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Report for 1954

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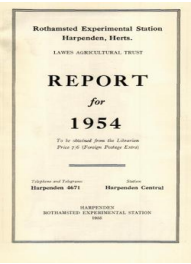
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Bee Department

C. G. Butler

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BEE DEPARTMENT

C. G. Butler

General

A number of lectures have been given by members of the Department to Scientific Societies, Beekeepers' Associations, etc., and assistance has been given at several week-end courses for beekeepers and others. Members of the Department have also continued to serve on various committees, including the Ministry's Bee Disease Advisory Committee and the Honey Marketing Standards Advisory Committee.

L. Bailey and C. G. Butler attended the XV International Beekeeping Congress in Copenhagen and read papers; they afterwards took part in an International Conference of Bee Research Workers at the Danish Bee Research Station.

L. Bailey and J. B. Free have both been awarded the Ph.D. degree of London University, and J. B. Free, who has held a special grant from the Agricultural Research Council for the past three years, has now been appointed a Scientific Officer in the Department.

Elizabeth Tyndale-Biscoe and Nancy Free have resigned in order to devote their time to domestic duties.

Bee Behaviour

Foraging behaviour

The effect of the scent of a crop in initiating the foraging activities of bees who have already learned to associate this particular scent with food has been demonstrated by C. R. Ribbands. He trained equal numbers of bees from a single colony to seek food in the afternoon only from each of two dishes of sugar syrup containing different scents and placed 50 yards apart. Subsequently both dishes of food were made available to the bees in the morning, and at the same time a small quantity of one or other of the scents associated with the dishes was placed in their hive. It was found that the addition to the hive atmosphere of the scent to which she had been trained doubled the chance that a bee would visit her feeding-place outside the usual feeding-time. It appears, therefore, that the foraging activities of bees may be initiated by the appearance in the hive atmosphere of a scent which they have learned to associate with food even in the absence of any dancing.

This observation may be expected to have a bearing on the elucidation of the problems involved when attempts are made to direct bees to particular crops for pollination purposes.

The influence of the psychological condition of a forager on the recruitment by her of further members of her colony to exploit a particular crop has also been investigated by C. R. Ribbands. He trained equal numbers of individually marked bees belonging to a single colony to collect syrup from each of three dishes placed in different directions from their hive. Dilute sugar syrup was supplied in one dish and concentrated syrup in another, whilst the third dish

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was first supplied with dilute, and later with concentrated, syrup. It was found that twice as many recruits always appeared at the dish in which the syrup concentration was increased as appeared at the dish in which a supply of concentrated syrup was constantly maintained.

It appears, therefore, that an improvement in the concentration of the nectar in the flowers of a crop is likely to cause the bees who are foraging on this crop to dance more and to disseminate more bee scent, and thus to attract more recruits to this crop, than bees on another crop in the flowers of which the nectar concentration remains constantly at a high level. This may account for some of the hitherto unexplained results of competition between flowering crops for the attention of pollinating bees.

Swarming

J. Simpson has continued to study the nature of the swarming impulse in honeybee colonies. In experiments in which colonies whose bees were making preparations to swarm were paired with colonies whose bees appeared to be making no attempts to do so, the queens of the two colonies of each pair were interchanged. Under these circumstances it was found that in some cases swarm preparations were made by the bees in either, or both, of the colonies of a pair. It therefore appears that the change which precedes swarm preparations is not confined either to the queen or to the workers of a colony.

This conclusion is reinforced by data collected by C. G. Butler, following upon an observation by J. Simpson that the workers of a colony will sometimes attempt to rear a new queen for themselves, even though their old one is still present, but after she has remained tethered amongst them for some time. Thus, for example, it has been found that if a mated queen is tethered on a comb in her hive in such a way that, whilst her movements are greatly restricted and she does not lay eggs in cells, the workers of her colony have ready access to her body at all times, her bees look after her and, for at least a week, make no attempt to rear a new queen for themselves. Indeed, some colonies, although continuously provided with young female larvae with which to do so, made no attempts to rear new queens, even when their own queens remained tethered for several consecutive weeks. However, the bees of most colonies started to do so after their queens had been tethered continuously for 10 or 12 days and, on being released, their queens in three cases out of fifty actually laid eggs in queen-cell cups, thus co-operating actively in the swarming preparations that their colonies were making. Interchange of such "swarming" queens with "non-swarming" ones yielded results similar to those obtained by J. Simpson and mentioned above. Usually, however, within 2 or 3 days of the release of a tethered queen in whose colony queen cells had been commenced, all the queen cells were destroyed by the bees and her colony returned to a non-swarming condition.

