ROTHAMSTED RESEARCH

Report for 1949

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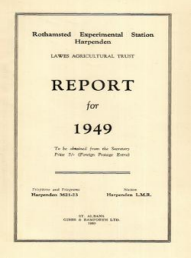

Bee Department

C. G. Butler

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BEE DEPARTMENT

By C. G. Butler

As in previous years several members of the department have read papers and given demonstrations at meetings of Scientific Societies, Beekeepers' Associations and other organisations. An Extension Course, arranged by London University, on the Physiology and Behaviour of the Honeybee was also given by Dr. C. G. Butler.

During the course of the last twenty-five or thirty years, very considerable advances have been made in the study of the sense-physiology and behaviour of the honeybee. As a result, numerous papers have been published in the world's scientific journals, and the need for some comprehensive account of the senses of the honeybee and the manner in which she uses them has become increasingly apparent. An attempt has been made to fill this want by the publication of a small book giving the results of some of the work (169).

Members of the department have continued to serve on various Committees such as the Bee Disease Advisory Committee, British Standards Sub-Committee for Beekeeping Equipment and the B.B.K.A. Research Committee. A new Bulletin on beehives has also been prepared for the Ministry of Agriculture and Fisheries.

Behaviour of Honeybee in the Field

Although the sense physiology of the honeybee has been extensively investigated, notably by von Frisch and his school, relatively little work has until recently been done on the way in which these senses are employed in the field, despite the fact that a sound knowledge of foraging behaviour is an essential preliminary to the properly controlled employment of the honeybee as a pollinating agent for fruit and seed crops.

Since 1939 a great deal of attention has been given by members of the department to this problem and as a result a number of papers have been published.

In 1943 Butler, Jeffree and Kalmus (J. Exp. Biol. **20,** 65–73) published the results of some work on the behaviour of marked honeybees when seeking sugar syrup from dishes and also when collecting nectar from various kinds of flowers. A large number of dishes were used in these experiments and were regularly arranged at twenty yard intervals from one another in a meadow. The data obtained confirmed and extended the work of earlier observers and indicated that once a honeybee has discovered a rich and abundant source of syrup or nectar at a particular site she tends strongly to confine her attention to this one site for hours and sometimes days on end; in the case of a dish of syrup to one particular dish and in the case of a plant to a definite and restricted area of the crop of flowers.

It was observed, however, that although this was the general rule there was, particularly when the supply of syrup in a dish failed or when the nectar supply in a group of flowers became diminished, a tendency for some of the bees that had been visiting a given dish or group of flowers with great regularity to visit neighbouring dishes or flowers. Since, however, the general tendency was clearly for a bee to confine her attention to a definite "foraging area"

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little significance was attached at the time to the very small proportion of the total foraging population that was visiting a dish or group of flowers which strayed on to adjacent dishes or flowers. It was also found that when the bees were offered syrup of two different concentrations in dishes set out at random in a field the bees tended to congregate upon those dishes which contained the more concentrated syrup. Bees have frequently been observed at any given time to choose the species of flower which is yielding the richest nectar, and in 1945 Butler (J. Exp. Biol., **21,** 5–12), as a result of further work, reached the conclusion that nectar concentration determines in the first instance which species of plant will be visited in preference to others in flower at the same time in any given district, and that the abundance of the nectar then determines the proportion of the foraging population of a colony which will work the flowers with the richest nectar.

In 1949 Ribbands published the results of some observations on the movements of honeybees which were foraging in a specially planted garden. The bees were so marked that each individual could be readily recognised from all other individuals.

The garden contained five kinds of flowers which were arranged in long rows and large beds, and the visits of marked bees to individual flowers in this garden were very carefully noted. In one part of the garden there was a row of *Eschscholtzia* plants growing parallel to and only nine inches away from a similar row of *Limnanthes* plants. Both species were in flower at the same time and although the *Eschscholtzia* plants were taller than the *Limnanthes* plants, the flowers of both were intermingling to a considerable extent. Yet, despite the close proximity of these flowers to one another most of the bees visiting them worked one or other of them, completely ignoring the other. Two marked bees, however, were found to be working both crops, and one of these bees was watched for two consecutive days and each visit paid to each flower in the garden was recorded. At first this bee appeared to be visiting both kinds of flowers indiscriminately, later it was noted, however, that during the course of the morning the proportion of *Eschscholtzia* flowers visited per foraging trip was gradually increasing, the proportion rising from 37% on the second foraging trip of the day to 61% on the sixth trip. The process was then reversed and the proportion of *Eschscholtzia* flowers visited per trip fell rapidly and consistently, eventually falling to 0·2% on the last trip of the day. These changes in the proportion of *Eschscholtzia* and *Limnanthes* flowers visited per trip were accompanied by changes in the period of time required by this bee to collect a full load and it would appear to be likely that they resulted from changes in the relative attractiveness of the two crops.

These regular changes in the proportions of the flowers of these two species that were visited on each foraging expedition indicate that this bee was not foraging in a random manner but was making a series of definite choices, based, presumably, on her ability to appreciate changes in the relative attractiveness or food content of the flowers of these two species at different times of the day.

