ROTHAMSTED RESEARCH

Report for 1952

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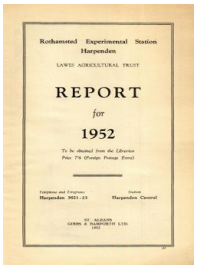

Bee Department

C. G. Butler

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BEE DEPARTMENT

C. G. BUTLER

GENERAL

As in previous years members of the department have given lectures and demonstrations at meetings of Scientific Societies, Beekeepers' Associations and other organizations, have served on various Committees, and have assisted with an Extension Course on "The Honeybee and some other Social Insects and their Allies", which was organized by London University.

C. G. Butler and C. R. Ribbands attended the meeting of the British Association in Belfast and read papers; a short film made by Mr. C. P. Abbott, in collaboration with C. G. Butler and J. B. Free, illustrating certain aspects of the behaviour of bees at the hive entrance, was also shown.

During the spring G. Raw (née Wykes) spent a few weeks at the Bienenabteilung of the Liebefeld Institute, Bern, demonstrating the technique for the quantitative analysis of nectar sugars by paper partition chromatography.

During the past year the research work of the department has been continued along the lines that have been outlined in previous reports, and a good deal of attention has been paid to tidying up some of the loose ends of previous work and in attempting to apply the information that has been obtained to specific practical problems.

In the past experience has shown that, largely on account of a lack of sufficient information regarding the sense physiology and behaviour of the honeybee, it was not possible to attempt to solve in a rational manner many of the problems with which seed growers and practical beekeepers are faced. To-day we possess much more of this fundamental information and it is intended that a much higher proportion than hitherto of the time of members of the department shall be devoted to the solution of particular problems in pollination and also in practical beekeeping. There are two ways in which many of the problems of practical beekeeping can be tackled. One is to make comparative tests on a very large scale of different methods of management, the other is to study the fundamental nature of the aspects of behaviour concerned and then, on the basis of the information obtained, to devise or select suitable practical methods of management. It is necessarily the second of these methods which is employed in the Bee Department.

BEE BEHAVIOUR

Division of labour

C. R. Ribbands has published the results of his work on the division of labour amongst the worker bees of a colony (132). He reached the conclusion that age plays only a subsidiary rôle in determining the occupation of each worker, and that the available food supplies determine the proportion of the total population of its bees that is required for each task. This presupposes extensive food sharing amongst the bees of a colony resulting in its adult

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members fitting their occupations to suit the requirements of their colony at any given time.

The extent to which food sharing does in fact occur has been investigated by C. R. Ribbands in collaboration with H. L. Nixon of the Plant Pathology Department (131), a radio-active tracer technique being used. It was found that within 27 hours of a single tablespoonful of sugar syrup containing a radio-active tracer being carried by six marked bees into the hive of a large colony, half the bees of the colony had received a share of this small quantity of syrup. The conclusion was reached, therefore, that food sharing takes place very quickly and thoroughly. It is hoped that it may be possible to carry out more detailed experiments on this subject, which clearly has an important bearing on the distribution of certain toxic substances which are sometimes collected by foraging bees and on the distribution of drugs fed to colonies in attempts to control disease, should more sensitive apparatus become available.

Recognition by bees of members of their own colony

In 1926 Professor K. von Frisch and Dr. G. A. Rösch showed that when foragers from a colony find a dish of concentrated sugar syrup and start to feed upon it they expose their Nassanoff, or scent-producing organs, and that the scent thus produced serves to attract other foraging bees to the source of food. Furthermore, although the scent produced is attractive to all bees it is more attractive to other members of the scent-producing bees' own colony than to bees from other colonies. Thus these workers demonstrated that bees can distinguish between members of their own colony and bees from other colonies by scent. Dr. H. Kalmus, of University College, London, and C. R. Ribbands have now successfully repeated and extended this work (130). They have shown that bees are not attracted by the sight or sound of other members of their colony, but rather by their scent. Each colony possesses its own particular odour which is shared by all its members. This colony odour is not hereditary but is derived from the food supply in use by the colony at any given time and shared by all its bees. Since the food supply of each colony differs in some degree from those of other colonies, each colony in an apiary is likely to posses an odour which is slightly different from that of other colonies. Clearly such distinctive colony odours play an important part in enabling the members of a colony to distinguish between friend and foe and thus to defend their hive against intruding bees from other colonies.

