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DRONE CONGREGATION AREAS. ONE ASPECT OF HONEY BEE MATING

The subject of honey bee mating was for a considerable time a complete mystery to most beekeepers and this mystery persisted up until recent time. (In fact to the present among some). The historical note in the January 2004 issue of Apis-UK gives an idea of thinking at the time and you can see that for most, their thinking was spot off. Indeed at one time it was imagined that honey bees did not mate at all but brought their seed back from the flowers, (see historical note in this issue) and even now many parts of the puzzle remain to be slotted into place. So What do we know about it all. Well one of the aspects of honey bee mating that still defies scientists is the flight of the drones and queens to Drone Congregation Areas (DCAs) and here despite much to be learned, the veil is slowly being lifted. We still actually know very little about these phenomena and the paucity of research on the subject doesn't help matters. Most of the research being carried out at the moment is in Germany. But firstly, let us have a look at what we do know.

A Drone comet forming under an artificial queen.

A drone investigating the fishing real on which traces of 9ODA may have been left.

DCAs are aerial zones where drones collect and where virgin queens fly to get mated. The queen is followed/pursued by many drones towards the middle of the zone. Moving away from the centre of the DCA you find less drones and less intense activity.

German research suggests that outside of the DCA, there is no mating activity at all. To find out where the drones come from, researchers in the 60s marked them. Drones from the hives on the thorax and drones in the DCA on the abdomen. Using data supplied from these observations, it was concluded that drones leaving the hive always head for the open horizon rather than say mountains.

They were able to discover that drones flew around 5 km and that rarely 6km. By using drone trapping methods within DCAs and using genetic fingerprinting, more information as to drone/colony distribution could be discovered. In one day, 2000 drones were trapped and genetic imprints of 142 of them were taken. At the same time, genetic imprints were taken of bees flying from hives
in the area.

Of the 142 drones tested, 80 were not related at all, 20 belonged to two brother groups, 6 to three brother groups and 1 to 4 brother groups. Statistical calculations determined that 240 colonies were represented in the DCA. The researchers concluded from this that the DCA is a centre of natural selection and that the high number of colonies represented in the DCA make sister/brother mating improbable. So in other words, bees have a system that gives as big a genetic mix as possible.

How many males are necessary to make up a DCA? To find out this, German researchers marked 500 drones. Then after half an hour to see whether the drones went back to the hive or off to a DCA, they trapped 1870 drones in a DCA. Of these, 77 were marked. From this they were able to make a statistical analysis of how many males visit a DCA. These experiments were repeated from 1999 to 2003 and it emerged that 12000 drones visit a DCA and under these conditions it is consideredunlikely for there to be any sister/brother mating.

How many drones are needed to form a stable DCA? Researchers found that around 1000 drones at least were required to form stable DCAs.
How long is the queen's mating flight? Researchers in Germany found that around 12% of queens did not come back from their mating flight. Thus the queen is taking a risk at this time and the flight should be as long as necessary and as short as possible. The normal length of a mating flight has already been assessed as between 10 and 30 minutes when the required number of drones is available. So in the following experiment to assess the effectiveness of given lengths of queen mating flights, the durations of the flights were classified as 'under' or 'over' 30 minutes. In a fairly complex experiment, using a known DCA with an estimated 5000 drones in its make up, marked queens were allowed to make one mating flight and three weeks later, the queens were dissected so that the quantity of sperm could be assessed. Unexpectedly they found that queens that had flown for more than half an hour had less sperm in them than queens that had flown for less than half an hour. It was concluded that queens that had received sufficient sperm (and presumably they have a method of assessing this), return to the hive. After 30 minutes, the queen returns to the hive whether or not she has received sufficient sperm. The researchers assumed that she returned because she was running out of fuel (honey). This has not been proven though. When these experiments were repeated using a DCA with an estimated 15000 drones, not one queen had to fly for more than 30 minutes. Thus if queens fly for more than 30 minutes, they are likely to be badly fertilised.

Another question that needed to be answered was: If the queen fly's to a DCA and drones from the same hive fly to the same DCA, could this cause a greater probability of brother/sister mating?
Using genetically known queens and observing the offspring of the queens over a two year period of experimentation, they found some interesting results: Drones prefer DCAs that are nearest to the hive and

queens prefer DCAs that are furthest away from the hive and so the drones and queen from a hive do not choose the same DCA.

So to summarise:
a. Up to 240 hives can be represented in a DCA.
b. Up to 15000 drones visit a single DCA.
c. More than 1000 drones are needed to form a stable DCA.
d. The length of a mating flight is less than 30 minutes.
e. Different choice of DCAs between drones and virgens makes inbreeding unlikely.

Much of this research was undertaken by Drs Gudrun and Nikolaus Koeniger of the Apicultural Institute of the JW Goethe University in Germany and was presented at the French Bee Breeders Association meeting in Limoges in France last November. It shows that we are learning more and more about the mechanisms of DCAs all the time but many questions remain.