The increasing length of time spent by this bee on each successive foraging expedition throughout the day indicates that the *Limnanthes* flowers were becoming less and less productive, but the

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single visits paid to *Eschscholtzia* flowers every now and again indicate that at each time of sampling the *Eschscholtzia* flowers were still found to be less attractive than the *Limnanthes* flowers. Ribbands pointed out that after only a single unsatisfactory visit to an *Eschscholtzia* flower the bee returned to the *Limnanthes* flowers ; each unsatisfactory visit to an *Eschscholtzia* flower appeared to reinforce the impression created on this bee by previous unsatisfactory visits to this species, with the result that the intervals between the occasional visits made to the *Eschscholtzia* flowers grew progressively longer. It would appear as though this bee was exercising both choice and memory, and that she was continually selecting the flowers of that species which was most satisfying to her at the time. Results illustrating similar behaviour on the part of other bees working in this garden were obtained.

It appears to be reasonably certain, therefore, that honeybees do not wander over a crop of different species of flowers at random, visiting first one species and then another, but rather that they quickly become accustomed to visit one particular species and a relatively small part of the total area occupied by a crop of flowers of this species. Every now and then, however, a bee will visit experimentally a few flowers of another species growing in the vicinity possibly only the flowers of one that is growing in the immediate vicinity, and, should it prove to be a more profitable source of food than that species, or, perhaps, than those species, which she has visited hitherto, each bee will select for herself a foraging area on the crop of this new species of flower and will remain faithful to it just so long as she does not discover, during one of her experimental visits, an even more profitable source of food elsewhere.

Recently Miss G. Wykes has been attempting to determine whether the variations which are known to occur in the composition of the total sugar content of floral nectars influence the preference shown by the honeybee for the nectar of one species of flower over that of another. Equal volumes of solutions of the same concentrations, but differing in constituent sugars, were offered to bees in the field and the preferences of the visiting bees noted. It was found that at the concentration of the solutions that were offered a significant preference was shown by the bees for a solution containing sucrose, glucose and fructose in the proportions 1 : 1 : 1, in comparison with any solution of the individual sugars, or of mixtures of these sugars in various proportions. This result appears to be of some biological significance since nectar, the natural source of carbohydrate for the bee, normally consists of a mixture of these three sugars, possibly in certain cases in the proportion 1 : 1 : 1.

This investigation is being continued in the laboratory and similar results to those in the field have been obtained, but further experiments have shown that the relative sweetness to the honeybee of the various sugar solutions almost certainly varies with their concentration, as is the case in man.

During the last few year Butler has been investigating the method by which a scout bee, that is to say a bee which leaves her hive without any preconceived ideas of where she is going to seek food or with what perfume it is associated, finds a new source of food. He has found that the honeybee is attracted to any area in

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which a strong floral perfume, such as oil-of-lavender, is present, and that she then tends to seek nectar from any small crevices in any small coloured, preferably patterned and moving, object, such as a disc of coloured paper, in this area.

Once a scout bee has been led to a source of food by the presence of a strong floral perfume, followed by colour or pattern, she samples the contained food and should it prove profitable to work, that is if it is both rich and abundant enough to satisfy her, she returns to her hive, and by means of the " dance language " discovered by von Frisch, quickly recruits further bees to work the source that she has discovered.

The Effects of Anaesthetics upon Foraging Behaviour

C. R. Ribbands has continued his work on the effect of various anaesthetics upon the foraging behaviour of bees, and a paper on this subject will be published shortly (167).

He has demonstrated that anaesthesia with chloroform does not either impair the memory, influence the foraging behaviour or reduce the longevity of honeybees. On the other hand, anaesthesia with carbon dioxide, although it does not impair the memory of treated bees, does result in a permanent change in their behaviour but has no direct effect upon their longevity. The pollen collecting activities of bees treated with carbon dioxide are either eliminated altogether or very markedly reduced. Similarly the treatment of newly emerged bees with carbon dioxide results in the elimination of all or most of their brood rearing and wax secreting activities and causes them to commence to forage at an early age. Since foraging life is necessarily more hazardous than life within the hive, the expectation of life of bees that have been treated with carbon dioxide is less than that of control bees that have not been treated in this way.

The effects of anaesthesia with nitrogen are similar to those obtained with carbon dioxide. It would appear likely, therefore, that temporary oxygen lack is the factor which results in the changes of behaviour mentioned.

Attempts are being made in the laboratory to study the physiological effects of anaesthesia with carbon dioxide on honeybees, and an attempt to discover the fundamental nature of the basis of the division of labour exhibited amongst the worker bees of every colony. Little success has been achieved so far, however.

Pollen Trapping

The regular routine trapping of samples of pollen which has been carried out for several years by means of pollen traps placed on the entrance of hives containing normal colonies of bees has been discontinued for the time being.

