)

Special remarks:

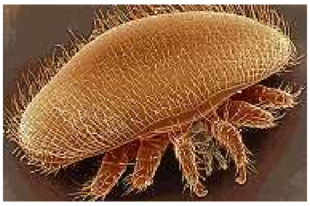
- It is a mistake to start a breeding program from heavily hybridized lines. The reasons are "genetic" and are outside the scope of this present work which is purposefully presented in as simple a manner as possible. Therefore, the selected colonies will be those containing almost pure strains. The way to determine purity of race cannot be reduced to simply examining the colour of tergites, you need to make use of biometry (measurement and analysis of certain morphological aspects of workers) and/or of electrophoresis (movement of certain enzymes in the hemolymph under the influence of electric fields) and/or DNA analysis. As for the famous question of choice, local or hybrid races, or even TH (Triple Hybrid - eg a virgin Caucasian queen *Apis mellifica caucasica* crossed with an Italian *Apis mellifica ligustica* will result in a daughter which will then be crossed with a local black bee, *Apis mellifica mellifica*), it depends on us rather than on the bees themselves. Explanation: semi-extensive beekeeping with minimum outside interference (feeding, moving the apiary, medical treatments etc.), low worry factor and low honey yield = local race. Intensive beekeeping with yearly renewal of queens, a lot of work and high honey yield = hybrid stock. There is no successful half-way measure in beekeeping: too great a risk of genetic pollution with F3 and F4 (successive generations of mixed races, rendering behaviour practically impossible to control).

- A cost-effective colony translates in behavioural terms by the bees' ability to change their queen without swarming. Pure lines showing this behaviour characteristic, whatever some may say, don't actually exist. What does exist, and at least we can be sure of this, is our determination to have parent colonies as close to the ideal as possible.



honey production

tolerance to disease



docility

requeening without swarming tendencies

cost effectiveness

sticking to the frame

good breeder

Well, like conscientious beekeepers, we have now assimilated and tried out all the preceding paragraphs in the apiary. And we now have four or five colonies indifferently labelled "selected", "parent" or "elite"; so where do we go from here?

The logical outcome is to maintain and multiply these strains by setting up a breeding program. To the uninitiated, the following sequence of events will appear particularly fastidious but remember, in spite of this, beekeepers are a privileged group compared, for example, to cattle breeders. If a cattle breeder wants to improve his stock (higher milk or meat production), he has to change his animals, whereas for beekeeping, the only change required is the colony's ovarian function (in other words the queen) and not the entire colony.

Half the selected colonies will be used as raw material to produce virgin queens, and the other half will be devoted to producing "drones" for the mating station.

How can a colony be made to produce queens? Without our intervention, there are three periods where this happens naturally:

1) When swarming occurs - a number of queen cells are built (from 5 to 40 depending on the race) around the edge of the brood cells

2) When the old queen dies. Cells called emergency cells appear in the centre of the brood

3)When the old queen is changed (a phenomenon known as supersedure)

Obviously, if we want to breed queens, we can't just wait for one of these events to occur naturally. We are going to have to artificially provoke one of the above situations in order to get the desired result. In fact, we are going to provoke two in quick succession. On the first day of the breeding program, we are going to simulate the loss of the queen and in the following days swarming. We need a queen-less hive, commonly called a "starter" for the first stage, and a breeding colony, commonly called a "finisher" for the second stage. There are two types of starters:

1) The temporary starter: a nucleus hive with four or five frames without a queen (sealed brood + bees, pollen, honey, water), a closed entrance and fully meshed bottom board. This type of starter is only suitable for small successive series of queen breeding. It can only be used for a short time because as the workers age, they produce less royal jelly.
2) The permanent starter: a hive with an open entrance, well-populated, containing sealed brood, without a queen. The foragers can bring in fresh supplies of nectar and pollen. New frames of sealed brood, also known as "ripe" brood, have to be supplied regularly to ensure the colony has a

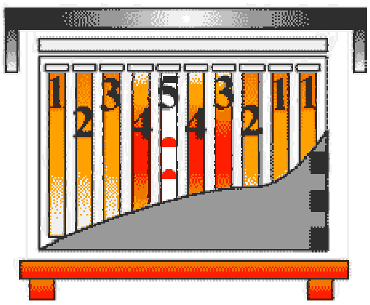
constant supply of young bees. This starter is the most practical and efficient and, what is more, can be easily transformed into a strong colony at the end of the breeding season.

