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HISTORY OF THE HUMBLE-BEE
IN NEW ZEALAND:
ITS INTRODUCTION AND RESULTS.

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P R E F A C E.

OWING to the introduction of humble-bees into New Zealand having been undertaken by semi-private institutions and private individuals, no official memoranda of these proceedings were filed in the Government archives, and, as no attempt had been made to keep up a series of records of subsequent results of such introduction, the officers of the Department of Agriculture found it difficult adequately to reply to questions on these matters. To rectify this I was requested, when it became known that I had taken part in an endeavour to introduce these bees, to furnish the Department with all particulars I could on both questions for publication.

Though I had a fair general knowledge of the circumstances connected with each attempt made to import the bees and some of the after-results, it was not sufficiently complete to warrant me, without obtaining some further details, assuming the responsibility of such publication. I therefore set about procuring the required information from the best sources, and the additional facts secured have enabled me to compile what I believe to be complete and reliable data on both subjects. For many of these facts I am indebted to the following gentlemen, to whom I express my thanks: Messrs. M. Murphy, F.L.S. (Christchurch); G. M. Thomson, F.L.S., M.P. (Dunedin); W. W. Smith, F.E.S. (Superintendent of Public Gardens, New Plymouth); W. G. Howes, F.E.S., F.L.S. (Dunedin); S. C. Farr (Christchurch, formerly secretary of the Canterbury Acclimatization Society); O. B. Pemberton (secretary of the Canterbury Agricultural and Pastoral Association); A. Macpherson (Fields Instructor, South Island); and the several seed and grain merchants who kindly gave the information asked for. I have also made free use of articles bearing on the questions contributed by Messrs. Thomson and Farr to the *New Zealand Journal of Science* and the *New Zealand Country Journal* (both out of print).

Owing to the fact that different names have been given by different entomologists to the same species of humble-bee, I found it somewhat

difficult at first to decide which to adopt. Eventually I concluded to conform to those given by F. W. L. Sladen, F.E.S., in his interesting and valuable work, "The Humble-bee, and How to Domesticate It," published recently by Macmillan and Co. (Limited), London.

ISAAC HOPKINS.

Auckland, March, 1914.

NOTE.—By the courtesy of the publishers—Messrs. Macmillan and Co. (Limited)—I have been permitted to reproduce for the purpose of this paper specimens of the humble-bees shown in the coloured plates of Mr. Sladen's work mentioned in the preface. The descriptions of the different species are also from the same source.—I. H.

HISTORY OF THE HUMBLE-BEE IN NEW ZEALAND.

L. HOPKINS.

OBJECT OF INTRODUCING HUMBLE-BEES.

IT is well known that the object of introducing humble-bees into New Zealand was to bring about the fertilization and seeding of red clover.* As, however, the statement has been made publicly on several occasions that seeds were to be found in red-clover blossoms prior to the advent of humble-bees, and it being in a measure quite correct (for which I can vouch), I will relate what in this connection came directly under my own observation.

HIVE-BEES AND RED CLOVER.

I am quite safe in saying that in New Zealand previous to the introduction of humble-bees there were no insects save hive-bees that could be regarded as likely to contribute to the profitable production of clover-seed, yet except on rare occasions, which I will explain, red-clover blossoms have no attraction for them. This want of attraction is not due to any dearth of nectar in the blossoms, as can readily be tested by pulling out the florets (as I have often done) and sucking the base of them. In fact, they contain much more nectar than blossoms of white clover, upon which hive-bees work so freely. The nectar is secreted at the base of the tubes of the florets, and to reach it the proboscis or tongue of an insect must be at least from 9 to 10 millimeters long, whereas the tongue of the hive-bee is only 6 mm. in length.

In my early days of beekeeping it was a moot point whether Italian bees, which were credited with the possession of longer tongues than ordinary bees, worked on red clover or not. At this time I had a unique opportunity of testing the matter thoroughly, an opportunity that would rarely occur; therefore I feel myself on safe ground when dealing with Italian bees and red clover.

* Where "red clover" (*Trifolium pratense*) is mentioned in this paper it must be understood to include "cow-grass" (*Trifolium pratense perenne*), and where the word "clover" alone is used it refers to both.

OBSERVATIONS.

For five years (1882-87) I was located on the late Mr. J. C. Firth's estate at Matamata, where I started large bee-farms. My bees, which were chiefly Italians, were near to thousands of acres of red clover, and, as Mr. Firth was as deeply interested in the question of the seeding of his clover as I was in my bees gathering nectar from it, we both kept a close watch on the bees. Now and again we saw a few here and there gathering pollen from the blossoms, and sometimes a good deal of pollen from red clover was brought in, when, no doubt, it was scarce elsewhere, as this latter was nearly always in blossom (second-crop flowers) after that of the white clover was over for the season.

In order to make a thorough test I shifted on one occasion a number of strong two-story colonies to the centre of a 700-acre paddock of red clover. The first crop had been cut for hay, and the second-crop flowers were just opening. There was no ordinary bee-forage anywhere near. After about the fourth day I examined the hives, and found from the odour that came from them on removing the covers that some nectar had been gathered from the surrounding clover. I also observed that some clover-pollen had been stored. Subsequently, when we examined the blossoms for seed, we found a head here and there carrying a good many, and others with very few, but the great majority with none.

There were two seasons out of the five when my bees worked more freely on the red clover than in others. In those seasons it was noticeable that myriads of small slate-coloured moths flitted about the clover, while they were rarely seen at other times. I was much interested, and in casting about for the reason I became satisfied after very many tests that the clover was secreting at times much more nectar than usual, and it may have been that it reached a higher level in the tubes on these occasions, and so came within reach of the tongues of the bees. Be that as it may, some red-clover nectar was gathered from second-crop flowers in those seasons, and more seeds could be found, but certainly not anything like enough to warrant an attempt being made to harvest them. Mr. Firth would have been pleased to have done so as an experiment had the prospective results been more promising, as he was then importing red-clover seed by 400-gallon-tankfuls.

Herman Müller, in his work "The Fertilization of Flowers" (page 186), remarks that the hive-bee "usually visits the red clover for its honey, which its proboscis is not able to reach in a legitimate manner, yet I have now and then seen hundreds of honey-bees on a patch of red clover all busy collecting pollen." I believe, as I have already remarked, that the hive-bee simply collects pollen from red clover when it is scarce elsewhere, which accounts for its being seen on

the plants only occasionally. In any case, its visits would bring about cross-fertilization and subsequent seeding.

It has been suggested by more than one correspondent that a strong wind blowing across a paddock of red clover when in full blossom, causing the chafing of the heads together, will bring about the transference of pollen from one flower to another and more or less seeding in consequence. Though this may occur, it is rather difficult to understand how it can happen, at least to any appreciable extent. The pollen-bearing anthers are under a hood-like covering, at the upper part of the flower-tube called the "carina," and, as Müller points out, the pollen is accessible only when the carina is pressed down. Therefore it is not likely that much pollen would escape from the tube when blossoms strike one another; it would be more likely to fall to the base.

