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The Cause and Control of Swarming in Bees

[Full Table of Content](#)



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D. Morland

D. Morland (1935) *Swarming and the Division of Labour in the Hive ; The Cause And Control Of Swarming In Bees*, pp 14 - 17 - DOI: <https://doi.org/10.23637/ERADOC-1-212>

SWARMING AND THE DIVISION OF LABOUR IN THE HIVE

By D. MORLAND, M.A.
(Rothamsted Experimental Station)

IN a former paper the Brood Food Theory of Gerstung was examined in the light of the work of Rösch, Soudek and others (*Annals of Applied Biology*, vol. XVII, 1930, p. 137). Gerstung considered the colony rather than the individual bee as the unit, and maintained that swarming is due to an unbalanced state of the hive population resulting in a surplus of nurse bees and the preparation of brood food in excess of the requirements of the nursing larvae. He held that it was this surplus which led to the raising of queen cells, since a single queen consumes royal jelly throughout her larval life, while worker larvae only receive it in their youngest and smallest stage. In my earlier paper I referred to the way in which Rösch's studies of the division of labour in the hive fit in with this theory. His method was to mark individual bees on emergence from their cells and to watch their activities in an observation hive.

During the past four seasons we have been making observations on similar lines in the experimental apiary at Rothamsted. Sealed brood without adhering bees is placed overnight in an incubator maintained at the hive temperature of 33°C. The following morning the newly emerged bees found on the combs are marked with a quick drying cellulose enamel on the back of the thorax. A code of colours is used by which it is possible to tell the date of emergence of any marked bee. When the marked bees have recovered from the temporary stupor caused by the solvent in the paint, they are introduced to a large six-frame observation hive. If proper care is exercised, these bees are accepted by the following morning and thereafter behave as normal inhabitants of the hive. Observations made on such marked bees confirm the findings of Rösch as to the sequence of promotion from nurse to housekeeper and then to forager, but some cases have been noticed of bees flying, carrying pollen and even accompanying the swarm at a precociously early age.

The addition to the observation colony of some thousands of bees, all potential nurses, exaggerated that preponderance of nurses over brood, which according to the brood food theory leads a colony to swarm. At the same time the levy of sealed brood taken from the strongest stocks of the apiary, for hatching in the incubator, produced in them the opposite condition. Any surplus of young bees in the incubator, which was not required for marking, was also introduced into the colonies under experiment. As a result of this it frequently

happened that the only colonies in the apiary to swarm were those to which marked bees had been added. This would suggest that the equalisation of stocks, which some authorities have so heartily condemned, or the establishment of nuclei on lines consistent with this theory, may be a practical method of swarm control, in apiaries which are known to be free from brood disease, provided that the nuclei or subsidised weaker stocks are given queens reared from the more desirable colonies.

When swarms emerged from the observation colonies of marked bees, they were hived in the usual way on empty drawn comb and left overnight with a comb of unsealed brood to settle down in their new home. The following day the usual sloping board was placed in front of the hive, containing the swarm, and a number of glass jars fitted with wide necked funnels corresponding to the batches of marked bees present in the original colony was provided. Sometimes the fly sheet of a tent was pitched over the hive as a protection from sun and wind. The frames were removed one, by one and either the coloured bees were picked off the combs and sorted into their appropriate jars, or else the bees were shaken on to the sloping board, and the marked ones picked out as they ran into the hive. This was repeated, until no more coloured bees remained on the combs or in the brood box. The jars of bees were then taken to the field laboratory and the bees given a whiff of ether for convenience in counting. After they had recovered they were re-introduced to the swarm. This was a full day's work for two people. The following day the same procedure was repeated with the parent stock. The possibility that anaesthetised bees might become confused and return to the parent colony was not lost sight of, but a special watch was kept, and there is no evidence that this took place. In one instance the same process was repeated with a cast which emerged after the prime swarm, but unfortunately on another occasion a cast absconded and was lost. No report of a stray swarm with strangely marked bees was received from the neighbouring beekeepers.

Once it was reported that bees of curious aspect, "having green mould growing on their backs," had been observed prospecting round an unoccupied hive one mile from the apiary. After this had continued for a week, it suddenly ceased on the day when a swarm issued from the observation hive with a clipped queen and was successfully hived. The informant was shown bees marked with a green spot on a white background and declared that they were the same.

After the first year the number of bees marked on each occasion was noted and kept approximately uniform, and a very good idea of the rate of mortality of worker bees at that time of year was obtained by adding together the numbers of each batch recovered from stock and swarm respectively. It is admitted that the handling necessary in the process of marking, clumsy application of the colour, or careless introduction, may cause some casualties (in one case the

entire batch perished from one of these causes) but with practice, a very high percentage of acceptance has been achieved during the later seasons. Once, when a swarm emerged on the day following the introduction of a batch of bees, only a very small loss out of the total introduced was recorded.

It will be seen from the diagrams that in the height of the season, after about 21 days, 50 per cent. of any batch had disappeared, and that by between 40 and 50 days the marked bees of any given colour had become extinct. It may be objected that the colours might wear off and an old bee appear not to have been marked, but in the comparatively rare instances when this has occurred such bees are very easy to recognise from the fact that there is a black shiny patch on the thorax from which the hairs are entirely absent, having come away with the paint. It might also be thought that the presence of the paint would in some way shorten the life of the bee, but except where a slip has been made and paint has got on to the base of the wing or over the spiracle, there seems no reason to believe that this is so.

Various statements have been made as to the age of the bees which constitute the swarm. It is most frequently said that it is the young bees which go out. In the light of Rösch's work, it was expected that it would be the middle aged bees (the "control bees" of an American writer) which would be found in the greatest numbers in the swarm. In the experiments at Rothamsted this was found to be the case, though not in very striking preponderance. While very young batches were poorly represented, the falling off of the older categories was due to the high rate of mortality of the foragers at this time of year and was almost as great among bees of the same age remaining in the parent stock, so that the difference in distribution of the different aged bees in stock and swarm was not so great as had been expected. A well-known beekeeper suggested that the high rate of mortality might be due partly to the use of an observation hive only one comb thick; in fact, we did not find it easy to winter bees properly in such a hive, in spite of heavy insulation. Since then, one or more control hives of the ordinary single walled type (now known as the "National" hive, see Ministry of Agriculture Marketing leaflet No. 79) was used. Results did not differ materially from those which had been obtained with the observation hive.

The use of marked bees has also afforded an opportunity to study the prevalence of drifting. Although the apiary is regularly arranged and contained only a few types of hive, the number of coloured bees found in other hives has been relatively small. This is remarkable when it is remembered that they are only adopted members of the colony. No attempt was made to mark drones, as they do not directly affect the Brood Food situation, but it is probable that more drifting might have been encountered in their case.

THE CAUSE AND CONTROL OF SWARMING IN BEES 17

Although the mass marking of bees does not lend itself to such detailed study of the division of labour as the marking of individual bees, as practised by Rösch, it has given a good indication of the way in which a stock is divided at swarming. There seem to be no very striking variations in the proportion of marked bees in stock and swarm and it is felt that any further work that may be undertaken on this problem should take the form of a determination of the distribution of bees of different ages in the different parts of hives worked on the "Demaree," "Snelgrove," or other systems of swarm control.* Probably the information desired could be obtained by using fewer and smaller batches of bees than in the studies which have here been reported. This might make it possible to have a larger number of stocks than just one or two devoted to the experiment.

• The work of the 1935 season has been on these lines.