How to set up a permanent starter

1. Choose a strong healthy colony.
2. Take out half the brood frames, with adhering bees but without the queen (you have to take your time to check out this last point) and replace them with frames of foundation or empty comb.
3. Place a queen excluder on top of the brood box, then on top of this a second brood box containing the prepared frames of brood and completed with frames of pollen and honey, leaving out one frame (to leave room for the future frame of queen-cell cups).
4. Leave the colony alone for eight days. This provides an upper brood box with brood frames in which no eggs have been laid for a week, making it impossible for the bees to construct natural queen cells.
5. At the end of eight days, make your first visit in the middle of the day when the old foragers are out in the fields, smoke and tap lightly on the hive to bring a maximum number of nurse bees into the top box, then remove it and fit it with a bottom board, and frame cover, close it with an outer cover and move it to a cool place until the evening when it can be taken to the breeding apiary (it is much more convenient to make this somewhere near to the beekeeper's home as breeding requires frequent visits).

This starter will be supplied with new bees by adding one or two frames of sealed brood once a week from support colonies. The ideal way of dealing with this is to keep a strong support colony next to the breeding hive as a "ripe brood supplier" and rotate frames in a triangular fashion (see three pages later).

A good starter could be described as a veritable fountain of bees when the frame cover is removed. The internal organization of the frames is explained in the following diagram.

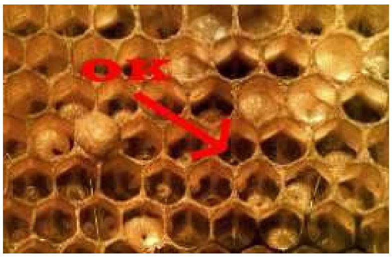


Captions:

1 frames of honey
2 frames of pollen
3 frames of older brood
4 frames of ripe brood

Starter

Pick up the larva from underneath and slide it, in the same position, into the plastic cell cup.



The ideal larvae are translucent, crescent shaped and scarcely visible to the naked eye.

From the selected hives, which the beekeeper will have brought closer to the breeding apiary to make things easier, frames containing young larvae will be removed and replaced to meet demand. As soon as they are removed they are placed in a warm, damp location to undergo what is incorrectly termed "grafting".

In fact, the operation is better described as the transfer of worker larvae aged between 0 and 36 hours, with a "grafting" tool, from their original cells to artificial queen-cell cups.

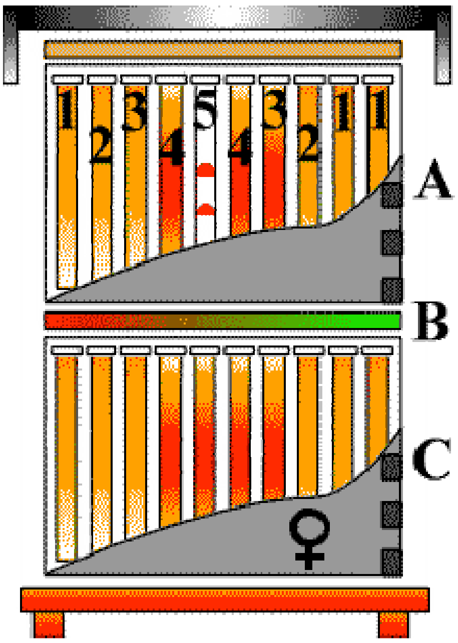
Nicotplast Equipment – the queen-cell cups can be made of wax or plastic. Strange as it may seem, plastic cell-cups are often accepted better than wax ones!

To further increase the rate of acceptance, the empty cell-cups should be "familiarized" first – this means putting the bars of empty cell-cups into a populated hive for a few hours – the choice of hive is unimportant.
Grafting can be done dry or with a drop of royal jelly in the bottom of the cell-cup. The cups should be easy to fit into place and remove and also able to be covered with a hatching cage if required.

In this field, Nicotplast equipment is the best in the world and furthermore, it has the added advantage of being very cheap; so there is not much point in searching elsewhere or turning out shaky homemade alternatives.

