ROTHAMSTED RESEARCH

Report for 1953

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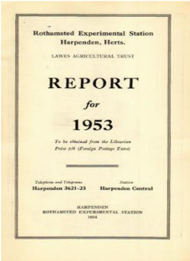

Bee Department

C. G. Butler

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BEE DEPARTMENT

C. G. Butler

General

During 1953 the work of the department has proceeded along the lines which have been outlined in previous reports. Members of the department have given lectures to Scientific Societies, Beekeepers' Associations and other organizations, and have taken part in Summer Schools and similar short courses; they have also continued to serve on various committees, such as the Ministry's Bee Disease Advisory Committee.

A book entitled *The Behaviour and Social Life of Honeybees*, on which he has been working for some time, has been completed by C. R. Ribbands (145). This is essentially a reference book, and will, without doubt, be of considerable value to bee research workers.

A book on the organization and behaviour of honeybee communities, *The World of the Honeybee*, has been written by C. G. Butler for the New Naturalist Series (144).

During the year Margaret Ryle resigned in order to take up a new appointment in Cambridge. At the time of her resignation the programme of work on nectar secretion, on which she and others had been engaged for several years, was nearing completion, and it is hoped that it has now been completed by Elizabeth Carlisle. Many of the results of this work have already been published, and others (M. Ryle, 152, 153) are in the press.

Throughout the winter C. G. Butler was seconded to the Department of Agriculture of the Government of Ceylon, in connection with the Colombo Plan, to give advice upon the development of beekeeping and bee breeding in the Dominion. A Sessional Paper giving the results of these investigations and recommendations for the future development of beekeeping in the Island has been prepared (147). During the summer Dr. B. A Baptist was sent over by the Government of Ceylon in order that he might obtain experience in practical beekeeping and bee breeding.

Bee Behaviour

Effects of certain anaesthetics on behaviour

During the last few years claims have been made that if a colony of honeybees is moved a short distance whilst its members are anaesthetized with nitrous oxide they do not, on recovering from this anaesthetic, show any tendency to drift back to the original site of their hive, as they would do when anaesthetized with chloroform and other anaesthetics. It has also been been claimed that anaesthesia with nitrous oxide, unlike that induced with carbon dioxide, does not result in acceleration of the rate of change-over by individuals from household duties to foraging, nor inhibit the pollen-gathering activities of established foragers. This anaesthetic, if the claims mentioned could be substantiated, would undoubtedly be of considerable practical value, and efforts have, therefore, been made to check them.

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The anaesthetic for which these claims have been made was prepared by its sponsors by adding ammonium nitrate crystals to the burning fuel in a beekeeper's " pipe " (used on the Continent for producing smoke with which to subdue bees during manipulation of their colonies). J. Simpson has demonstrated that the active agent in the fumes thus produced, which act very rapidly as an anaesthetic to bees, is certainly not nitrous oxide, but may be cyanides [which are, of course, harmful] and probably also some so far undetermined substance which appears to be a useful anaesthetic for bees. He has shown that pure nitrous oxide can produce anaesthesia only if it is used to dilute the oxygen in the atmosphere in which the bees are placed to about a tenth of its normal atmospheric tension at sea-level.

Simpson has found that no inhibition of drifting is obtained by anaesthesia with carbon dioxide, nitrous oxide or the fumes produced by adding ammonium nitrate to burning smoker fuel; furthermore, all three of these anaesthetics resulted in foraging bees ceasing to collect pollen, and also in acceleration of the histological changes in the pharyngeal glands of household bees which normally occur about the time when they first commence to forage.

C. R. Ribbands has also, independently, carried out experiments with nitrous oxide anaesthesia and found that the effect on drifting is negligible.

In practical, apiary, tests Simpson has shown that when whole colonies are anaesthetized with the fumes produced by adding ammonium nitrate to burning smoker fuel they occasionally fail to recover (probably on account of cyanide poisoning), but the results of his experiments suggest that this danger can be eliminated by using the minimum proportion of ammonium nitrate to fuel necessary to produce anaesthesia. Apart from its slightly toxic effect, this method, using the minimum quantity of ammonium nitrate necessary, appears to be the most efficient and simple one so far suggested for anaesthetizing whole colonies of bees *in situ*.

Foraging behaviour

C. R. Ribbands and Nancy Free (née Speirs) have continued their observations on the behaviour of individual worker honeybees which were visiting dishes of sugar syrup and have, as a result, suggested that, although the interplay of choice and memory enables a honeybee to exploit her environment very adequately, she is not an automaton who invariably chooses the best of those crops with which she has become acquainted. They have found that even if a bee has become aware of another dish which contains syrup of a higher concentration, she may continue to forage from another dish to which she is more accustomed. These observations confirm the existence of an aspect of bee behaviour which is implicit in earlier work but which has not hitherto been revealed by Ribbands' own observations, nor demonstrated in detail.