THE FIRST ATTEMPT TO INTRODUCE HUMBLE-BEES.

It is to the Canterbury Acclimatization Society that credit is due for making the first attempt to introduce them, and the subsequent stocking of New Zealand with humble-bees. In 1870 Mr. Fereday, a member of the society, suggested importing them, and in June, 1872, it was decided to do so. The late Dr. Frank Buckland was communicated with. He endeavoured to make up a consignment to be sent out from England in 1873, but owing to a difficulty in getting the bees in time the attempt was abandoned. On the 13th January, 1876, Mr. S. C. Farr received from the late Hon. John Hall, who had just arrived at Lyttelton in the ship "Orari," a note stating that he had brought a consignment of humble-bees from Dr. Buckland. Mr. Farr went for them at once, but on opening the package he discovered that they were all dead. No further steps to introduce the bees were taken by the society until about eight years after, but in the meantime attempts were made by private individuals.

THE FIRST HUMBLE-BEES LIBERATED IN NEW ZEALAND.

Until a few years ago I was under the impression that I had liberated the first humble-bees in this country, but was corrected by a resident in Timaru, who stated he liberated in 1883 some which came to the order of a lady, I think (I have not the details now, so am writing from memory). Mine were liberated in February, 1884.

With regard to my part in the matter, I commenced to take an interest in humble-bees in 1880, and, after giving the subject due consideration, I decided to make an attempt to import some as soon as my business arrangements allowed me sufficient leisure to attend to it. My subsequent engagement to go to Matamata put the question off for the time being, but on informing Mr. Firth of my intention

shortly after reaching Matamata he fell in with the scheme at once, with the result that an order for 100 queens was sent in September, 1882, to Messrs. Neighbour and Sons, London. After stating the object of importing the bees I left the selection of them to the firm, not knowing anything about them myself; but I gave instructions how they were to be packed, and to be brought out in the ship's cool room, at a temperature of about 40° F.

They came, but did not reach me till the following May, and, as might be expected, all were dead. Another order was despatched, with instructions to ship the bees to reach Auckland not later than January, but earlier if possible. They reached me in February, 1884; but out of the 145 bees that came only two were alive. As they seemed rather weak, I nursed them till next day, fed them on diluted honey, and liberated them next morning in strong condition. I never saw any indication afterwards of their having established themselves. Other consignments arrived by post, and in the steamships "Ionic" and "Doric," in January and February, 1885. A total of nearly five hundred bees came in the several consignments, but all were dead except the two mentioned. From the difference in their size, markings, and colours we concluded at the time that queens of three or four species had been sent, but what they were we had no knowledge.

FURTHER IMPORTATIONS.

The second consignment of bees to the order of the Canterbury Acclimatization Society arrived in the s.s. "Doric" at Lyttelton on the 17th February, 1884, and the third, of 200 bees, was landed from the s.s. "Ruapehu" in April of the same year. Both lots were dead.

Success at last rewarded the society for its persistent efforts, for in January and February of 1885 the fourth and fifth consignments arrived, the former by the s.s. "Tongariro," consisting of 282 bees, out of which forty-five were alive, and the latter of 260, by the s.s. "Aorangi," when forty-eight of them landed safely. The forty-five were liberated at once on Mr. Dean's estate, Riccarton, in the presence of Messrs. H. R. Webb, M. Murphy, S. C. Farr, and the curator of the society, and the forty-eight on Mr. C. Clark's property near the foot of the Port Hills. Both lots of bees were strong and healthy when liberated, and doubtless the majority, if not all, of them succeeded in establishing themselves.

Their progeny spread over the country during the first few years with remarkable rapidity. Whole nests and queens were sent from Canterbury to various parts of the North Island, where they also became established and flourished; so that it is correct to say the whole of New Zealand was stocked by the progeny of the survivors of the above two consignments.

SPREADING ABROAD.

Just twelve months after the first bees were liberated—that is, in January, 1886—some were seen at Mount Peel, a distance of between eighty and ninety miles in a straight line from the place of liberation, and also at Castlehill, sixty-four miles in another direction. Early in 1887 they were reported from Kaikoura in the north and Timaru in the south—about a hundred miles in opposite directions. In the autumn of the same year they were established in the Oamaru district; and at the end of the year they had made their way up the Waitaki basin, through Lindis Pass, and were seen on the Hawea flats. In February, 1888, they were reported from Dunedin and Waihola; and in November, 1889, they were seen at the head of Lake Wakatipu, and in the neighbourhood of Invercargill early in 1890. Thus in five years the humble-bees had practically spread over the whole of the eastern half of the South Island.

With regard to their spreading in the North Island, from the fact that queens and nests, as I have said, were sent to different parts at different times, it was impossible to note their progress accurately, and so far as I am aware no attempt was made to do so.

CANTERBURY AGRICULTURAL AND PASTORAL ASSOCIATION'S IMPORTATIONS.

For reasons given in another part of this paper the above association decided to attempt the introduction of different species of humble-bees to those already in the country. Before taking action, however, the association wisely sought the advice of the late Lord Avebury (formerly Sir John Lubbock) as to the most suitable species to obtain. In reply, under date of the 8th July, 1905, he said, "I think you would find any of the following useful: *Bombus lapidarius*, *B. sylvarum*, *B. agrorum*, *B. lucorum*, and *B. raiellus* (or *derhamellus*)." He suggested Mr. Sladen, then of Ripple Court, Dover, as a suitable agent for securing and forwarding the bees, and this gentleman was subsequently engaged by the association, with very good results.

Mr. O. B. Pemberton, the secretary of the association, writing me in January, 1913, said,—

"We got out in all three shipments, arriving as follows:—

Arrival.	Number sent.	Live Queens.
(1.) 24th February, 1906	15	10
(2.) 29th November, 1906	165	71
(3.) 27th December, 1906	145	62

"The queens we got out were *B. lapidarius* and *B. hortorum*. These were all liberated by me in different localities. I have not heard of any of the *B. lapidarius* being seen, so I presume they did not live."

SPECIES OF HUMBLE-BEES NOW IN NEW ZEALAND.