The starter's young worker population gives the young larvae in the brood frame its first deposit of royal jelly. The frame is taken out 24 hours later. You can expect an eighty per cent acceptance rate. The cell cups need to be reorganized to fill the spaces left by failed larvae. The frame is then placed in the "finisher" hive.

The finisher can be vertical or horizontal. The most practical system, vertical, can be seen in the diagram below:



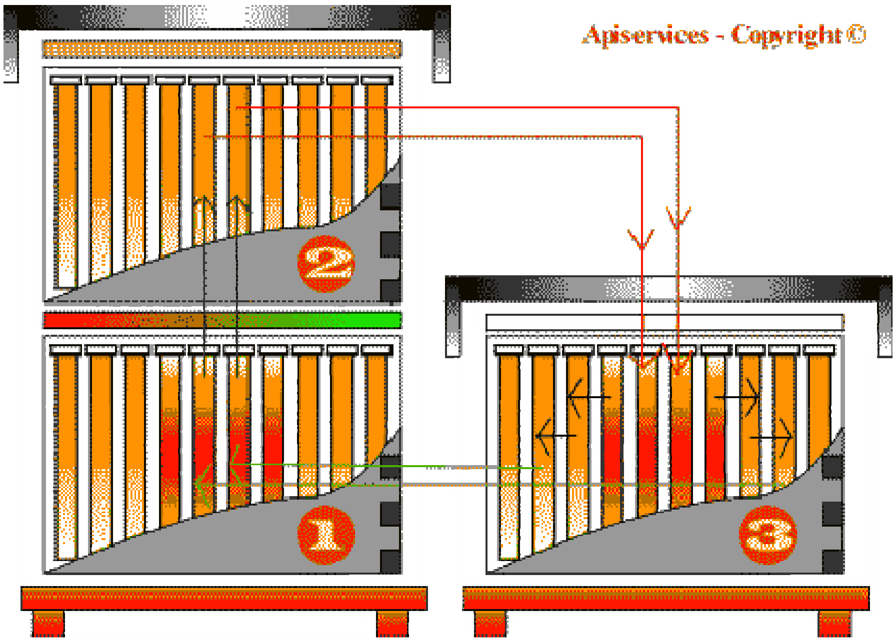
Vertical Finisher

Captions:

A Upper hive body for breeding
B Queen excluder
C Lower hive body with Queen

1 honey frames
1 pollen frames
2 frames of older brood
3 frames of ripe brood
4 frame with cell-cup bars

Just as with the starter hive, the finisher should be densely populated and contain sealed brood comb in its upper box to attract nurse bees. Another hive can be set up to provide frames of sealed brood.



Rotation of ripe brood frames from a vertical hive used to supply workers

Once a week:

1. 2 frames of young brood from the brood box (N°1) of the supply hive (containing a queen) are transferred to the top brood box (N°2), which is separated from the bottom box by a queen excluder;
2. the two extra frames from the upper brood box (N°2), which were transferred a week earlier (so only contain larvae over 4 days old), are brushed clean of bees and placed in the middle of the open permanent starter (N°3). The other frames are pushed to the outside;
3. the surplus frames on the edges of the starter (N°3) are placed, without their bees, into the spaces left during the first operation in the bottom brood box of the supply hive (N°1).

This method can also be used to supply bees for the upper boxes on finishers to ensure strong worker colonies without disturbing the lower boxes containing the queen.

The frame of queen cells spends nine to ten days in the finisher. If your queen production requires several breeding hives, care must be taken to keep a simple flow chart as a record, without which serious mistakes in timing can be made.

Dates Finishers	1	2	3	4	5	6	7	8	9	10	Etc...
N°1	IC 29			CS 24						PN,PC 22	BQ 20
N°2			IC 27			CS 26					PN,PC 25
N°3	PN,PC 41	BQ 38		IC 33			CS 32				
Etc...											

Abbreviations:

IC = Introduction of queen Cells from the starter + number of cells

CS = Check if queen cells are Sealed + number of cells

PN = Prepare *Nuclei* at last six hours before introducing queen cells (or caged virgin queens)

PC = Possible introduction of queen Cages

BQ = Birth of Queen + number OK

Great care must be taken when inspecting the queen cells, especially when the bees are starting to seal them – the young pupae are particularly fragile at this stage.

During very hot weather, which can shorten the larval stage, or if the beekeeper is likely to be away on the tenth day, it is worth taking the precaution of topping each queen cell with a hatching cage.