C. R. Ribbands and N. Speirs are now engaged in reinvestigating the activity of the olfactory sense of the honeybee and her ability to discriminate between mixtures of scents. They have already been able to show that the bee's abilities in these directions are greater than the results of previous work have indicated.

C. R. Ribbands and N. Speirs have also carried out some experiments on the reorientation of honeybees at the hive entrance; marked bees of known ages were used. The bees reorientated quickly and completely in these experiments, and age had no effect upon their adaptability. Once again colony odour played an important part in this reorientation.

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Swarming

J. Simpson has continued his study of the fundamental processes involved in swarming. Throughout the past season groups of colonies were treated in three different ways in attempts to induce them to swarm: (1) Very large quantities of sealed brood were given resulting, temporarily, in a considerable increase in the proportion of young bees in the colonies. (2) All eggs and unsealed brood were removed. (3) The bees were severely crowded by reduction of the space within their hives. Some, but not all, of the colonies in which the bees were severely crowded made attempts to swarm; none of the colonies subjected to the other types of treatment showed any inclination to do so. This variability in the behaviour of the bees of the overcrowded colonies may, perhaps, be explained by genetical differences, or, alternatively, may indicate that although overcrowding is a predisposing factor it is not the only condition necessary to induce swarming. According to Gerstung's brood food theory swarming results from the efforts of the bees of a colony in which there is an excess of bees of nursing age to find an outlet for the surplus brood food they produce by rearing queens. However, the failure of the treatment in which the experimental colonies were flooded with young bees—i.e. bees which normally produce brood food—to cause swarming is strong evidence against the correctness of this theory. No sign of any surplus brood food was observed in these colonies. Furthermore in the case of those colonies in which attempts were made to remove all eggs and unsealed brood an occasional larvae was overlooked and such larvae appeared to be receiving abnormally large amounts of brood food; nevertheless none of these colonies made any attempt to swarm.

Bumblebee behaviour

J. B. Free has continued his work on the behaviour of various species of bumblebees in an attempt to determine their efficiency as pollinating agents, particularly of red clover.

A comparison is also being made of the relative efficiency of honeybees and various species of bumblebees in this connection. If it be found that the bumblebee should be used in preference to the honeybee as a pollinating agent for red clover it will be desirable that we should know much more than we do about the foraging behaviour of the various species and of the economy of their colonies.

J. B. Free has commenced to study such aspects of bumblebee behaviour as the size of the foraging areas of individuals; their constancy to particular crops; the nature of the division of labour; and the orientating abilities of foraging bumblebees when their nests are moved to new sites; and has made some useful progress.

Should it prove to be desirable to attempt to increase the number of bumblebees in particular areas for purposes of pollination, this will have to be done either by providing suitable nesting sites, etc., or by moving captive colonies maintained in nest-boxes to those areas. J. B. Free has obtained some degree of success in experiments both with artificial nesting sites and in inducing over-wintered queens to found colonies in captivity. However should

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it prove desirable to use bumblebees for the pollination of certain crops, considerable work still requires to be done before it will be known whether or not either of these methods are likely to prove practicable in the field.

Nectar secretion

G. Raw has, with the help of E. Carlisle, continued her quantitative investigations of the different sugars present in nectar. The fructose/glucose ratio, which is known to influence the tendency of honeys to granulate, was found to vary widely in the nectars of the flowers of the twelve species examined. The results suggest that the relative proportions of sucrose, glucose and fructose normally tend to remain constant in the nectar of any given species, but further work is required before any definite conclusion can be reached.

M. Ryle has continued her work on the effect of fertilizer treatment on nectar secretion in red clover. G. Raw has taken the opportunity of using the plants in this experiment to investigate the possible influence of fertilizer treatments on the sugar composition of the nectars produced.