Swarming

J. Simpson has continued his investigations on the causes of swarming by studying the effects of combining overcrowding of the bees in the hive with either an excess, or a deficiency, of brood for them to feed. From a preliminary examination, the results appear to confirm the previous year's conclusion that whilst overcrowding of the bees in the hive predisposes a colony to swarm, an excess of bees to brood has little, if any, such effect.

The organization of social life

C. G. Butler has shown that queen honeybees secrete on all parts of their bodies a substance (" queen substance ") which the household bees of their colonies urgently seek. This substance is obtained by young worker bees, who happen to be near to the queen at any given time, by licking her body. Many of the bees that have just obtained a supply directly from the queen move rapidly over the combs offering food which contains " queen substance " to other members of their colony. In this way " queen substance " becomes widely shared amongst the members of a colony. As long as worker bees obtain sufficient " queen substance " they remain inhibited from building emergency or supersedure queen cells, and from tolerating the presence of eggs or larvae in swarm queen cell cups (or artificial queen cell cups).

The " queen substance " of virgin queens appears to differ from that of mated, laying queens, but it is probable that all virgin queens produce one kind of substance and that all mated queens produce another kind. The results of experiments indicate that it is appreciation of the difference between the " queen substances " of virgin and mated, laying queens, rather than any difference in their behaviour, which enables worker honeybees to distinguish between them.

It seems probable that the readily demonstrable craving of workers for " queen substance " is one of the most important factors, if not the most important, in the maintenance of colony cohesion, not only in honeybees but also in the ants and termites. It is also very likely that it plays an important part in swarming; a temporary shortage of supply or, more probably, a breakdown in its distribution, leading to the toleration of eggs and larvae in queen cell cups.

It is hoped that the results of some parts of this investigation will be published shortly.

Clustering behaviour

J. B. Free and C. G. Butler have continued their analysis of the factors involved in the formation of a cluster of honeybees. They have been able to verify the fact, first demonstrated by Lecomte in 1950, that if one hundred or more worker honeybees are scattered individually in an arena in total darkness they will soon all come together to form a single cluster.

The bees appear to cluster together in this way in search of warmth and food and, if a queen is present, as usually occurs in nature, " queen substance ". (See Section on " The organization of social life ".)

Various factors combine to attract the " lost " bees together, such as the fact that the temperature of the incipient cluster is higher than that of its surroundings (if it is not no cluster is formed, and if it exceeds a certain level any cluster that has already formed tends to break up), the scent produced by the individuals of which the cluster

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is formed, and the vibrations produced by the clustering bees. It has been demonstrated that each of these factors is, on its own, sufficient to induce clustering, even in total darkness. In the light, vision also plays its part in attracting stray individuals towards an incipient cluster.

It is hoped to publish these observations in detail before long.

Bumblebee behaviour

J. B. Free has continued his work on the behaviour of various species of bumblebees, with particular reference to the sizes of the foraging areas of individuals and their constancy to particular crops; the nature of the division of labour shown by the workers of a colony; and the physiology of caste production. He has shown that it is possible to induce queen production from the first batch of brood produced by an overwintered queen by providing her with ample food and attendant workers from other colonies.

General Research

Red clover pollination

E. Carlisle has continued the work on the effect of fertilizer treatments on nectar secretion by red clover which was begun by M. Ryle and herself. The results of last season's field experiments are now being analysed and prepared for publication. Two papers on this subject have already been written by M. Ryle (152, 153).

The yield of nectar appears to be the principal limiting factor in the attractiveness of red clover for honeybees. M. Ryle has demonstrated that marked variation occurs in the nectar yield between clones, and an attempt is therefore being made by C. G. Butler, J. Simpson and E. Tyndale-Biscoe to assess the possibility of selecting strains of established varieties of red clover with a much increased tendency to secrete nectar.

Experiments carried out in 1952, by the above workers together with J. B. Free, not only confirm the need of red clover for insect pollination but also appear to indicate that large variations in the percentage seed set can occur even with a population of honeybees larger than that required to pollinate all the florets. Before investigating the causes of such variations, it has been necessary to carry out further experiments to eliminate a possibility that they might have been due to constriction of the clover heads by the muslin bags which were placed over them. During 1953, therefore, a study of seed set variation has been made by a method which does not involve bagging the heads. The results appear to confirm the presence of variations in set even when excess honeybees are used to pollinate the flowers.

A comparison is also being made by J. Simpson between the proportion of florets in which seed is set on watered and unwatered plots of red clover. On account of the wetness of the summer of 1953, it is doubtful whether any differences will be demonstrable.