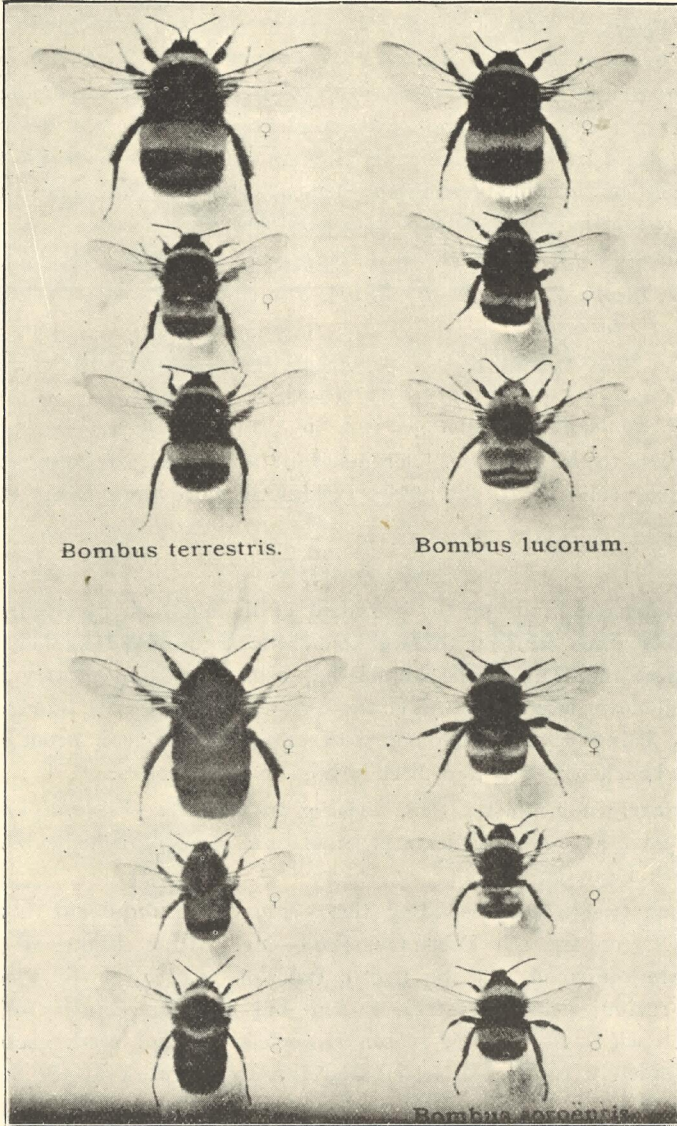
In my endeavour to obtain the correct names of the different kinds of humble-bees in New Zealand at the present time, I found considerable difficulty in distinguishing between those given me as species and others as varieties of certain species. This difficulty to a layman arises from the fact that in several instances different names have been given by different naturalists to the same species. Take, for instance, *B. terrestris* (so named by Linnæus), one of the most common of humble-bees: its synonym is *virginalis* (so named by Kirby)—I am following Sladen. *Virginalis* has been given me as a "variety" of *B. terrestris*, and this may be correct according to some naturalists. Mr. Sladen is a Fellow of the Entomological Society of London, and has given special study to the humble-bees of Great Britain. His work has just been published, and he is an acknowledged authority on these bees, therefore I shall be quite safe in following him and adopting the same nomenclature.

Evidently there was no one among those who took a leading part in the introduction of humble-bees in the first instance sufficiently well acquainted with the different species, or of their comparative value for the purpose required, to understand which would be the best to obtain. Doubt was expressed within a short time after the bees became established as to the particular species we had and whether they were the best. To clear up this point a number of specimens representing those imported were sent in the early part of 1895, by the Canterbury Acclimatization Society, to Miss E. A. Ormerod (formerly Entomologist to the Royal Agricultural Society, England) for identification. This lady, writing in reply to Mr. A. Carrick, the president, under date of the 4th March, 1895, said,—

"You mention that it is believed that the bees imported into New Zealand in 1885 were of two kinds—*Bombus lapidarius* and *B. terrestris*—and that now it is suggested that the kind with you is *B. subterraneus*. Of those you sent I find some are *B. terrestris* and some are *B. subterraneus*; but I do not find any specimens of *B. lapidarius*."

In another part of her letter Miss Ormerod said, "I may quite safely say that you have both *B. terrestris* and *B. subterraneus* present."

In reply to the question whether she thought the best species of humble-bee for fertilizing red clover had been imported, and suggesting sending for others, Miss Ormerod said, "If where locally grown seed was unknown as an article of commerce before the humble-bee was acclimatized you are now having some hundreds of tons of dressed locally grown seed being annually bought and sold in your market, I do not consider that you could do better than continue as you are doing. It appears the kinds of humble-bees you have imported are



Bombus terrestris.

Bombus lucorum.

Bombus lapidarius.

Bombus soroënsis.

healthy and prolific in their new country, and are doing their work well, and I certainly would not advise making any alterations."

Mr. Pemberton, writing in August last, said, "*Re* species imported [by the Canterbury Agricultural and Pastoral Association]: (1) *B. lapidarius*; (2) *B. hortorum*; (3) *B. hortorum* (variety *harrisellus*); (4) *B. hortorum* (variety *subterraneus*); (5) *B. derhamellus*. The majority of the bees which arrived alive were species 1, 2, and 3."

As the result of a large number of inquiries, and some comparisons of bees caught by myself made with specimens shown in the beautifully coloured plates in Mr. Sladen's work, I am satisfied we have the following species of humble-bees established at the present time in New Zealand (adopting Mr. Sladen's nomenclature):—

- (1.) *Bombus terrestris* (Linn.). Synonym, *virginalis* (Kirby).
- (2.) *B. lucorum* (probably). This bee is closely related and very like *B. terrestris*.
- (3.) *B. ruderatus* (Fab.). Synonyms, *subterraneus* (Linn.), according to Smith; *harrisellus* (Kirby).
- (4.) *B. hortorum* (Linn.).

With regard to *B. lucorum*, mentioned in above list, it being so very like its near relative *B. terrestris*, I think it more than likely that we have it.

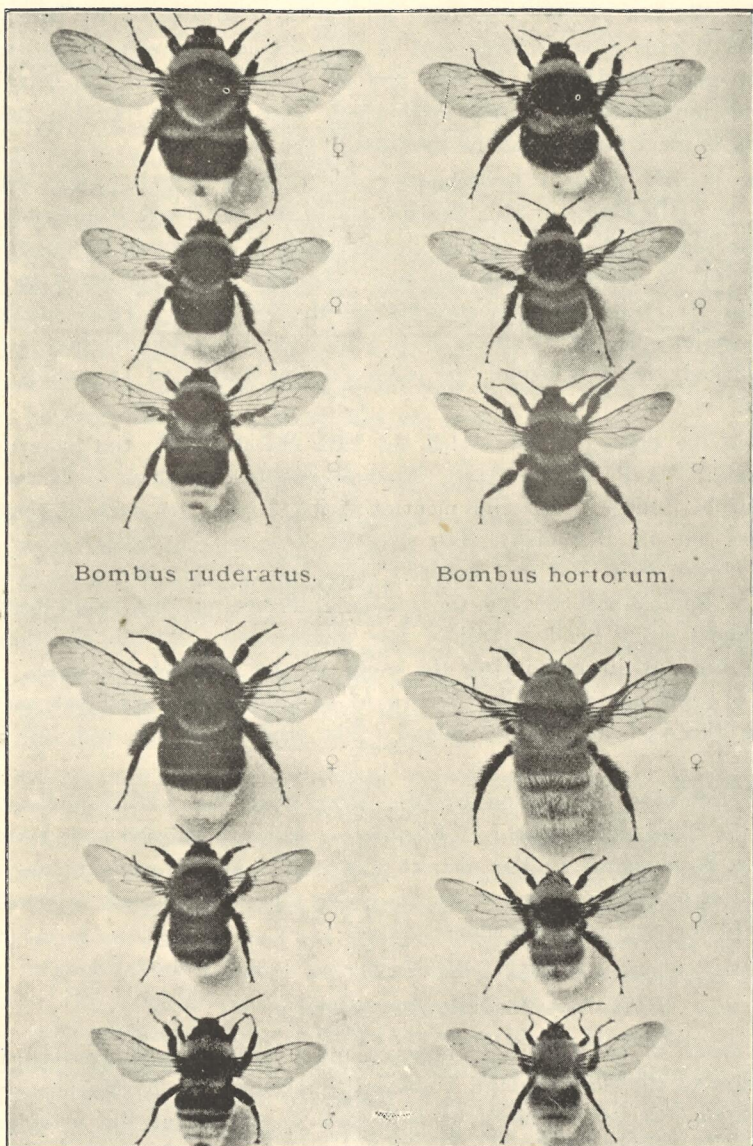
GOOD RESULTS.