The organization of social life

By making use of radioactive ^{14}C sugar C. R. Ribbands has been able to extend his investigations to determine the extent to which the bees of a colony share the sugary liquids which are collected by

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the various members of their community. The data obtained in his most recent experiment indicate that a load of radioactive syrup which was collected by a single bee was ultimately shared amongst nearly all the 20,000 members of her colony. This result strongly supports the hypothesis that the individual odour which each colony of honeybees possesses, and which is common to all the members of the colony and differs from those of other colonies, is derived, to a considerable extent if not entirely, from the food which the members of the colony have been sharing amongst themselves. Thus the bees of a colony are enabled to recognize, by means of their body odours, members of their own colony and to distinguish them from intruders from other colonies.

This last and most important conclusion has been agreed by those who have worked on this subject most recently (Kalmus, H. & Ribbands, C. R. (1952). *Proc. roy. Soc.* B., **140**, 50; Butler, C. G. & Free, J. B. (1952). *Behaviour*, **4**, 262; Ribbands, C. R. (176) & Free, J. B. (174)). However, there is still some disagreement between these authors with regard to the part which the behaviour of an intruder, particularly that of a would-be robber bee, plays in determining the kind of treatment to which she is subjected by any guard bees who intercept her.

C. G. Butler has continued his work to determine the nature and function of the substance (" queen substance ") which the household bees of a colony seek by licking the body of their queen. Some of his earlier results have been published (173). There is good reason to suppose that inhibition of ovary development in worker bees, as well as inhibition of queen-cell production, is dependent upon the circulation amongst the members of a honeybee colony of an adequate quantity of " queen substance ". That this is indeed the case has recently been demonstrated by adding to the protein-rich diet on which a group of queenless bees were being kept, the honey-stomach contents of other worker bees who had just been licking the bodies of their queens. Ovary development in these experimental bees was significantly less than that in a control group, fed on the same diet except that the honey-stomach contents added were obtained from bees who had not been near a queen for several days. It has also been found that whereas a mated queen normally produces sufficient " queen substance " to inhibit queen-cell toleration and production by the workers of her colony, a virgin queen does not always do so. It is hoped to publish further results of these investigations shortly.

General Research

Nutrition of honeybee larvae

In the past it has been supposed that the addition of pollen to the diet of a female honeybee larva is essential in order to provide the larva's protein requirements. Further, it has even been supposed that, since those larvae which are destined to become queens usually receive very little pollen, the addition or otherwise of pollen to the diet of a female larva may help to determine whether a worker bee or a queen is produced. However, by means of estimates, based upon haemocytometer counts of the number of shells of pollen grains in the guts of mature larvae, J. Simpson has shown that

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different worker larvae receive a variable amount of pollen in their diet in summer, and sometimes none at all in winter. It is, indeed, probable that, even in summer, less than a tenth of the protein requirements of a larva are supplied in the form of pollen.

Division of labour in Bumblebee colonies

J. B. Free has continued to work on the biology and behaviour of bumblebees. In studies on the division of labour amongst the workers of a colony he has confirmed that the larger individuals go foraging more often than their smaller sisters, and that those of the smaller members of the colony who do go foraging do so less regularly than the larger ones. Thus the division of labour into its two main sections—household duties and foraging—appears to be largely dependent upon the body sizes of the bees concerned. In fact, about two-thirds of the workers of any colony are either constantly concerned with foraging or with household duties, but the remaining third carry out both these duties at different times in their lives. However, it was found that, as in the case of honeybees, individual workers will adapt their behaviour and forsake one occupation in favour of another to meet the current requirements of their colonies.

The type of food (nectar and pollen) which foraging bumblebees collect is also determined to some extent by the needs of their colonies. Thus both the number of larvae present and the nature of the food reserves in their nests have a marked bearing on the type of food collected at any given time.

Behaviour of egg-laying workers in Bumblebee colonies

If a colony of bumblebees loses its queen, the ovaries of many of its workers soon develop, provided that they have adequate nourishment, and unfertilized, male-producing eggs are laid. J. B. Free has studied the behaviour of workers who, having lost their queen, have commenced to lay eggs. He found that in each colony one of the workers became " dominant " in her behaviour. Such a dominant individual spends most of her time incubating a new clump of eggs, which she herself has probably laid, and actually drives other members of her colony away from them.

In some queenless colonies a hierarchical system developed, similar to the " pecking order " in flocks of birds. In these cases a particular laying worker was dominant and attacked all the other members of her colony, and in many cases a second worker who attacked all bees except the dominant individual was also present. Indeed, in a few cases a third individual was present who attacked all the members of her colony except the two individuals who were higher in the hierarchy than herself. It was found that the behaviour of any individual bee and, consequently, her position in a hierarchy, is correlated with the state of development of her ovaries. The most dominant individuals possessed the most highly developed ovaries.