Although this technique is undoubtedly a useful tool for the elucidation of certain specific problems it appears doubtful whether routine trapping, with the heavy labour of sorting the catch into its constituent pollen species, will yield further results of major importance unless some method can be devised to overcome some of the errors inherent in the present apparatus. The pollen traps so far devised are all of the same basic design and suffer from the serious disadvantage that they trap a higher proportion of the larger sized

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pollen loads. It is characteristic of some plant species that bees only collect very small loads of pollen from them and these loads, although they may in the aggregate be extremely important in the economy of a colony are almost entirely missed by the present traps.

J. Simpson has further elaborated his keys, based on those worked out by Miss A. D. Synge when she was a member of the department, for the identification of the pollens of British plants visited by bees. These keys are, together with the fairly extensive pollen collection, in constant use in the department and are thus being subjected to considerable testing. It was hoped that it might prove to be possible to publish a monograph on the identification of the pollens of bee plants occurring in Britain, but the heavy cost of reproduction of the necessary photomicrographs appears to make this impossible, at all events for the time being.

Bee Breeding and Strain Trials

The development of the technique of artificial insemination of queen honeybees has been continued, and certain small advances have been made. Much work still requires to be done on the study of the sexual development of drones, however.

Between June 9th and August 20th, 191 queens were inseminated and, on account of various accidents such as the destruction of a large batch of queens early in the season by overheating with a microscope lamp, less than 50 per cent were wholly successful. None the less 43 queens of various strains which it was desired to test were introduced into colonies in out-apiaries and continued to lay well and produce satisfactory brood. The development and behaviour of these colonies will be studied in detail during 1950.

During 1949 the development and behaviour of the inseminated queens of different strains introduced in the summer of 1948 into nuclei in one of the out-apiaries was studied and some useful information obtained. Some of the colonies headed by these queens did remarkably well, and the difference observed between the different strains of bees in the apiary was well marked.

Work has been commenced in an attempt to distinguish biometrically between the different strains of bees maintained by the department. Since the production by means of instrumental insemination of the large number of queens necessary for strain trials is an extremely tedious business, it is hoped that it will prove to be practicable to mate large numbers of queens with selected drones in normal queen-mating apiaries and, by studying the biometrical ratios of the offspring of queens mated in this way, to be able to select those queens that have mated with the drones desired.

Instrumental insemination will, of course, continue to be employed for the production of breeder queens.

Nectar Secretion

Miss G. Wykes has continued her work on the influence of the available supplies of carbohydrates on the process of nectar secretion by various flowering plants. By placing flowers of the same age in feeding solutions of varying sucrose content she has found that with increasing concentration of the feeding solution, up to about 20 per cent., there is a proportionate increase in the concentration of the nectar secreted by the flower and in the total amount of sugar

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secreted. No significant differences were observed when the feeding solutions consisted of glucose, fructose or sucrose of the same concentration. By means of ringing and defoliating experiments with the flowering shoots of horse-chestnut and apple trees it was shown that interference with the normal carbohydrate supply either before or during the flowering period, results in a partial reduction, or total cessation, of nectar secretion.

An attempt has also been made to determine the possible effects of insect visits on nectar secretion. Preliminary results suggest that frequent withdrawal of nectar from a flower by insects tends to stimulate the secretion of further nectar.

Syrup Feeding

J. Simpson is investigating the composition of the stores of "honey" resulting from the autumn feeding of sugar syrup to colonies of bees. A few analyses undertaken in 1948, and the results so far obtained in the examination of a more extensive series of samples resulting from 1949 feeding, have shown that "honey" produced from autumn fed sugar syrup has a somewhat lower water content, and a very much higher sucrose content than normal floral honey. These results were obtained when both concentrated and dilute syrup was fed and whether feeding took place early or late in the season.

Humidity in the Winter Cluster

J. Simpson has now completed a paper on the humidity of the atmosphere within a winter cluster of honeybees (169), and has found that variations in the atmospheric conditions outside the hive have little effect at normal winter temperatures on humidity within the cluster. He has also continued his previous work on the water balance of the individual honeybee by making use of Dixon's constant pressure modification of the Barcroft respiratory manometer to measure the loss of water by individual bees.

It is felt that the results so far obtained require confirmation by other methods, but they suggest that bees are unable to compensate for variations in atmospheric humidity by control of the evaporation of water from their bodies, and that when a honeybee is in a state of rest very little of the water lost passes through the spiracles.

Nosema and Amoeba Diseases

H. Hassanein has continued his work on the development of these diseases in the adult honeybee and on their influence upon the behaviour of infected individuals.

European Foul Brood Disease

Mrs. Schreiner (Miss E. Kops) has continued her attempts to repeat the observations of Professor R. Burri of the Liebefeld Institute, Berne, on the *Bacillus eurydice, Bacillus alvei, Bacillus pluton* complex. So far no results similar to those reported by Professor Burri have been obtained and in no case so far has *B. pluton* been recognised in a pure culture of *B. eurydice*.

(This work, since Miss Kops' marriage, has been transferred to Cambridge for the time being.)

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