The statement made by the president of the Canterbury Acclimatization Society when writing to Miss Ormerod, as disclosed by her reply, to the effect that before the humble-bee came into the country locally grown red-clover seed was unknown, and that afterwards hundreds of tons were being saved and dealt with annually, is clear proof of the enormous benefit the bees had already been to the farmers.

Mr. Farr, in August, 1889, writing to the *New Zealand Country Journal*, gave a few particulars of individual cases of benefits received, from which I quote:—

"About twelve months after their [humble-bees] advent into the colony—*i.e.*, on the 4th February, 1886—Mr. Walter Blake, of Avonhead Farm, affirmed that he had a field of red clover in which he had in previous years been able to find but a small quantity of seed, a few in each head, in this season a perfect mass of seed, each head being completely full." He attributed this to the work of the humble-bees.

"In April, 1888, a splendid sample of cow-grass was shown at Mr. Stead's office [Christchurch], well seeded and of rich growth, from the farm of Mr. T. Teape, Spreydon [near Christchurch]. It was one of the first samples shown of cow-grass seeding in Canterbury. The



Bombus ruderatus.

Bombus hortorum.

Bombus latreillellus.

Bombus distinguendus.

seed was rich, plump, and healthy, such as no farmer would hesitate making use of—thanks to the humble-bees.”—*Lyttelton Times*.

“In the *Press* (Christchurch), dated 19th July, 1888, it was reported, ‘We saw on Saturday last, on the farm of Mr. G. H. Martin, Eyreton, 3 tons of red-clover seed of this season’s growth, which was in very good condition. It may now be considered as quite certain that the humble-bee is fairly established, and that the bee has been working to good purpose in the interests of the farmers.’”

The *Weekly Press* (Christchurch), for the 1st March, 1889, contained the following: “Mr. Herbert Gardiner, of Irwell [Canterbury] has this season 21 acres of red clover which is estimated to produce from 3 cwt. to 4 cwt. of seed per acre. Another crop considered to be equal to Mr. Gardiner’s is growing at Meadowbank. These magnificent results must be attributable to our friends the humble-bees, who must already have benefited the colony to the extent of thousands of pounds.”

From the same journal, dated the 15th March, 1889, the following is quoted: “A Profitable Crop: We were shown a paddock of 26 acres [at Lincoln College, Canterbury] from which 2 tons per acre of clover hay was cut in December. The paddock has now a luxuriant crop of red clover, even and well headed. This field was the resort of thousands of humble-bees during the season of flowering, the result being that almost every head is full of fine plump seed. We do not think we are far out in estimating the yield of the paddock at 4 cwt. or 5 cwt. of seed per acre, or a return of something like £10 per acre, valuing the seed at 6d. per pound. The seed is plump and full of vitality.”

The following was taken by Mr. Farr from the *Lyttelton Times*, dated the 22nd July, 1889: “Ellesmere: A large quantity of clover-seed has been grown in the district this year. At the present time it is the most payable crop a farmer can grow; one man cleared, at Irwell, over £13 an acre with his clover crop.”

MORE RECENT RESULTS.

In order to secure exact information as regards seed-growing in late years in the South Island I obtained, through Mr. A. Macpherson, answers to a series of questions addressed to several of the principal seed and grain merchants in the Provinces of Canterbury and Marlborough. As they were practically unanimous on every point it is only necessary to give the substance of their replies, as follows:—

I. Successful clover-seed growing is due in the first place to the work of humble-bees.

2. Climatic conditions control the situation. Given a bright season, with an average temperature and rainfall, there will be plenty of bees at work and an abundance of seed produced. On the other hand, in a cold wet season there will be few bees and little seed.

3. In favourable seasons there has always been plenty of seed harvested since the humble-bees were established.

4. All but one agree that it is advisable to import more bees, but they give no specific reason why. I take it that it is because they would like to see more bees about.

In an interesting article on "The Growing of Clover-seed" in the *New Zealand Farmer* for June, 1913, it is stated that in Marlborough Province alone, "last season, 6,610 acres were sown down in red clover for seed, estimated to yield an average of 158 lb. to the acre"—a total of nearly 446 tons 5 cwt. Messrs. McCullum Bros., on their farm at Waterlea, have had yields as high as 720 lb. per acre; they estimated a yield this year of 40 or 50 tons of seed. The seed is bolder and brighter than the average English seed.

SEED-GROWING IN THE SOUTH ISLAND.

Formerly Canterbury was noted for its abundant crops of red-clover seed, but owing to the seasons having been very changeable during the last ten years there has, during that time, been great variation in the quantities harvested from time to time. One correspondent writes, "Nine or ten years ago the clover-seed crops were especially heavy; again three years ago we had very heavy crops in Canterbury; during the last two years our crops have been practically nil." Another Canterbury firm writes in the same strain.

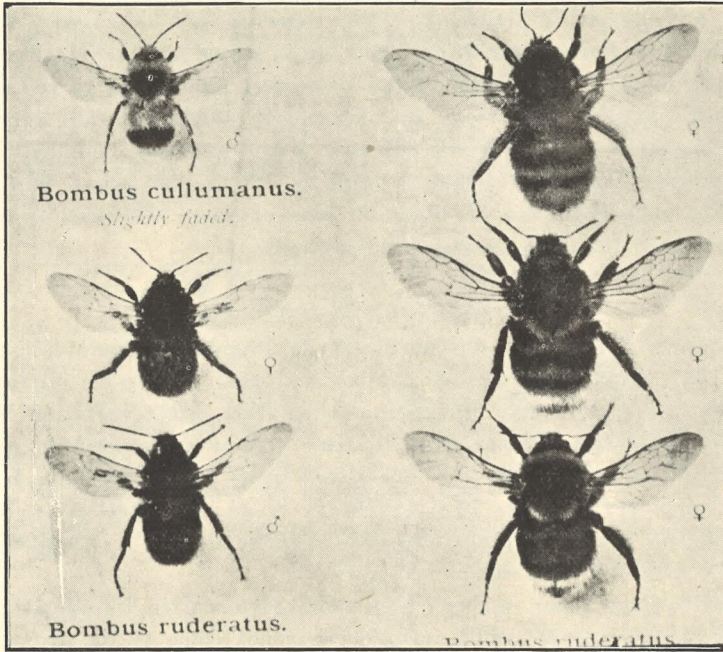
Marlborough seems to have been more favoured in its climatic conditions of late years, and has in consequence come to the front as a seed-growing province, while the quality of its seed is very highly spoken of by Canterbury merchants. A Marlborough firm informs me that "for the past ten years the shutting-up of clover-paddocks for the purpose of cutting for seed has shown a gradual increase year by year, and a good many farmers have laid down areas in cow-grass" [for seed]. For several years past considerable quantities of seed have been exported from Marlborough to all parts of the Dominion.

