ROTHAMSTED RESEARCH

Report for 1955

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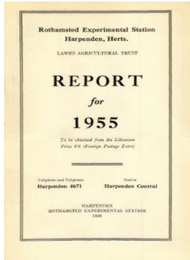
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Bee Department

C. G. Butler

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BEE DEPARTMENT

C. G. Butler

General

Throughout the year the research work of the department has been continued along the lines mentioned in recent reports. In addition, several members of the department have continued to serve on a number of Committees and have also given lectures and demonstrations at meetings of Scientific Societies, Beekeepers' Associations and other organizations.

C. R. Ribbands has been awarded the Sc.D. degree of Cambridge University, and Doreen Gibbons and Inge Riedel have joined the scientific staff. T. Palmer-Jones of New Zealand has been a guest in the department for about five months, during which he made a detailed study of bee research methods and practical beekeeping in this country.

Bee Behaviour

Foraging behaviour

C. R. Ribbands, in collaboration with Professor J. B. S. Haldane, has been conducting an experiment designed to assess the accuracy with which foragers communicate the whereabouts of food crops to other members of their colonies. As this experiment progressed it became clear that the use of body odour was playing an unexpectedly large part in attracting companions to the immediate vicinity of the foragers. If conditions are propitious it is hoped to continue this work during 1956.

Conclusions that have hitherto been reached on the practicability and efficacy of attempts to cause honeybees to visit the flowers of selected crops which require pollination have been conflicting. J. B. Free has, therefore, been attempting to obtain answers to some of the problems involved. Two of the questions he has been studying are: whether the nectar and pollen already stored in the combs of a colony influence the choice of plants from which its members will collect food, and whether syrup feeding of colonies results in any increase in the proportion of pollen to nectar subsequently collected by their members.

Swarming

Investigation of the factors controlling the incidence of swarming by honeybee colonies has been continued by J. Simpson by an analysis of records made by beekeepers during their routine inspections of colonies during the swarming season. The following tentative conclusions have been reached.

The proportion of colonies which produce queen cells in the presence of a laying queen, and therefore are possibly preparing to swarm, varies from year to year. Smaller, but still significant, variations occur between apiary sites. These variations appear to be related to environmental differences, not to changes in methods of

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management or to the genetical characteristics of the colonies of bees concerned.

The onset of queen cell production in individual colonies occurs, as a rule, between the middle of May and the end of July, and is most frequent around midsummer.

The bees in over half of the colonies which begin to produce queen cells eventually cease to do so, without swarming, with no other treatment by the beekeeper than regular removal of the queen cells produced. It is uncertain whether any colonies in which queen cells are found will in fact swarm even without such treatment, since observations of experimental colonies in which queen cells have been left have shown that in a number of cases transient queen cell production takes place without swarming. Since amongst colonies which produce queen cells the proportion which fail to swarm, though they receive no other treatment than regular queen cell removal, is greater after midsummer than before, it is probable that observations of queen cell incidence fail to give an entirely reliable index of the relative incidence of swarming at different times.

Colonies whose queens are replaced before the end of June, by new ones reared in the current season, are much less likely to produce queen cells during the rest of the season than colonies which are not re-queened in this way. However, owing to the uncertain relationship between swarming and queen cell production this does not necessarily mean that re-queening early in the season with a current season's queen will reduce the tendency of a colony to swarm.

The organization of social life

The results of C. R. Ribbands's food-sharing experiment, which was carried out in 1954 in order to determine the distribution amongst the members of a colony of one honey-stomachful of radioactive ^{14}C sugar syrup collected and carried into the colony by a single bee, are still being analysed. Most of the routine work has now been completed, and it is hoped that the results will be published during 1956.

C. R. Ribbands considers that food sharing provides the network of communication which is the basis of social life in the honeybee community (164).

One of the functions of food sharing is, as he has shown, the production of distinctive community odours, another, as C. G. Butler has recently shown (179), is the widespread distribution of queen substance amongst the worker bees of a colony.

Queen substance plays a vital part in the social organization of the honeybee community, since, provided it is obtained from the queen in sufficient quantity and shared out amongst the workers of her colony as normally happens, it prevents development of the worker's ovaries, as well as inhibiting the production of all kinds of queen cells. Failure, or inadequacy, of the supply of queen substance in circulation amongst the members of a colony results in queen cell production and worker ovary development.

Effective extracts of queen substance have now been obtained from queen honeybees, even from long-dead ones, in various organic solvents (179), and C. G. Butler and Dr. D. B. Carlisle, of The Laboratory, Plymouth, have demonstrated that extracts of the sinus glands of female prawns (*Leander serratus*) are effective in inhibiting ovary development in worker honeybees, and that honeybee queen substance can also act as an inhibitor of ovary development in prawns (180). C. G. Butler has also been able to demonstrate that honeybee queen substance and ant queen substance (extracted from queens of *Formica fusca* and *F. rufa*) are interchangeable. It appears possible, therefore, that a single ovary-inhibiting substance is present in different Arthropods, and that in some of the social insects this substance has acquired the additional function of controlling queen production.