We now have a batch of ripe queen cells or new-born virgin queens.

Birth of a queen
She cuts out the bottom of the cell with her mandibles

We are now going to look at mating stations and the introduction of mated queens into production hives. We ended up at the end of the process with a batch of ripe queen cells or a nice group of virgin queens. What should we do with them and just out of interest, why do queen breeders not introduce these queens straight into the production hives? Why go to the trouble of creating mating stations full of micro-colonies? There are four main answers to these questions:

1. queen cells or virgin queens have a greater chance of being accepted in lightly populated colonies;
2. introducing a queen cell into a production hive interrupts egg-laying for one or two weeks;
3. a small number of queens turn out to be bad egg-layers, it helps to find this out before putting them into a production hive, the time spent in the *nucleus* (Latin (sing) *nucleus*, (pl) *nuclei*) serves as a testing ground and makes culling easier;
4. the controlled mating necessary for good line breeding is virtually impossible in a production apiary.

The key words are "controlled breeding", this is where we need to concentrate all our effort. There are several different types of mating stations or methods:

1. flooding the area with drone hives from selected breeding lines (the most frequently used system);
2. islands (minimum of 5 km from the mainland. Or oasis (at least 20 km apart), free of hives or wild swarms (rare conditions);
3. deep hidden valleys without hives or wild swarms (true isolation remains to be proved)
4. protected areas, experiments have been made with fifteen meter-high towers of netting (mediocre results);
5. out of season breeding, either early in isotherm boxes (not easy), or by transporting drone hives and nuclei prepared in hotter regions toward colder regions earlier in the year (difficult and costly);
6. by releasing virgin queens and drones in the evening once hive activity is over for the day (a method that deserves more attention).

The ideal solution, of course, still remains I.I.
(Instrumental Insemination)

However, we are going to concentrate on the first method, known as the saturation method.

This subject is a source of continuing disagreement among academics, whose opinions differ on questions such as:

- is it the males that fly several kilometres or the queens, or both?
- is there always a drone congregation area?
- how many drone hives are needed for how many nuclei?
- should drone hives be placed in the apiary or around a circumference several kilometres away?

In answer to the last question, some authors go as far as stating the exact distance of 2,600 meters and others 3,200 meters! Let's not fall into the ridiculous trap of arguing over a 1000 meters. In our opinion, the race in use, prevailing winds, type of ground, altitude, maximum temperatures, and perhaps even the telluric faults or natural magnetic fields, not to mention hertzian pollution, are factors likely to surprise tape-measure fanatics. Put a maximum number of drone hives on a circumference of 0 to 3,000 meters around your apiary, and all will be well.

There is nothing easier than producing a drone hive. You need a young queen of 6 to 8 months old, a drone brood frame placed on the edge of the brood nest a month and a half before the first mating. This frame should contain practically exclusively male cells. There are two ways of doing this:

- use special drone-cell foundation (bigger cells)
- put small starters of normal wax foundation

To be sure of getting off to a good start, supplement feed during food shortages (with protein-enriched candy in cold weather). Obviously, to avoid inbreeding when crossing bees from the same race and to benefit from the effects of heterosis, the drone hives should be from a different strain to the one in the hives used to produce larvae for queen rearing.