It will be seen from the foregoing that the growing and harvesting of red-clover seed, though not heard of so much during late years, has proved a profitable industry in parts of the South Island since the humble-bee became established up to the present time.

NORTH ISLAND.

Mr. Arthur Yates, head of the firm of Arthur Yates and Co., grain and seed merchants, Auckland, informed me that in comparison with

the South Island there is very little red-clover seed harvested in the North Island. The reason of this is not, he said, that the humble-bees are of no value in this respect, as he gave instances of farmers not far from Auckland, and in the Bay of Plenty, who had grown considerable quantities; but he thought it was chiefly due to the large extent of dairying going on that there was not more attention given to seed-growing in the North.



(Black specimens.)

Bombus ruderatus.
(Queens of three varieties.)

CLIMATIC CONDITIONS.

As the result of my inquiries I am convinced that the prosperity of the humble-bee over any given area depends much upon the rainfall, the temperature being suitable. Within certain limits it will prosper, but beyond them it will suffer and become scarce. Just what those limits are I cannot say, though probably we may get some enlightenment from the figures of the mean annual rainfall of the eastern half of the South Island, where the bees have done so well. The greater part of Marlborough, Canterbury, and Otago Provinces, according to the official "Mean Annual Rainfall Map of New Zealand," registers under

30 in., while portions of Otago, Southland, a small part of Canterbury and Nelson registers under 40 in. The greater part of the North Island registers under 70 in., and but a very small portion under 40 in. It may then be that the parts of the South Island mentioned are better adapted for growing red-clover seed than any other portions of the Dominion.

ENEMIES OF HUMBLE-BEES IN NEW ZEALAND.

As I have already stated, the bees spread over the eastern half of the South Island with remarkable rapidity after their introduction. This gave rise to some uneasiness, as it was thought by many that they were likely to become so numerous as to eventually prove a pest. After some years, however, of what appeared to be exceptional prosperity there came a check, when the bees dwindled in numbers very rapidly. They became very scarce in districts where they had been plentiful. There seemed to be no plausible reason for the decline: some suggested disease, others that enemies had developed; but so far as I am aware no satisfactory explanation has ever been forthcoming. I am inclined to think that the falling-off was due to a series of unfavourable seasons closely following each other; unusually heavy rainfalls will cause great destruction by flooding their nests. As the bees again became more plentiful, the suggestions of disease or the development of enemies as the cause of their temporary decline do not appear to hold good (see Appendix).

I have not been able to learn from my many correspondents that there are at the present time any enemies of humble-bees in this country likely to do serious damage to them. Two or three have mentioned birds and robber-flies killing a few; one mentioned flies as having been seen catching them; but none of my correspondents believe they do any damage worth mentioning.

ENEMIES IN EUROPE.

It will be well to mention some of the humble-bee enemies to be found in other countries, so that those interested may be on the alert to discover if any of them are present or likely to develop in this country. The following list is compiled from Mr. Sladen's work. He says, "Only a very few of the numerous queens that set out in the spring with so much promise succeed in establishing colonies. Their failure is due not so much to unfavourable weather as to the attacks of enemies." These are very numerous indeed, and were it not that so many queens are bred it seems likely that humble-bees would soon become extinct.

Ants and mice are the earliest in the season to attack the nest and devour the brood, after which comes the "usurper-bee," of the genus *Psithyrus*, which "may enter the nest, kill the queen, and make slaves of her children." I shall refer to this bee again. Later on there is the risk of an attack from the grub or caterpillar of the humble-bee wax-moth (*Aphomia sociella*), which consumes the brood. "As soon as any of these foes have found and entered the nest there is no escape for the inhabitants from destruction." Mr. Sladen says he has "found them [caterpillars] in the nests of *B. terrestris*, *B. hortorum*, and other underground dwellers, but I have never seen them in nests of *B. lapidarius*."

The larva of a two-winged fly (*Brachycoma devia*) much resembling the common house-fly also devours the brood of humble-bees. Then there are earwigs, slugs, worms, some of the Hemiptera (field-bugs), Coleoptera (beetles), and others of the Diptera (flies), with their larvæ, which infest and do more or less damage in the nests, so that the poor humble-bee runs an almost infinite number of risks in its struggle for existence.

PSITHYRUS, THE "USURPER-BEE."

This enemy of the humble-bee is worthy of special notice, as, according to Sladen, it is the deadliest of all "to which several of the commonest species of humble-bees are liable to fall a prey," and they "so closely resemble the true humble-bees themselves that only a student can tell the difference between them." They are often referred to as "cuckoo-bees," which seems a very appropriate name, considering their habits. It is remarkable that "each species of *Psithyrus* breeds only in the nests of its own particular species of *Bombus*," and that the former produce no workers (neuters). There is really no need for these latter, as their hosts do practically all the work for them.

I have one of Mr. Sladen's coloured plates before me showing thirteen specimens of six different species of *Psithyrus*, all photographed in natural colours, life size, and it would indeed be difficult even for a close observer to distinguish the difference between them and the true *Bombi* without such assistance.

The "usurper" queens hibernate, and, as the nests of their future hosts must be in an advanced stage, with brood coming on and workers busy, before they are suitable for the former to occupy, the *Psithyrus* queens do not emerge from their winter sleep until long after the humble-bee queens have started work in spring. Mr. Sladen says, "Investigation showed that it is the practice of the *Psithyrus* female to enter the nest of the *Bombus*, to sting the queen to death, and then to get the poor workers to rear her young instead of their own brothers

and sisters. The way in which the *Psithyrus* queen proceeds in order to ensure the success of her atrocious work has all the appearance of a cunning plan cleverly conceived and carried out by one who not only is a mistress of the crime of murder, but also knows how to commit it at the most advantageous time for herself and future children, compelling the poor orphans she creates to become her willing slaves."



CAUTION.

The question will no doubt occur to many who read the foregoing, "Have we already imported these usurper bees?" It is not at all likely Mr. Sladen, who had all to do with sending the consignments of humble-bees for the Canterbury Agricultural and Pastoral Association in 1906, would have made the mistake of overlooking the former. The first successful consignments that came the late Mr. Baldwin, whom

I knew by repute as a prominent British beekeeper, had most to do with, but whether he also had expert knowledge of humble-bees I never heard. If he had not he might readily have made a mistake and sent a few *Psithyrus* queens. Let us hope not.