It is not yet clear whether queen substance reacts directly upon the metabolism of a recipient bee or whether it merely acts as a " trigger mechanism " and results in the release of a hormone which inhibits ovary development. If queen substance only acts as a trigger mechanism it is quite likely that still other releasing mechanisms exist.

These investigations are being continued, and it is hoped to publish further results shortly.

An investigation of the stimuli leading to food exchange between the worker bees of a colony has been made by J. B. Free. As was anticipated, he has found that bees who are offering food to other bees, or begging for food from them, usually direct their offering or soliciting movements towards the heads of other bees; indeed, excised heads alone are sufficient to elicit either of these reactions. He has also shown that although the colour and shape of a bee's head play little or no part in eliciting either of these responses, the scent of a bee's head is an important stimulus in doing so. Furthermore, it has been found that the excised heads of bees taken from the same colony as the experimental bees, whose reactions are being studied, are more effective in releasing both these responses than are the heads of bees from other colonies. It therefore appears that colony odour may be important in this respect.

Free has also shown that the antennae provide a contact stimulus to both reactions and that their effect can be simulated by means of artificial antennae.

Whereas movement appears to play no part in releasing the begging response of a bee, it plays a significant rôle in releasing offering behaviour. Both begging and offering are innate reactions, the precision of which shows improvement with age, independently of conditioning.

General Research

Behaviour of drones within the hive

As a part of the bee breeding research programme J. B. Free has begun to study the behaviour of drones inside the hive, using marked individuals of known ages. He has found that worker bees feed drones of 2 and 3 days old the most frequently, and also that drones of this age are fed for longer on each occasion and therefore presumably receive more food than drones of other ages. The number of times a drone is fed decreases rapidly as he becomes older. The ages of those worker bees who were seen to feed drones varied between 2 and 26 days, but workers of 4–6 days old were especially concerned. Drones of 4 days old and more will take honey for themselves from storage cells, but younger ones do not appear

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to do so. Drones seem to spend about three-quarters of the time that they are in the hive more or less stationary on the combs, but the periods of inactivity are frequently interrupted by short periods of movement over the combs. The age of a drone appears to be important in determining the behaviour of the workers towards him. For instance, even when in late summer the older drones of a colony are being driven from their hive by the workers, the younger drones present may not be treated in this way at all, but, on the contrary, may still continue to be fed by the workers.

Queen introduction

The studies on the problems involved in queen introduction mentioned in previous reports have been extended, partly with the help of members of the Bee Research Association and other bee-keepers. An analysis by C. G. Butler and J. Simpson of the results obtained to date (full details of which it is hoped to publish shortly) suggest :

(*a*) That when young, or old, virgin queens were introduced directly (without caging) to colonies from which young (1–5 days) or old (12–28 days) virgin queens had just been removed, comparison of the results showed that it was much easier to introduce a queen into a colony from which a similar queen had been removed than into a colony from which a dissimilar queen had been taken.

Between old, laying, queens and old, virgin, queens a similar but less extreme pattern of behaviour was observed, whilst with other combinations of queens of different categories (which included newly mated queens who had just begun to lay eggs) the difference in the proportion of successes between introductions of like and unlike queens were mostly non-significant. It is suggested that from the point of view of introduction to colonies, young and old virgin queens are sharply differentiated, while the other categories of queens studied possess intermediate characteristics in this respect.

(*b*) When mated, laying, queens were interchanged directly and the treatment given to them by bees of the recipient colonies was noted, it was found that the queens were more frequently molested by bees belonging to bad-tempered colonies than by those of good-tempered colonies.

(*c*) An analysis of the results of queen introductions made in the course of normal beekeeping practice, using a special cage in which the queen was confined without either food or attendants, showed that mated, tested, queens could be introduced to colonies from which laying queens had just been removed with a probable average success of at least 90 per cent. Virgin queens could similarly be replaced by mated, tested, queens with a probable success of at least 80 per cent.

The size of colony to which a queen was introduced appeared to have little, if any, effect on the likelihood of her acceptance.

Introduction of virgin queens by means of the cage method to colonies from which laying queens had been removed was less successful and requires further study.

(*d*) The proportion of successful introductions varied significantly in the different summer months, and was actually lowest in June. Difficulty was also found in introducing mated, tested, queens to colonies which were or had recently been rearing queen cells. Since June is the month when queen cells are most frequently present in colonies (see section on swarming), these two observations may be related to one another.