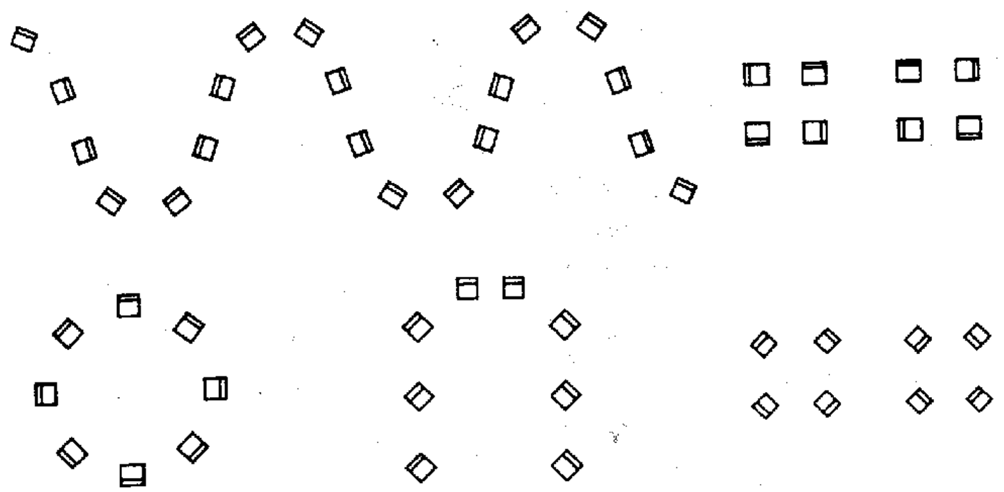
The nucs

As far as mating hives are concerned, they vary greatly from one breeder to another. Every year sees another type of mating hive on the market, especially since the invention of new lighter, insulating materials (nucleus hives such as Kemp, Apidea, Mini-Plus, Apilux etc.)

The smallest nucs (two or three frames, each only 10 cm^2) can only hold about a cupful of bees and are therefore difficult to manage:

1. desertion after mating;
2. rapid engorgement of the brood nest;
3. vulnerability to cold nights.

What is more, they prevent the young queen from showing her full egg-laying potential, thus making it difficult to detect and eliminate bad egg-layers. On the other hand, they require few bees when first set up. If you are a first-time breeder start with a conventional nucleus hive made to take three to five frames of the same size as your production hives. Use stock from you production hives to populate them, just as if you were making artificial swarms, without a queen, and then put them in groups of four in the mating apiary.



To avoid drifting, there should be entrance holes on all four sides of the hive.

After half a day, give the hive one or two ready-to-hatch queen cells. If the mating apiary is a long way from the breeding apiary or if the weather is particularly cold, it is advisable to transport the queen cells upright in a box insulted with polystyrene and containing either a heated brick or a bottle filled with water heated to 35°C, add a little thermometer to check and you will be off to a good start.

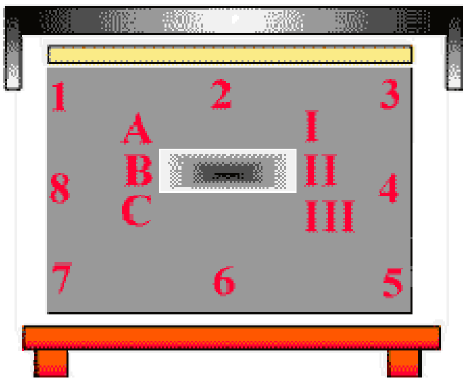
The best position to hang the queen cell is perfectly illustrated in the photo opposite. To increase the acceptation rate, it is a good idea to cover the cell with a band of aluminium paper, making sure to leave the bottom free; strangely enough, worker bees only attack the sides of queen cells.

If you have left things too late, and already have virgin queens, there are three completely different methods of introduction:

1. traditional – cage and candy
2. astute – covering the queen with royal jelly and putting her straight into the hive
3. unusual – re-birthing in an artificial queen cup cell sealed with wax, the workers will never discover the trick.

Just as for breeding, you have to be very strict with dates and use a good planning chart. An idea that helps to avoid over-visiting the nucs is to show their state by marking them, for example with a system of coloured drawing pins on the back of the nucs.

State:
1. **introduction of queen cell(s)**
2. **(or) introduction of virgin queen**
3. **check acceptance**
4. **check start of egg-laying**
5. **check compactness of laying**
6. **queen marked**
7. ***nucleus* with drone laying queen**
8. **orphaned *nucleus***



Population:
- **A. too strong**
- **B. normal**
- **C. too weak**

Supplies :
- **I. too strong**
- **II. normal**
- **III. too weak**

The above schema allows you to set up a relatively complete and detailed plan. All you need is three drawing pins on the back of the nucs: the first is moved around the edge, from position n°1 to position n°2, the second indicates the population's strength from position A to position C (neutral being level with the hand grip) and finally, the third represents the level of supplies. The two latter drawing pins are especially useful for nucs with small colonies. The stronger nucleus hives (made up of four or five brood combs) contain sufficient reserves of bees and stores.