Thanks to the kind co-operation of the Director of East Malling Research Station and his assistants, M. Ryle, with the help of E. Carlisle, has been able to study the secretion of nectar by apple trees under different fertilizer treatments. The results obtained showed that extra potash significantly increased the mean quantity of sugar produced per flower. They also suggested that phosphate increased it, but that nitrate decreased it provided that adequate potash was present. The highest mean yield was obtained from trees receiving phosphate and the higher dose of potash but no nitrate. It was one-and-three-quarter times the lowest mean yield which was from trees receiving no phosphate and the lower dose of potash (nitrate having no effect). It is concluded that increase of nectar yields of apple trees by means of fertilizer treatments and, therefore almost certainly, an increase in their attractiveness to nectar-seeking pollinating insects, is a practical possibility.

General Research

Pollen supplement trials

C. G. Butler, E. Carlisle and J. Simpson have completed in the Rothamsted apiaries a series of tests of the value of pollen supplement feeding towards increasing the amount of brood reared by colonies of bees in the spring. These trials have been carried out during the years 1949–52, the principal mixture fed consisting of soya flour with dried brewer's yeast. The results, as shown in the following table, indicate that the increase in the amount of brood produced (the long-term effect of which has yet to be assessed) varied considerably from year to year. It probably averaged at least 100 per cent in 1951 but may have been negative in 1952.

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Mean area of sealed brood (sq. ins.) in colonies in pollen supplement trials

Year	Control	Soya-yeast mixture	Difference required for significance (P=0·05)
1949 and 1950	124	201	24
1951	145	312	24
1952	539	513	84

Honey stomach contents of pollen gathering bees

Observers of foraging bees in the field have claimed to be able to distinguish between bees gathering pollen and nectar and those gathering pollen only by comparing the translucencies of the spots produced by absorbing on filter paper the contents of the bees' honey stomachs as a rough measure of sugar concentration. It was assumed that bees gathering pollen only would take out honey from the hive and that this would have a higher concentration than the nectar carried by bees gathering both pollen and nectar. J. Simpson and C. G. Butler have now shown that this procedure is useless since the range of sugar concentrations (measured by refractometer) found in the honey stomachs of bees working crops, such as poppies, yielding only pollen is similar to that of nectar. The alternative possibility that consistent differences in translucency might result from the greater proportion of sucrose in nectar than in honey was eliminated by a comparison of honey diluted to the concentration of average nectar with a pure sucrose solution of the same concentration.

Queen introduction

The problem of introducing virgin or laying queens to colonies of bees has been recognized as an extremely important one. Although many methods are known, some of which often give satisfactory results, we cannot hope to be able to introduce queens without loss or damage until we can forecast the behaviour that will take place when any given queen is introduced to the members of any given colony, whatever the condition of the queen and colony may be, as we shall not know how to set the stage in such a way that both bees and queen will welcome one another.

A strange queen is no more than an intruder, welcome or otherwise, when she is introduced to the bees of a colony other than the one in which she was reared. It will obviously be an advantage, therefore, if, before one begins to experiment with queens, one obtains some information on the way in which the worker bees of a colony respond to intruding workers from other colonies. This latter problem has been investigated by C. G. Butler and J. B. Free and a paper prepared on the subject (128).

It was found that honeybees do not normally guard the entrance of their hives and examine incoming bees of any kind unless their colonies have been alerted in some way, such as by the presence of numbers of strange bees. They are much more readily alerted during a nectar dearth and tend to give up guard duties when nectar is abundant. Should numbers of strange bees attempt to enter

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the hive of a really alert colony mass fighting sometimes takes place between the excited guards of the colonies concerned and many bees are killed. Normally, however, such a high degree of excitement does not occur and only robber bees which try to enter alert colonies are attacked, unwitting intruders being examined and, on being recognized as intruders by their strange body odours, mauled and dragged away from the hive entrance but not stung. Such unwitting intruders often adopt a submissive attitude towards the guard bees, remaining more or less passive whilst being examined or mauled. When the guard bee approaches the head of such a submissive intruder the latter offers her a drop of food between her open mandibles. Usually such offers of food are refused and after several refusals the submissive bee extends her tongue and commences to " strop " it with her forelegs. It is believed that this is a " displacement activity " released by the frustration of the submissive intruder's urges to give food and to enter the hive.

Bees suffering from a form of " bee paralysis " have also been seen to be examined and mauled by guards of their own colony, presumably on account of some strange body odour resulting from disturbance of their metabolism. Such bees assume a submissive attitude and are often dragged away from the hive entrance.

