Last year we got packages about the first of May and we did not lose a single one, but this year we lost twenty-nine out of ninety. We attribute that to the fact that when it was cold the bees would not take care of them.

CHAIRMAN PADDOCK: The next paper on the program is "Some Apicultural Investigations" by Wallace Parks of Ames, Iowa.

SOME APICULTURAL INVESTIGATIONS

By WALLACE PARKS, *Ames, Iowa*

(Withdrawn for publication elsewhere)

MR. E. C. COTTON: I would like to ask Mr. Parks if he knows if those bees that made a few trips had larger loads than those that made many trips.

MR. PARKS: I am inclined to believe that in most cases the bees making very few trips were old bees.

CHAIRMAN PADDOCK: The next paper is by Mr. L. V. France.

THE PROBLEM OF CONTROLLED FERTILIZATION OF QUEEN BEES¹

By L. V. FRANCE, *University Farm, St. Paul, Minn.*

This problem is without doubt the most important one which has to be solved before the pursuit of beekeeping, or industry, if it can be called such, may advance farther than its present stage. We know fairly well how to manage the honey bee, in her present more or less hybrid and variable condition, for surplus honey production. We are also able, after a fashion, to control the bee diseases and keep the winter loss down to about ten per cent. (10%). In an apiary of one hundred colonies of the purest breeding possible at present, we find a few colonies that surpass all of the others in honey production, gentleness, comb building and wax production qualities, resistance to certain diseases, hardiness, length of life, etc. For the *one single reason* that we are not able to control the mating of our queen bees we cannot keep and combine these desirable characteristics when they once appear in one or more colonies.

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An illustration of this occurred about 1906. E. R. Root discovered one of his colonies of bees working on red clover when all other colonies were doing nothing. Investigation showed that the tongue length of the bees of this colony was twenty-three one-hundredths (23-100) to twenty four one hundredths (24-100) of an inch while the tongues of ordinary bees are sixteen one-hundredths (16-100) of an inch to seventeen one-hundredths (17-100) of an inch in length. This particular sport colony degenerated back to the normal stock, although an attempt was made to save the long-tongue character. (E. R. Root, *Jour. of Heredity*, Vol 7, No. 1, Jan. 1916. Page 46).

The solution of this problem requires a knowledge of bee behavior and of the morphology and physiological reactions of the generative organs. The data of real value which are now available are meagre and it is apparent that a successful solution of this problem necessitates a very large amount of further study and investigation.

When we are able to definitely control queen bee matings, there will then be available for genetic or heredity studies an animal offering probably greater opportunities for results than has the fruit fly, *Drosophila*. This one possibility alone would be worth more to the people of the United States than all the honey produced in this country.

About 1800, F. Huber, in France showed that the queen bee is mated in the open air, on the wing, and that this fertilization may last for several years.

In 1745 Bonnet described parthenogenesis in plant lice. About 1845 Dzierzon in "Eichstädt Bienenzeitung" stated his theory that drone bees develop from unfertilized eggs.

The movable frame hive invented about 1851, Italian bees introduced from 1861 on, the honey extractor about 1860, comb foundation about 1857, a practical bellows smoker about 1865, and great crops of honey secured from bees created such an interest that the *American Bee Journal* began its publication in 1865 during the Civil War.

It was soon apparent that it was difficult to keep pure the Italian bees or any of the other races being introduced, Carniolan, Caucassian, and Cyprian especially, because of the almost universal presence of common black or German bees within a mile or so of any conveniently located queen breeding apiary. The desire also developed to produce breeding stock of the different races of bees, emphasizing gentleness, honey gathering qualities and color markings.

From 1870 to perhaps 1900 the dream of beekeepers as noted especially in the *American Bee Journal* was to control the mating of the queen so that races and strains could be kept pure and desired qualities obtained and propagated.

An investigation of the literature has given to us a list of about thirty references of attempts to control queen bee matings. These attempts are of two general types, *first*, enclosure of some sort to permit a more or less natural meeting place for a queen and a drone, including various small glass covered boxes on hives, tents and greenhouses, one of the latter being the largest glass building in America; *second*, the more or less forcible mating of the queen by bringing a queen and drone together and then forcing out the drone's organs by pressure on the abdomen, or by forcible injection of drone sperms or sperm fluid into the vagina of a virgin queen.

Considerable interest was directed towards Minnesota in 1914 when Jager and Howard secured one successful mating out of six trials by this last mentioned method, injection of sperms into the vagina of the virgin queen. In 1915 and 1916 however, Prof. Howard and myself secured only three partial successes out of fifty-five attempts and we concluded first that to continue further by that method would necessitate more study of the morphology and functioning of the sexual organs and second, that a different method would be more likely to yield immediate results. I tried a certain kind of a tent in a greenhouse at University Farm in 1918 and failed to mate the virgin queen used but secured some valuable data.