Should any more bees be sent for in the future, it will be of the highest importance to engage only thorough experts in humble-bees to collect and ship them, sending particular instructions to them to beware of *Psithyrus*.

PARASITES.

Beside the external parasites already mentioned, there is an internal thread-worm, *Sphaerularia bombi*. It is not stated whether it does much harm, so I presume it does not.

In the report of the "Isle of Wight disease" among hive-bees (May, 1912), issued by the British Board of Agriculture and Fisheries, p. 131, Drs. Graham-Smith and Fantham found a parasite resembling *Nosema apis*, which is believed to be the cause of the above disease, in a number of dead humble-bees.

Mites, which I suppose are similar to those mentioned by Mr. Sladen, have been seen in large numbers on the bodies of humble-bees in New Zealand. Mr. Thomson has seen them. I have examined many bees, but have not yet detected any. They are said to be harmless.

COMPLAINTS.

It was anticipated by a number of those engaged in beekeeping, when the first attempts to introduce humble-bees were made, that an immense amount of injury would be done to their industry if the bees were successfully established. When it became known that I was taking a hand in it quite a number of letters were sent me protesting against my action: the humble-bees, the writers said, would get most of the honey, the beekeeping industry would be ruined, and so forth. As my living at the time depended solely upon my success as a honey-producer, it may be taken for granted that I had given the subject serious consideration, and what influenced me most in the confident assurance I had that no harm would result to our industry was that not a word had been said in any of the text-books on bee-culture, or in any of the current bee literature, against humble-bees. As the whole of this literature had been written and published in countries where such bees were in abundance, I was quite satisfied that as no mention was made of them they were not considered harmful.

As an indication of the prejudice of some beekeepers at the time, one wrote to Mr. Farr just twelve months after he liberated the first bees, when there could only have been very few about. He condemned

the bees and those who imported them, "for," said he, "they had already proved to be a great nuisance, depriving the hive-bee of its honey—so much so that stocks [colonies of bees] had to be fed for winter," &c. Most probably the cause of shortness of stores was due either to a poor season or unskilful management. No complaints having been made since there has been ample time to test the question thoroughly, it may be taken for granted that beekeepers are satisfied that they have nothing to fear from the work of humble-bees.

THE PERFORATION OF FLOWER-TUBES.

Had those who interested themselves in the importation of the first humble-bees been acquainted with the habits of the various species, it is more than probable that they would have avoided *Bombus terrestris* and its near relative *B. lucorum*, the tongues of which are too short to reach the nectar in red-clover blossoms in a legitimate manner. It is quite certain we have the former, and very likely the latter, in New Zealand. As I have already stated, the nectar lies at a depth of 9 mm. to 10 mm. in the tubes, while the tongue of the *B. terrestris* worker is only 7 mm. and that of the queen 9 mm. in length. The above two species and *B. pratorum* are credited in Europe with biting holes through the base of the tubes of clover and other flowers to secure the nectar they cannot reach from above.

I have not been able to obtain any decisive information as to whether the clover-tubes are punctured by *B. terrestris* in this country or not, but Mr. Farr, writing in the *New Zealand Country Journal* in March, 1891, said he "had most carefully watched the bees, and examined hundreds of heads of clover in a day, but not in a single instance have we found the tubes bitten." At all events, contrary to what many think, it matters little whether clover, bean, or any other flower tubes are punctured: it does not prevent fertilization and the production of seeds, providing the blossoms are visited in a legitimate manner by some other insect. So that, having *B. ruderatus* and *B. hortorum* in the country, with longer tongues, which seek the nectar from above and so carry the pollen on their bodies from one blossom to another, we get seeds all the same even if the tubes are bitten.

SHOULD MORE HUMBLE-BEES BE IMPORTED?

I understand the Department of Agriculture has been requested to import more bees, but I am not aware of the reasons for the request. I was asked if I could advise on the matter. With the view of obtaining the opinion of my correspondents I asked most of them if they thought it advisable to do so, and with the exception of two, who do

not think it necessary, they were all in favour of making further importations, though they gave no specific reasons for their opinion. Now that I have a fairly good grip of the whole question I feel more competent to express an opinion than I did, and I believe that it is advisable to import more bees of useful species different to those we already have.

My reason for this suggestion is that it would be greatly to the country's advantage if species adapted to different climatic conditions were established. For instance, successful clover-seed growing at the present time is confined to a very small portion of the Dominion. The migration of great numbers of humble-bees from the Canterbury Province, where they used to be so plentiful and where the bulk of the seed was grown, to Marlborough, one can only surmise has been caused by climatic conditions: the bees we have find the climate of Marlborough more suitable, apparently.

In the following short list of different species, selected from the descriptions given of them in Mr. Sladen's work, I believe will be found those most suitable to import. Müller, from whose work I have obtained the lengths of their tongues, shows that they all work on red clover in a legitimate manner.

- (1.) *B. lapidarius* (Linn.); commonly known as the "red-tailed bee" Length of proboscis—Worker, 10 mm.; queen, 14 mm. This is a prolific species, largely distributed, and I believe would be most suitable.
- (2.) *B. derhamellus* (Kirby); syn. *raiellus* (Kirby); "red-shanked bee." Proboscis—Worker, 10 mm.; queen, 13 mm. Widely distributed in Great Britain and Ireland.
- (3.) *B. agrorum* (Fab.); syn. *Muscorum* (Linn.) according to Smith; "common carder-bee." Proboscis—Worker, 10 mm.; queen, 15 mm. Very common throughout the United Kingdom.
- (4.) *B. sylvarum* (Linn.); "shrill carder-bee." Proboscis—Worker, 10–12 mm.; queen, 14 mm. Widely distributed in England and Ireland.
- (5.) *B. muscorum* (Linn.); syn. *venustus* (Smith): includes *B. heliferanus*; *cognatus* (Stevens); *smithianus* (White); "large carder-bee." Proboscis—Worker and queen, 10 mm. to 14 mm. Not an abundant species, but noticed by Sladen to be commonest in damp, cold seasons.

W. G. Howes, who travels a good deal, states that humble-bees are getting very scarce in the southern districts, so that it is possible some of the above species would be better adapted for those parts of the Dominion.

The suggestion made by Mr. O. B. Pemberton is worthy of the Department's consideration—viz., that if the Department import more bees, arrangements should be made for one or more shipments to be sent each year until complete success is achieved. As he reasonably states, "It is very disheartening to get out a consignment and after liberating the bees unsuitable weather sets in and destroys them; by importing the most suitable kinds for a few years there would be a reasonable chance of all the species establishing themselves."

LIFE-HISTORY OF HUMBLE-BEES.