The various visits to nucleus hives, once the queen cells have been introduced, are as follows:

- check for acceptance the day after expected births: the bottom of the cells should be cleanly cut out like the top of a can of food;
- check for the beginning of egg-laying after ten days, eliminate the queens which have not started egg-laying by the end of three weeks;
- check for brood uniformity fifteen days later, eliminate queens producing scattered brood;
- marking queens, see the colour code for different years;

Queens	Colors	Years	Examples
	Blue	0 & 5	2005, 2010, 2015
	White	1 & 6	2006, 2011, 2016
	Yellow	2 & 7	2007, 2012, 2017
	Red	3 & 8	2008, 2013, 2018
	Green	4 & 9	2009, 2014, 2019

- avoid clipping (cutting the right wing of queens born in even years and the left for odd years) as this encourages supersedure (changing the queen without swarming);

- removal of the mated and tested queen accompanied by six or seven servants and the introduction of a new queen cell.

To produce twice as many queens in the same amount of time with the same number of nucleus hives (or the same number of queens with half the number of hives), you can introduce a new batch of queen cells (protected by round queen cages), just after they have been sealed, into nucleus hives, which still have their young newly egg-laying queen. This speeds up production by:

- freeing the breeders more quickly;
- keeping laying queens and queen cells together, without danger, in the nucleus hives. Three to four days after birth, the laying queen is removed (for use in a production hive), the virgin queen is released and leaves immediately for her mating flight. And a few days later, one or two caged queen cells can once again be introduced.

The introduction of mated queens into production hives requires a four-step procedure, which luckily can be accomplished on the same day:

- location and elimination of the old queen
- a forced ten-second immersion of the cage to get rid of the servants without the queen flying away;
- introduction of the new selected and mated queen, alone, under a flat cage placed over hatching brood comb. The hatching workers will adopt the queen (never having known the old queen). The newly-freed cells allow the new queen to start egg laying. The workers themselves often free the new queen by digging a tunnel in the wax! The only inconvenience - you have to come back four days later to remove the cage;
- recording of the process on each hive's individual form and then in the genealogical book.

This last point is, of course, capital for the success of selective breeding. A follow up should be done after each honey flow to check how each introduced queen is performing. This will ensure you make the right choices for next year's selective-breeding plan for both a drone strain and two or three queen strains.

An incubator helps to cut down work for finishers thus increasing breeding rotations.

To summarize this training, if you obtain thirty queens after grafting a hundred queen-cells, you can consider your result to be top of the norm. In fact, for each stage you have to allow for at least 15% wastage in a good year. This because just as for natural swarms or fruit, there are good and bad breeding years.

Acts	**Success**	**Result**
Grafting of 100 queen-cells => removed from the starter	85 %	85 cells
Introduction into finisher => end of finisher	85 %	72 cells
Acceptation in nucleus hive	85 %	61 queens
Mating and acceptable egg laying	85 %	52 queens
Introduction into the production hive	85 %	44 queens
No supersedure and honey production OK	85 %	37 queens

Causes of failure in breeding programs

1) Diseases

- varroatosis
- foul brood
- nosema

2) Grafting conditions

- in sunlight or under a hot lamp
- atmosphere too dry
- too long period

3) Manipulations

- larvae too old
- removal or placing larvae
- queen cells only just sealed
- drop in temperature

4) Worker behaviour

- presence of the old queen
- laying workers
- cannibalism
- building of undesirable queen cells
- introduction of virgin queen in presence of eggs
- colony too weak

5) Supercedures

- foreign races
- fumigationing or too frequent visits
- mutilations or careless marking

6) Material

- deformed queen excluders
- queen cage (risk of mutilation)

7) Management of schedule

- bad feeding management
- mistakes in the breeding calendar
- breeding out of season

8) Losses during mating flights

- birds
- drifting

9) Insemination

- queens too old
- wounding with instruments
- post-operative narcosis

This lesson has purposefully only dealt with one method of queen breeding. Remember that selective breeding is a long-term project when it is undertaken seriously (and to be worthwhile it cannot be treated lightly). Apart from the pleasure of carrying out the work, financial gains can be substantial just as they can drop drastically as soon as standards drop. For practical purposes, especially when the breeding stock consists of a modest number of colonies, we would advise you to buy expensive queens from time to time from experienced professional queen breeders and then multiply them locally.

Beekeeping has its enemies such as diseases and poisoning from pesticides and plant treatments. Today it is more than ever important to own strong productive colonies. At the present time, there is only one way open to us in order to achieve this: selective breeding and queen rearing. So, over to you…