The latest and one of the most valuable contributions to the solution of this mating problem appeared in the Journal of Experimental Zoology for August 1920 in the form of two very excellent papers by G. H. Bishop of the Entomology Division, Wisconsin University, on the morphology and probable physiological functioning of the generative organs of the drone and queen.

It is our opinion that bee culture may have reached its probable development under the present conditions. Our so-called pure Italians seem at best to be something of a mixture. Controlled mating of queen bees will permit actual "pure" races and strains to be produced. When we have them, then with the proper breeding procedure it will be possible to create a honey bee that is uniformly gentle, hardy, long life period, great honey gatherers, resistance to disease, etc. on to our "ideal" bee for Minnesota and the Northwest.

I feel very confident that someone in the near future will devise some method whereby matings may be controlled. We expect the solution of that problem will give bee culture as great a step forward from its present stage as the invention of the movable frame hive did in 1851.

Finally we feel at times that if it were permissible and we could "get away with it" as so many seem to be doing just now, we would rob a bank, build a large, high domed green-house similar to the one in Como

Park, St. Paul, to permit a twelve months experimental period, and probably we might be able to make a contribution.

REFERENCES WITH BRIEF DATA

- ? H. L. JEFFREY. Confined in several hives of bees were some virgin queens and drones of selected stock. These hives had above the combs a space three to four inches high free and clear, to give the bees room in which to gather when being moved, it being the intention to take them some distance from other bees and there liberate them, trusting that the matings of the queens would be with the selected drones. The hives were moved by wheelbarrows, and on inspection at the end of the journey he found that all six queens had mated. Subsequent similar attempts failed. Mr. Jeffrey is credited with being a close observer. R. I. Agri. Exp. Sta. Report 1908—p. 306.
- ? W. E. FLOWER. Cage of mosquito netting about 15 x 15 feet. One successful mating. R. I. Agric. Exp. Sta., Report 1908—p. 307.
- 1873 J. HASBROUCK. Small glass covered box on hive. Many queens fertilized, also many failures. *Am. Bee Jour.* Vol. 14—1873.
- 1875 J. HASBROUCK. Small glass covered box on hive—three matings. *Am. Bee Jour.* Vol. 15—p. 519.
- 1875 DAVIS. Small glass covered box on hive—one mating. *Am. Bee Jour.* Vol. 15.
- 1875 BAGLEY. Small glass covered box on hive—one mating. *Am. Bee Jour.* Vol. 15.
- 1878 J. HASBROUCK. Small glass covered box on hive—several matings. *Am. Bee Jour.* Nov. 1878.
- 1881 CRAMER. Small glass covered box on hive—two matings. *Am. Bee Jour.* Vol. 17, p. 19.
- 1881 FINCASTLE. Small glass covered box on hive—five matings. *Am. Bee Jour.* Vol. 17.
- 1882 SHUCK. Queen tied to thread so she could fly only above the home apiary—one mating. *Am. Bee Jour.* 1882, p. 789.
- 1884 BROWN. Small glass covered box on hive—one mating. *Gleanings in Bee Cult.* 1884. p. 674.
- 1885 COOK. In hive. Queen had imperfect wings—one mating. *Gleanings in Bee Cult.* Vol. X, p. 544.
- 1887 McLAIN. Large tent—one mating of 6, later 3 of 6. *Am. Bee Jour.* Vol. 23, 1887.
- 1888 McLAIN. Large tent—six matings. *Am. Bee Jour.* Vol. 24, p. 487.
- 1887 McLAIN. Squeezing drops of sperm fluid from drone organ into vulva of queen—twenty-five matings. *Am. Bee Jour.* Vol. 23.
- 1887 McLAIN. Squeezing contents of seminal vesicles into vulva of queen—three matings. *Am. Bee Jour.* Vol. 23.
- 1887 McLAIN. Diluting sperm fluid with introduction into vulva—six matings. out of twenty-seven. *Am. Bee Jour.* Vol. 23.
- 1885-6 McLAIN. Various methods as above. Reports U. S. D. A. 1885 and 1886.
- 1887 McLAIN. Various methods as above. Reports U. S. Com. Agr. 1887.
- 1887 HOHENSHELL. Greenhouse—two matings. *Am. Bee Jour.* Vol. 23, 1887.
- 1887 BALCH. Squeezing drops of sperm fluid from drone organ into vulva of queen. Had practiced this on defective winged queens for fifteen years. *Am. Bee Jour.* Vol. 23, 1887.