It having been proved that the result of introducing humble-bees into this country has been of immense value to farmers, it naturally follows that it is to the latter's interest to protect these bees as much as possible from injury and destruction. Before, however, we can devise efficient means to protect animals that are of use to us we must know something of their life-history, habits, natural enemies, and accidents they are liable to. There are very few people in New Zealand, I think, who have more than a vague knowledge of these subjects as connected with humble-bees; it is therefore with the view of creating more general interest in these useful insects, and so contributing, I hope, in some small degree to their protection, that I now give the result of my investigation.

THE QUEEN.

Though the size of the colonies and mode of nesting varies somewhat in different species of the true *Bombus*, the life-history of all are much the same. The following refers particularly to the underground-nesting species, the same as we have in New Zealand.

The queen, like the queen of the hive-bees, is the mother of the colony, but she is more than this—she is the founder of the colony. The queen of the hive-bees is born into a colony of worker-bees and drones (males) already established; she is cared for and fed by the workers, and in the usual course commences to lay eggs when from eight to ten days old, and thenceforward is little more than a laying-machine, doing nothing else. The humble-bee queen, on the other hand, after waking up from her long winter's sleep is alone, without workers, and without a nest for the future colony. The nest she has emerged from after her winter hibernation was only a temporary one, usually on or near the surface, chosen the previous autumn to winter in.

The big, burly, good-natured bees to be seen in our gardens in spring are queens gathering their food while probably working hard excavating their nesting-places. Should a queen come across an old nesting-place or other suitable excavation she will take charge, and

after refurbishing it build a small nest of short dry grass or other suitable material. The tunnel for ingress and egress to and from the nest may be any length from a few inches to 2 ft. or 3 ft., but usually about 2 ft. The nest having been started, the queen collects some pollen, which she moulds into a small ball and places in the centre of the nest. On this she builds the first cell, in which she lays her first eggs, usually about a dozen in one cell. Later on more cells are built and more eggs laid. The queen now sits closely on the cells so that the warmth from her body may mature the brood. In a little over three weeks the workers emerge, and when only three or four days old commence to take their share of the work in enlarging the nest and gathering food. The honey, of which there is never very much, is stored in waxen honey-pots. There is no need to store large quantities, as the colony comes to an end at the end of the season, so that in a manner of speaking the bees live day by day almost from hand to mouth. Towards the latter part of the season, after the young queens begin to emerge, more honey is often stored. Mr. Sladen says, "In a favourable season a populous colony may have all the vacated cocoons, amounting to over four hundred, filled with thick honey and sealed over with wax."

SIZE OF COLONIES.

The number of worker-bees in colonies of *lapidarius*, *terrestris*, and its nearest relation, *lucorum*, often reach three hundred, and this number is largely added to when the males and young queens are reckoned. Mr. Sladen says, "The total number of males and queens reared varies from one hundred to five hundred, according to the staff of workers;" and that "on an average it may be estimated that nearly twice as many males as queens are produced."

First of all workers are bred; later on in the season the males; and after them the young queens, for duty in the following season. Before the end of the season the young queens are impregnated, and soon after leave the parent nest to seek each a temporary nest in which to take their winter sleep. By this time the colony has dwindled down—"the combs grow mouldy, and the old queen dies." The description of her last days by Mr. Sladen is very interesting. He says, "The aged queen often spends the evening of her life very pleasantly with her little band of worn-out workers. They sit together on two or three cells on the top of the ruined edifice, and make no attempt to rear any more brood. The exhaustive work of bearing done, the queen's body shrinks to its original size, and she becomes quite alive and youthful-looking again. This well-earned rest lasts for about a week, and death, when at last it comes, brings no discomfort. One night, a little

cooler than usual, finding the food-supply exhausted, the queen grows torpid, as she has done many a time before in the early part of her career; but on this occasion, her life-work finished, there is no awakening."

HIBERNATION.

The period of hibernation of humble-bee queens varies in the different species: some nest earlier than others, and wake up out of their torpor earlier in the spring. According to Sladen, hibernation lasts about nine months—that, of course, is in England. Nothing approaching definiteness, so far as I have been able to ascertain, is known concerning this question in relation to the bees in New Zealand. Owing to the fact of their having been seen about very late in the season, and again seen a little over two months after, as far south as Dunedin, it has been suggested that they may not hibernate at all in the warmer parts of the Dominion. Mr. G. M. Thomson, Dunedin, in the *New Zealand Journal of Science*, January, 1891, mentions that he saw them nearly daily visiting flowers through the summer and autumn up to the 5th June, when cold weather with frosts set in, and the bees disappeared until the 13th August, when they were seen again. He also mentions that "Mr. James Gilmore, of Goodwood, about thirty miles north of Dunedin, stated that he saw them right through the winter, except in rainy weather." In a letter recently received Mr. Thomson tells me "we had very heavy snowfalls on the 1st and 3rd September (1894), and two days after I saw a humble-bee working in my garden." Mr. Thomson contributed to the above journal a very interesting series of notes on the various plants visited by humble-bees in the South, but of late years he has been unable to keep up his investigations.

During last year I saw humble-bee queens flying at Ruakura Farm of Instrukon on the 22nd June, and again in the vicinity of Auckland on the 4th September.

It is quite likely that during a mild winter the warmth of the ground will arouse the bees, especially if their winter nests happen to be where the sun will have an effect. Even in England the young queens choose a bank with a northern aspect, so as not to be aroused too soon in the spring. Though they are disturbed before their time they become torpid again when the temperature falls. It will be interesting, however, to keep notes on this subject through a series of seasons and in different parts of the Dominion. It will be an easy matter to jot down the dates, from, say, March onward to the following October or November on each occasion when the bees are seen.

DISEASE-GERMS.

I have mentioned under the heading of "Parasites" that Drs. Graham-Smith, M.D., and Fantham, D.Sc., B.A., F.Z.S., who are now

investigating on behalf of the British Government the disastrous "Isle of Wight disease" among hive-bees, found an internal parasite resembling *Nosema apis* in a number of dead humble-bees. This parasite, so far as the investigation had gone up to the time of their report being published, gave indications of being intimately connected with, if not the actual cause of, the above disease. I would therefore suggest that, before any further steps are taken to import more humble-bees, the opinion of these gentlemen be obtained as to whether there would be any risk of the bees conveying the disease-germs or not. [I have since written Dr. Graham-Smith, and am awaiting his reply.]

CONCLUSION.

To the student of entomology the facts set down in this paper will doubtless prove interesting, and possibly of some value, as the opportunity for studying and recording the behaviour of humble-bees when transported to an entirely new country where climatic and other conditions largely differ from those obtaining in their native land will rarely if ever occur again. It is also of some importance to learn that so far not a trace of any change of habit (except perhaps in the period of hibernation) has been noticed in the bees from those natural to them in their original home.

Though the work of collecting data has been very considerable and taken up much time, it has been interesting to gather and place on record facts that might not have been available later on. I have endeavoured to avoid mistakes, and in the foregoing I believe the Department of Agriculture will have a correct history of the humble-bees now in New Zealand.

APPENDIX.