Biometrical investigations

Elizabeth Carlisle has continued her studies of the characteristics of ten supposedly pure races of *Apis mellifera*, specimens of which the Rev. Brother Adam very kindly collected for the Department from countries in Western Europe, North Africa and the Eastern

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Mediterranean. The characters measured were those which have previously been found to show the greatest racial variation—length and width of fore-wing, length of tongue and hind-leg, number of hooks on the leading edge of the hind-wing, and the cubital index (ratio of lengths of two veins in the fore-wing). The specimens were also classified by colour, the number of broad or narrow light-coloured abdominal stripes and the presence or absence of a light-coloured scutellum being the characteristics studied.

From the data obtained it appears that a fairly distinct trend of racial variations extends from North-west Europe to the eastern Mediterranean, but few clear-cut differences are apparent between bees in adjacent regions. The samples of German, French and Swiss bees examined were very similar in most respects, and together appear to form a group, the members of which differ from the bees of Italy in cubital index, tongue length and hind-leg length, and from the so-called Carniolan race in cubital index and tongue length. The bees from Greece and Crete were found to be similar in all the characters measured except for the cubital index, which in the Cretan bee is very near the French index. The bees of the Syrian and Cyprian races were found to differ in fore-wing and tongue lengths only; and bees of the Tellian race from North Africa and of the Sicula race from Sicily only differed from one another in fore-wing length.

It is hoped that a detailed account of this work will be published shortly.

Queen introduction

With the help of a number of beekeepers, including members of the Bee Research Association, C. G. Butler has continued to study the problems involved when a queen reared in one colony is introduced to the bees of another colony whose queen has been removed. During 1953, 230 mated queens of different ages, including nearly 100 that had been through the post or caged in mailing cages for periods as long as 5 days, were introduced to colonies, by means of a very simple cage, directly the old queens had been removed. Only one queen was lost. During 1954 several hundred queens have again been introduced successfully and with a minimum of trouble, but several queens have been lost.

The reason or reasons for these losses is still uncertain, but experimental evidence has been obtained which strongly supports the assumption that some of them were due to the bad temper of the bees of the recipient colonies.

It is hoped to continue these investigations during 1955, when it is proposed to experiment with a slightly modified cage which, while still retaining those features which have been shown to be desirable in the earlier experimental cage, will also ensure that the queen cannot be released by the bees of the recipient colony before the end of a predetermined period of time. In this way it is hoped that all difficulties will finally be overcome.

Bee Diseases

Nosema disease

L. Bailey has now demonstrated that the transference of all the adult members of a colony on to clean combs during the early

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summer is an effective means of eliminating infection with *Nosema apis*. Furthermore, the brood in the old combs can be allowed to emerge and join the colony, the bees of which can also recover stores of food from these old combs, before they are removed for sterilization. Such sterilization can be carried out effectively with the fumes of glacial acetic acid or, if no honey or pollen remain in them, with formaldehyde. A full account of this work has been published.

Acarine disease

L. Bailey and Elizabeth Carlisle have carried out trials with a number of acaricides applied as a smoke to bees infected with *Acarapis woodi*. "Ovotran" (*p*-chlorophenyl, *p*-chlorobenzene sulphonate) was particularly effective. The number of larval mites and eggs in infected bees treated showed a highly significant reduction a few days after treatment. Indeed, it was found that all life stages of *A. woodi* were destroyed.

European Foul Brood

L. Bailey has attempted several times to infect small, healthy, honeybee colonies with bacteria which were considered to be the possible causal organisms of European Foul Brood. On several occasions Professor L. P. Garrod, who has kindly been co-operating by attempting to cultivate the suspected organism (*Bacillus pluton*), has obtained a weak growth of a very similar organism (a strictly anaerobic, encapsulated *Diplococcus*) from diseased larvae which has been tested in this way. On all but one occasion no infection was found, but in one trial a large, apparently growing, collection of Gram +ve organisms closely resembling *B. pluton* was found in one larva.

F. A. Skinner (Microbiology) has also attempted to culture the causative organism. He isolated several Gram +ve cocci, all of which were facultative anaerobes. These were tested in hand-reared honeybee larvae, but none grew. On the other hand, a good growth of *B. pluton* was obtained in control larvae infected with "scale" material.

A convenient, but still not entirely satisfactory, method of hand-rearing larvae was devised late in the season. Day-old larvae were grafted into empty cells of wax or glass and fed with food taken from larvae in hives. The experimental larvae were kept in screw-topped jars containing about 20 ml. of 50 per cent KOH. Such larvae grew well to full size, but never pupated.

So far completely satisfactory methods of testing artificially-cultivated organisms for pathogenicity have not been developed. Nevertheless, much work upon the epidemiology of the disease can be done without cultivating the responsible organism, and L. Bailey has commenced working on these problems.

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