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DRONE CONGREGATION AREAS Part 2
"There is a natural occurrence to be met with upon the highest part of the down in hot summer days, which always amuses me much, without giving me any satisfaction with respect to the cause of it; and that is a loud audible humming of bees in the air, tho' not one insect is to be seen. This sound is to be heard distinctly, the whole common through, from the money-dells, to Mr White's avenue-gate (at Newton). Any person would suppose that a large swarm of bees was in motion and playing about over his head".

In that extract from his journals written for 1 st July 1792, Gilbert White, a country parson from Hampshire England , described an example of the phenomena that were later to become known as Drone Congregation Areas (DCAs). Since that day, despite much research on the subject place, and the fact that DCAs are now a recognized feature of the beekeeping landscape, much about them remains a mystery. This second article on the subject, describes how any beekeeper interested in the subject can find and study DCAs in his or her own area, and maybe contribute to our knowledge of the subject. (Incidentally, that DCA described by Gilbert White can still be heard on warm summer days from certain vantage points on Selborne Common in Hampshire, and is believed to be the oldest known DCA in the world).

We know some of the answers to some of the mysteries surrounding DCAs, but many questions remain unanswered. So what are these? And can you help?

The first question first. What exactly defines a DCA in the mind of a drone and a queen? How do drones know where to go? How do queens know where to go? Which pheromones are involved in the process? What geographical and meteorological conditions are necessary for their formation? These questions are less easy to answer. However, some aspects to all this can be made clearer by very simple research. For instance every DCA

investigated will increase our knowledge of topographical conditions necessary for their formation. Ditto meteorological conditions, related flying heights and numbers of drones, boundaries, distances from apiaries, (some researchers believe that there are two types of DCA). Those near and dependent upon specific apiaries and those at a distance from all apiaries). Which weather conditions affect the formation of each type? Do queens tend to use apiary DCAs in time of bad weather, and distant assembly areas in time of good weather? Every bit of information found out, even if it merely confirms the results of other research helps us to see the picture. This type of research can be carried out by anyone or a group of people, easily and inexpensively. It's fun, and it's important and it helps beekeepers to be better aware of the local 'bee scene' in their area.

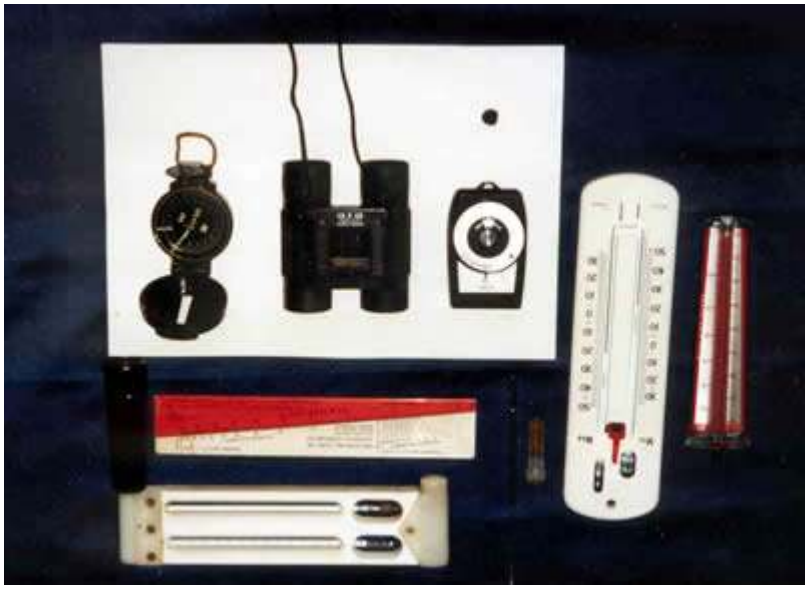
If you've read this far, you may be asking yourself the questions; why bother, when there are government agencies who investigate all this; and secondly; has any of this got any practical application to beekeeping today.

The answers to both those questions are to my mind very simple. To the first, government agencies have their own research priorities, and never ever, in any country, have anywhere near enough funds to research everything that they would like to. In fact it seems, less every year. Any contribution from you is welcome. To the second; there are two answers. Firstly, I believe that research simply to increase knowledge is a good thing. You never know when that irrelevant little trifle may provide the final piece in the jigsaw, and save the world. Secondly, research into natural queen mating may provide some clues as to the best time of day for, and the best conditions under which to conduct artificial insemination in breeding programs. It may tell us more about the suitability of native bees over imports in relation to mating success in adverse weather conditions. It may even provide answers to questions you hadn't thought of.

Firstly though you have to find your DCA. The best way to do this is to ask beekeepers, or University departments having beekeeping specialists, or your area Bee Disease Inspector. Someone will know of evidence of one. Another way is to investigate the vicinity of apiaries on warm Spring/Summer days. They can be found by asking around local beekeepers, and when a beekeeper told me that he perhaps had one several hundred yards from his apiary, I went along and had a look. I then threw handfuls of pebbles into the air and in one of the areas; the pebbles were swooped on by drones. I was then pretty sure that I'd found what I was looking for. I then collected the equipment necessary to confirm this and start the research.