NOTES BY MR. W. W. SMITH, F.E.S.

MR. SMITH, who has paid particular attention to the progress of humble-bees and their work in New Zealand since their introduction, very kindly looked through my paper with a view to suggesting any needed corrections or additions. He subsequently sent me the following notes:—

“(1.) In a closely aggregated head of floret-tubes like that of red clover there are certain to be some occasionally shorter than normal in which hive-bees could reach the nectar and in doing so fertilize the flower. Your remarks that hive-bees do occasionally effect fertilization is scientifically correct.

“(2.) Your remarks *re* ‘myriads of small slate-coloured moths’ working on the flowers are interesting; several species of moths may sometimes be seen visiting clover-flowers. A common diurnal moth doing so is *Melanchra composita*. I have placed several of these moths in a large glass vase with flowers of red clover and watched them carefully probing the tubes for nectar. There never was any doubt with me but that this species of moth was the chief fertilizer of the clover prior to the coming of the humble-bee.

“(3.) You refer to humble-bees diminishing in numbers a few years after their introduction into New Zealand. The winters of 1894 and 1895 were exceptionally severe in Canterbury, which was the chief cause of their reduction in numbers for several years afterwards.

“(4.) I have several times seen the mites infesting the under-parts of humble-bees. They are generally more noticeable early in the season.

“(5.) As no harm has resulted from previous introductions of humble-bees, I cannot see that any injury would follow further introductions of these valuable economic insects. It would be of imperative importance that none of their ‘cuckoos’ accompany them. The selection you enumerate is the best you could possibly have made.

“(6.) Queens of the three forms naturalized in the North Island may be seen on the wing almost every day of warm sunshine in the public park at New Plymouth throughout the winter months.

“(7.) I may remark that your paper is a very full and accurate up-to-date history of these very interesting and valuable insects in New Zealand, and I would add that the Department of Agriculture has done excellent service to posterity by collecting while yet available authentic records respecting the introduction, distribution, habits, and notable services rendered by humble-bees in this country.”

ABBREVIATED DESCRIPTION OF ILLUSTRATIONS.

*Bombi.**Bombus terrestris.*

Queen large; black, with a large band of deep yellow across the front of the thorax, and another on the second segment of the abdomen,

with tail tawny; dark specimens have the yellow band on the thorax narrow and dusky or absent, and often the yellow band on the abdomen brownish.

Worker resembles queen, but the tail is tawny-white, always; however, shading into tawny at its base.

Male black, with a yellow band across the front of the thorax, a yellow band on the second segment of the abdomen, and the tail tawny-white; larger than worker, but smaller than queen.

B. lucorum.

Queen slightly smaller than *terrestris*; resembles *terrestris*, but the yellow bands are of a lemon tint and the tail is white.

Worker differs from queen in size only; distinguishable from *terrestris* worker by the pure-white tail.

Male: Colouring similar to that of *terrestris*, with the yellow paler and more widespread, and with the tail pure-white instead of tawny-white; dark specimens are coloured almost like *terrestris*; slightly larger than worker, but smaller than queen.

B. lapidarius.

Queen large; black, with the last three segments of the abdomen bright-red; hairs of corbicula entirely black; occasionally there is a narrow greyish-yellow band on the front of the thorax, or a trace of it.

Worker differs from the queen in size only, the latter being twice the size of worker, as shown.

Male: Head black, with face sulphur-yellow; thorax black, with a sulphur-yellow band in front and a narrower one behind; abdomen black, with the four last segments bright red.

B. ruderatus.—Closely allied to *B. hortorum*; known also as *B. subterraneus* and *B. harrisellus*.

Queen large; larger than *hortorum*. The lightest examples are coloured very like *hortorum*—namely, with two yellow bands on the thorax, the base of the abdomen yellow, and the tail white; but the yellow bands are of a slightly deeper and duller tint than in *hortorum*, and the yellow band at back of the thorax is approximately of same width in the middle as the yellow band on the front of the thorax. There are darker specimens, and some entirely black—the *Apis harrisella* of Kirby.

Worker banded, and entirely black specimens occur; the banded variety is coloured like the lightest variety of the queen.

Male banded, and black specimens occur, as in the worker.

B. hortorum.—Closely related to *B. ruderatus*.

Queen: Head black; thorax black, with a bright-yellow band in front and a slightly narrower one behind; abdomen black, with the first segment yellow, the yellow extending on to the extreme base of the second segment, the fourth and fifth segments white, the white generally extending on to the edge of the third segment, and the sixth segment black. In dark specimens the yellow bands are somewhat narrowed, and darkened by an admixture of black hairs.

Worker differs from the queen in size only.

Male: Head black, more or less yellow on top. In other respects the markings are somewhat similar to those of the queen and worker.

B. latreillellus.—Also termed *B. subterraneus* (Linn.).

Queen large. Head black; thorax black, with a yellow band in front and a very narrow one behind, the yellow, as in *runderatus*, rather deep (except in young specimens), and soon becoming dull and brownish with exposure; abdomen black, with fourth and fifth segments white, and with a fringe of yellowish or dingy white on the edge of the third segment, a narrower and fainter one on the edge of the second segment. In light specimens, which are not common, the first segment is yellow.

Worker resembles the queen, but the yellow band on the back of the thorax is sometimes absent, and in small specimens there is generally no trace of yellow on the first segment.

Male rather large; abdomen rather elongate. Pale yellow, with a greenish or brownish tinge, with the exception of the following black markings: The head black, except on top and middle of face; a black band across the thorax between wings; a black band across second segment of abdomen, and another, generally narrower, across the third segment. These bands are separated by a narrow one of greenish-white.

Psithyrus.

Psithyrus rupestris.—Parasitic on *B. lapidarius*.

Queen: Black, with fourth and following segments of abdomen red, but less bright than *lapidarius*; wings dark-brown.

Male: Head black. Thorax black, with indistinct yellowish-grey bands in front and behind; fourth and following segments red.

Plentiful in East Kent, where it victimises from 20 to 40 per cent. of *B. lapidarius* colonies.

Psithyrus vestalis.—Parasitic on *B. terrestris*.

Queen large. Head and thorax black, with a deep yellow (often brownish-yellow) band in front; abdomen black, with third segment lemon-yellow on sides except at base; fourth segment white, and fifth segment white on sides.

Male: Head black, often with yellow hairs on top. Thorax black, with yellow band in front. Abdomen black; sometimes first segment yellow, not prominent; third segment yellow; fourth and fifth white.

Psithyrus distinctus.—Believed to be parasitic on *B. lucorum*.

Both *Queen* and *Male* resemble *Ps. vestalis*, to which they are closely related.

Psithyrus barbutellus.—Parasitic on *B. hortorum*.

Queen: Head black, with dull yellow hairs on top; thorax black, with dull yellow band in front, and a narrow one behind; abdomen black, sometimes dull yellow on first segment, with fourth and fifth segments white.

Male: Colouration similar to *Ps. distinctus*, except that there is no definite tinge of yellow on the sides of the third segment.