Queen introduction

As a result of his earlier work with J. B. Free on the way in which the worker bees of colonies respond to intruding workers from other colonies (see 1952 Report) and his own work on the existence of

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" queen substance " and its importance in the maintenance of colony cohesion and organization (see Section on " The organization of social life "), C. G. Butler has suggested, as a working hypothesis, that the following points should be observed when introducing to colonies mated queens, of any age or strain: (*a*) the colony to be requeened should not be left queenless for more than a few minutes; the new queen should be introduced directly the old queen has been removed. The bees must not be allowed to suffer even temporarily from a deficiency of " queen substance " if it can be helped. Experiment has shown that the longer the interval between the removal of the old, mated queen and the introduction of a new, mated queen, the greater the chance of failure. (*b*) The new queen should be introduced alone, without attendants. The presence of attendants with strange body odours probably tends to alert the bees of the recipient colony, and this may lead to difficulties. (*c*) Ideally the queen should be released (by the bees) from her cage an hour or so after introduction, by which time any alertness caused by disturbance should have died down. (*d*) No food should be provided in the cage. The proper food for a mated queen is almost certainly brood-food, and the bees will provide this if the cage has a large mesh and is placed amongst bees of the right age. (*e*) The cage should be placed between combs containing the youngest larvae in the hive, as it is here that the nurse bees, who are producing brood-food, congregate. (*f*) The mesh of the wire-gauze of the cage must be large (3–4 mm.) so that the nurse bees can feed the queen and can lick her body, and thus obtain " queen substance ". (*g*) A colony should be left undisturbed for at least four days after a queen has been introduced in her cage, otherwise there is a slight risk of her being " balled ".

The cage suggested is made entirely of wire-gauze, and has one open end. The open end is covered with a single thickness of newspaper after the queen has been placed in it and just before it is put amongst the bees of the recipient colony. It has been found that the temporary reduction in the amount of " queen substance " in circulation before the queen is released from the introducing cage sometimes leads to the formation of a few emergency queen cells. However, experience indicates that these may safely be ignored, as the bees will destroy them after a day or two, when, presumably, the supply of " queen substance " has returned to normal again.

So far, 230 mated queens, including nearly 100 that had been in the mail or caged in the laboratory for anything up to five days, have been introduced by this method, with the loss of only one. With the aid of a number of beekeepers it is hoped to carry out further trials of this method during 1954. A preliminary report is being prepared for publication.

Bee Diseases

Nosema disease

L. Bailey has continued his work on Nosema disease. He has demonstrated that if the adult bees of an infected colony are transferred entirely on to clean comb-foundation early in the active season, the disease will be eliminated from this colony by the following spring.

It now seems quite definite that Nosema disease is carried over in a colony from one year to the next on old combs, and that infected bees do not transmit this disease to any significant extent at those times of the year when they can fly freely (150).

Successful attempts to fumigate combs and kill all the contained Nosema spores have been made at room temperature, both with the vapour of formaldehyde and with that of acetic acid. After exposure to the air for seven days combs that have been fumigated in this way did not appear to have any harmful effect upon the adult bees, or brood, of the colonies to which they were given.

The large-scale field experiments using the drug fumagillin against Nosema have been continued. It has been found that spread of the disease within overwintering clusters of bees, and the contamination of their combs with faecal matter containing spores of the organisms concerned, can be effectively prevented by feeding colonies with this drug in the autumn. Colonies treated in this way appeared to be healthy by the following spring, but subsequently, some mild relapses took place as brood rearing developed and the brood area expanded over comb which had not been completely cleaned of Nosema spores during the previous season.

It appears that the autumn is the optimum time of year for treatment of colonies with fumagillin, as the combs are in their cleanest condition at this time. The few bees which are still diseased are cured by the drug, and thus prevented from spreading the disease during the winter. Spring or summer treatment with fumagillin does not appear to be satisfactory, as the bees are cured only temporarily, and infection of the combs remains the same and the disease follows its normal course when treatment is discontinued (149).

Nosema infection reduces the proteolytic activity of the ventriculus of the adult bee, and also reduces the buffering power of the contents of this organ in the alkaline range. The inorganic phosphate content of the ventricular lumen increases significantly when infection develops, due presumably to the lysis of intracellular granules of calcium phosphate. The buffering power of the midgut of the honeybee in the alkaline range is not, therefore, due to inorganic phosphate, as has been suggested by earlier workers.

Other diseases

Work on Amoeba, Acarine and European Foul Brood diseases has been continued as opportunities occurred.

Bee Breeding

E. Carlisle has now completed a detailed biometric study of the honeybees of Europe and the Middle East. A few specimens of *Apis dorsata*, *A. florea* and *A. indica* have also been examined. The results of this work are being prepared for publication.

The production of queens of selected strains for trials has made considerable progress during the past year. Mated queens have been sent to a number of County Beekeeping Instructors and others who have kindly agreed to help with this work.