One of the results of food sharing amongst the adult members of a colony is the production of distinctive colony odours, and experiments by C. R. Ribbands involving the transference of queens between colonies which have been foraging on heather and colonies which have not, show that these distinctive colony odours play a part in the difficulties of queen introduction.

Wax-moth

It has been observed by L. Bailey that infestation by the Lesser Wax-Moth (*Achroia grisella*) was eliminated in combs which were fumigated with acetic acid vapour for the control of Nosema and Amoeba diseases. Adult and larval wax-moths were killed within 24 hours. Some fumigation experiments with the eggs of the Greater Wax-Moth (*Galleria mellonella*) and of the Lesser Wax-Moth showed that they were killed after exposure to acetic acid fumes for 12–24 hours at 59° F. Over 2 days' exposure at this temperature were required to kill their eggs with *p*-dichlorobenzene.

Bee Diseases

Nosema disease

Attempts to eradicate Nosema from most of the Department's colonies were begun by L. Bailey in 1954. The bees of each colony were transferred on to combs sterilized with acetic acid or formaldehyde as described in the last Annual Report. In April 1955 only 7 per cent of the colonies showed any infection. This figure includes colonies which had not been treated for various reasons, and compares well with the figure of 90 per cent of colonies infected in 1952, the year before research work on the control of this disease was begun.

The remaining infected colonies have now been treated, and all combs that are not in use are now sterilized with the fumes from 80 per cent acetic acid as a routine measure before they are re-used. It is hoped that the disease will be eliminated by these simple precautions.

Acarine disease

L. Bailey and Elizabeth Carlisle have demonstrated by means of field tests that the mite *Acarapis woodi* can be eliminated from infected colonies by two applications of any of the following acaricides: di-(*p*-chlorophenyl)-methyl carbinol ("Dimite", "P.K."), ethyl di-(*p*-chlorophenyl)-glycollate ("Chlorobenzilate", "Folbex") and *p*-chlorophenyl, *p*-chlorobenzene sulphonate (PCPCBS, the

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active ingredient of "Ovotran"). These acaricides were applied as smokes. The weather was warm (55–70° F.) at the times of application, and the disturbance caused in two out of eight colonies which were treated in the evening following a heavy nectar flow caused the deaths of several thousand bees. The queens were not affected.

It seems likely that treatment with these acaricides can best be carried out during warm weather, in early summer, before the main nectar flow begins, as treatment is distinctly less efficient when applied during cool (40–60° F.) weather.

Whereas PCPCBS was still the only acaricide treatment which produced rapid ovicidal effects in further laboratory tests, it proved no more efficient than the other acaricides in field trials during 1955. The ovicidal effect, although significant, is probably too slight.

It is probable that much more efficient acaricides of these types for use against *Acarapis woodi* are to be found. Even phenyl salicylate has recently been found to be highly effective, but it may be too toxic to bees. Methyl salicylate also has significant effects, but again it appears that its toxicity to the bee reduces its practical value. Nitrobenzene, probably the active constituent of Frow's mixture, was found to be toxic to bees but not to mites when applied as a smoke. Tests with Frow's mixture applied in the usual fashion during the winter of 1954–55 showed it to be very effective against the mites. But controlled experiments demonstrated that all the infected bees also died in treated colonies in the latter part of the winter. This proved to be disastrous to the heavily infected colonies which were treated, but such an effect would be acceptable in the cases of colonies which were only lightly infected.

European Foul Brood

L. Bailey has continued to study the natural cycle of infection. All the bees from infected colonies were transferred to uncontaminated combs in the late summer of 1954, when the disease had practically disappeared for the season. During 1955 these experimental colonies became very strong, but a few larvae that had died from the disease were first found in mid-June, and infection rapidly increased and reached a peak at the end of the month. As there is no evidence that any stage in the life history of the organism responsible for this disease occurs in the adult honeybee, it is considered likely that in these cases contamination was carried mechanically by the bees on to the clean combs to which they were transferred in 1954. In the control colonies dead larvae were found in mid-April and the infection increased less abruptly, but it also reached its peak at the end of June. The control colonies were by this time markedly weaker than the experimental colonies. Despite the different rate of development of infection and the different effect it had on the strengths of the control and experimental colonies, the signs of infection began to disappear from all colonies simultaneously and at the same rate, and by mid-August were scarcely detectable. The ability of this disease to develop in very strong colonies (each of which eventually gave yields of surplus honey of 50–100 lb.) suggests that the statements of some workers that the maintenance of strong colonies obviates this disease are incorrect and that, although the effect of the disease may be masked and easily pass unnoticed, it does not suppress its development.

Work has been continued on the isolation of "*Bacillus*" *pluton* and on the effects of antibiotics and sterilizing agents upon the course of European Foul Brood disease.

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