Even when guards are present a few intruders succeed in entering the hive where they are subjected to further examination and mauling, often being dragged out of the hive. Those that succeed in remaining within the hive for two or three hours appear to be adopted by the colony having, presumably, acquired the colony odour. Such accepted bees have been seen twenty-four hours after first entering the hive of a strange colony guarding its entrance against further intruders from their parent colony.

Undoubtedly all the factors which influence colony alertness play an important part in determining the ease or otherwise with which colonies can be united together, or strange queens introduced to colonies. In preliminary work with queens C. G. Butler has found that queens will sometimes adopt a submissive attitude towards guard bees and even offer them food just as submissive workers do. It has also been found that when a queen is " balled ", the bees forming the " ball " around the queen will often sting one another in their attempts to sting the queen. Furthermore, some of the workers that have been " balling " the queen are themselves " balled " by other members of their colony when they leave her. This suggests that the scent of the queen is transferred to the bodies of some of the workers " balling " her and serves to excite the other bees to attack bees contaminated with the queen's body odour. Experiment has shown that this theory is correct, and some evidence has also been obtained which suggests that the bees of a colony recognize the presence of their own queen, although they may be in a remote part of the hive, by her odour adhering to the bodies of some of the workers that have recently been with her. In this simple way, perhaps, all the bees of a colony are able to detect the presence or absence of their queen; however, further work will be done in order to establish this probability.

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Pollination of red clover

The acquisition of four plastic-screen cages has enable C. G. Butler, E. Tyndale-Biscoe, J. B. Free and J. Simpson to begin investigations on the relative efficiency of honeybees and " robbing " and " non-robbing " species of bumblebees as pollinators of red clover. A good deal of work has also been done in attempts to induce honeybees to work red clover flowers for pollen or nectar, and also to increase the amount of pollen collected by colonies by robbing the returning foragers of a high proportion of their pollen loads, a specially designed trapping-screen being used for this purpose. Unfortunately no useful increase in foraging (pollinating) activity has been obtained with any of the methods so far tried.

Bee Diseases

Nosema disease

L. Bailey has devoted a good deal of time to checking and extending the investigations of Dr. H. Katznelson and Dr. C. A. Jamieson of Canada, upon the effect of the new antibiotic " fumagillin " on the infection of worker honeybees by *Nosema apis*.

He has found that this drug prevents the establishment of this disease within the ventricular epithelium and also may cure the heavily infected bee within a short space of time by suppression of the spread of infection already present and the sloughing away of the diseased tissue by the natural generation of the epithelium. The lowest effective dose of the drug seems to be about 1 mgm. per 100 mls. of syrup fed freely.

Large-scale field experiments are now being carried out with the drug which appears to offer high promise of providing an efficient treatment for this widespread and serious disease.

Very promising results have also been obtained in attempts to eliminate this disease from colonies in the field by transference of bees to clean comb foundation.

European foul brood, acarine disease, etc.

H. Finegan has continued the work on E.F.B. commenced by Mrs. Schreiner. In particular attempts are being made to culture *Bacillus pluton*.

A number of Gram-positive organisms, very similar in appearance to *B. pluton* have been isolated and have been tested for pathogenicity on honeybee larvae reared artificially outside the hive. This technique allows of much better control than do similar trials with larvae in the hive.

J. Simpson, in collaboration with F. A. Skinner of the Soil Microbiology Department, has carried out further tests to determine the practical value of a yeast-like organism, *Acaromyces laviae*, which is apparently capable of destroying the parasitic mite, *Acarapis woodi*, which is responsible for acarine disease in bees. Mention has already been made in the section of this report dealing with experiments on queen introduction of observations that have been made on the behaviour of the worker bees of a colony towards members of their colony suffering from bee paralysis.

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Bee Breeding

Work has been continued on this subject and, thanks to the generosity of the Reverend Brother Adam of Buckfast Abbey, who is collaborating with us in a study of the characteristics of the honeybees of Europe and the Middle East, a unique collection of bees from apiaries in these parts of the world has been built up during the last two or three years. These are being carefully examined and described and it is hoped to obtain a detailed picture of the material available for use in attempts to improve our present strains of bees.

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