The equipment needed is as follows:

A Mini-max thermometer, for temperature.
A Hygrometer for humidity measurements.
A wind speed meter.
A simple light meter.
A directional compass.
A home made clinometer.
A camera.
Large and small balloons.
Some balloon gas.
A fishing rod with 80 yards of line and some coloured string.
A small piece of sponge to make a queen.
Some synthetic 9 ODA or some Bee Boost.
Some acetone or pure alcohol (if using the 9 ODA).
A folding chair, hip flask and a good book.



Equipment used in the research

All that sounds complicated but not all of it is necessary. For instance, if you only want to investigate the boundaries of a DCA, all you need is the fishing rod and line, the balloons and the gas, (and possibly the hip flask). Each extra item, will enable you to find out an extra piece of information about the DCA.

Most photography enthusiasts will have a light meter, and anyway, a simple one is very cheap to buy. Hygrometers, wind meters and thermometers can be 'borrowed from any university or high school science department, and large meteorological balloons can be obtained from met offices. A cheaper alternative are party balloons. They use less gas and are much safer.

A clinometer can be made from a plastic compass, some glue and some string.

Finding a source of 9 ODA and so these days it may be best to use Bee Boost made by Pherotech in Canada and sold by bee appliance merchants in the UK.

Having collected together all of the equipment that you have decided you need, it is time to prepare your sponge queen if you are using the 9 ODA. It should be covered with some soft cloth and impregnated it with 3mg of 9 ODA mixed with 1ml of acetone, then tied to the end of the fishing line, tied on the balloons and now you can march off to your DCA. Then let the balloons fly and up with the queen. If you are right about the area having a DCA and the temperature is around 18 to 20C+ and it is between around 1400 and 1800 hours, then within 5 seconds, above about 20 feet, a comet shaped group of drones will immediately pursue the queen, only to fall away and be replaced by new comets, constantly forming and reforming. I quote from Norman Gary (1963): "The intensive, dynamic fight of drones in this study was a striking spectacle". And so it was. You must see it to appreciate it. You have now confirmed your DCA and will be ready to start some research if that is what you are intending to do.

In order to guide those of you wishing to carry out some research, it may be relevant to say how I carried out mine. Each day from 1100 hours, and every 15 minutes subsequently, the queen was raised to the maximum extent of the line, i.e. 50 metres . This height would vary with the wind speed and would be lower, the higher the speed. I used the clinometer to gauge this. The brightly coloured markers on the line were spaced every 5 metres. Then, every 15 minutes, the temperature, relative humidity, wind speed and direction and light level were recorded. When drones started to appear, I measured the height at which they first picked up the queen; the maximum height at which they remained interested, and the minimum height to which drones could be drawn down to, prior to leaving the queen. At first, I used a net around the queen to 'capture' the drones and count their numbers, but rapidly discontinued this line of approach when I found that my party balloons would only take it up to 10 feet in height.

The first day had awful weather, cold drizzle, and of course, nothing happened but at least it told me that in those conditions, drones would not assemble. The hip flask came into its own and at end of day, I retired wet and cold to the 'Kings Head' and the landlord's special hot toddy.

The next 7 days were very fine, and everything went to plan. It was non-stop data recording, but I was getting some good data, and seeing things that beekeepers normally don't. For instance, on one occasion, some distance

from the apiary whilst walking along a lane with my rod and line, I was besieged by drones that appeared to 'bubble up' from the hedgerows. They were all over me, possibly because I had traces of 9 ODA on me and they thought I was a queen. All in all, I found it all very interesting.

The Results

So what did I find out? Well, having put all the measurements through my little scientific calculator I came up with the results outlined below:

a. Drones tended to congregate between the mean times of 1417 hrs and 1804 hrs and would form drone comets between the hours of 1449 hrs and 1740 hrs.

b. Drone flight within the DCA and the formation of comets outside of these mean times, occurred only when other factors were involved. e.g. a shorter flying day the day before because of bad whether would cause an increase in flying time the next day.

c. Drones flying back to the apiary outside of these times were not interested in the queen.

d. Drones require a temperature of around 17C to fly to a DCA and for sufficient drones to be on the wing to form comets; the temperature had to be around 18C . (This finding contrasts with most other researchers who noted higher temperatures needed for DCA formation.

e. As temperatures lowered towards the end of the day, the drones were only interested in the queen at a higher height.

All of these results of course apply to only one DCA in one location for a period of a week. Other results such as the relationship between relative humidity and temperature and light levels were less conclusive, and I have not included them.

So will you shake the world with your discoveries? You just might, but even if you don't, you will know a lot more about your bees and their behavior and will have seen a sight that few beekeepers and even fewer members of the public will ever have seen. You will probably raise more questions that you are able to answer and if you share your new knowledge, all of us will know something about yet another distinct DCA. It's worth it.