- 1901 J. S. DAVITTE of Aragon, Ga., used a tent of mosquito netting, 30 feet high and 30 feet in diameter. Colonies of bees containing selected drones and queens of mating age were placed at the bottoms of such enclosure with the outside entrance covered with queen excluding perforated zinc and an inside entrance opened from 11:00 a. m. to 1:30 p. m. on favorable days. *Daville reported 100 successful matings*. This general plan has been tried by others but without success. One man used wire cloth instead of mosquito netting and the queens, drones and workers killed themselves on the screen. Davitte's cage was wrecked by a wind storm and not rebuilt. *Beekeeper's Review*, Feb. 1901 and R. I. Agri. Exp. Sta. report, 1908, p. 307.
- 1903 E. F. PHILLIPS. Glass covered vivarium, Univ. Penn. Nuclei containing drones and queens had outside entrances protected with perforated zinc and unprotected inside entrances. Drones were used that had never flown out-doors. Observations were taken from the rafters. The queens would soon strike the glass roof and alight and the drones would at once disperse, there apparently being no attraction in a queen at rest. No matings. *Beekeeping*. E. F. Phillips, 1915, p. 69-70.
- 1907-8 A. C. MILLER and L. J. COLE. A cloth tent nine feet square, nine feet high, double walled, the cloth walls one inch apart permitted bees to fly in apparently a normal manner. Several trials with no matings. The queens struck the top a great deal in flying. The drones did not strike the top but flew freely. It may be the drones failed to recognize the queen because of the presence of many flying workers or if recognized mating failed to occur because of unfavorable conditions, such as confinement and limitation of vertical space permitting reaction of the queen to the drone. R. I. Agr. Exp. Sta. Report, 1908. p. 306-311
- 1915 WILMON NEWELL. Controlled matings at isolated bee-free stations on the Texas Gulf Coast Prairie. Natural matings in the air. Successful crossing of Italians and Carniolans. *Science*, n.s. 41; No. 1049, 218-219.
- 1915 JAGAR and HOWARD. Diluting sperm fluid and using pipette to introduce the fluid into the vagina—one mating of six. *Science*, n.s. Vol. 40, No. 1037, p. 720.
- 1915-16 HOWARD and FRANCE. Diluting sperm fluid and contents of seminal vesicles of mature drones and introduction with pipette into vagina. Three partial successes of fifty-five. *Jour. Ec. Ent.* Vol. 11, No. 2, p. 265-267.
- 1915-1916. C. E. BARTHOLEMEW. Personal statements to C. W. Howard and L. V. France that he had at Ames, Iowa successfully mated several queens by forcing the contents of the drones sexual organs into the vagina of receptive virgin queens. This item unpublished so far as is known.
- 1917 GEO. D. SHAFER. (a) Virgin queen and drone were each fastened at end of a fine elastic wire holder. With wings buzzing queen and drone were brought face to face in the air. No matings from several trials.
(b) Forcing out drone sexual organs into vagina of queen. No matings from several trials. *Tech. Bull.* 34, Mich. Agr. Exp. Station.
- 1917 E. R. ROOT. "So far the only feasible plan for mating queens with select drones is to put perforated zinc over the entrances of all colonies not having choice drones, leaving only select drones to have the freedom of the air. A still better plan is to take the queen mating nuclei to an island where there is a colony containing select drones. This island should be located at least five miles from the mainland." 1917 Edition, A. B. C. of Bee Culture, A. I. Root Co., Medina, Ohio.

- 1917 H. H. & E. R. ROOT. Garden truck greenhouse. Largest glass building in America 600 feet long, 60 feet wide, and 30 feet high. No matings from 24 queens.
- 1917 H. H. & E. R. ROOT. "As a final word we give it as our opinion that while this experiment is not absolutely conclusive yet we feel that if mating under cover is ever accomplished the percentage of mating may be so low that the success will be interesting more from a scientific than from a practical viewpoint. In other words, while the queens and drones may fly naturally in a great enclosure like the greenhouse in which this experiment was tried, yet conditions nevertheless are not normal, as they are out of doors, and any possible successful matings will doubtless be limited. Yet having said this we are not quite prepared to add that this cannot be done. We may try the experiment again—indeed we are likely to try it again." *Gleanings in Bee Culture*, Vol. 45, No. 1, to 7; January-July, 1917.
- 1918 L. V. FRANCE. Round canvass tent, double walls, 4 feet in diameter, 7 feet high at peak with about 8 inches space between the canvas walls. A nucleus, containing workers, drones and a five day old virgin queen was placed in the tent and observations taken. No natural, mating flights occurred. The Virgin appeared to fly naturally in the tent, returning unaided to the hive, when removed from the nucleus and thrown into the air. The drones appeared to fly naturally, more so at first than after several days confinement in the tent. The queen failed to mate. Temperature ranged from 64 degrees F. to 92 degrees F. *Science* n. s. Vol. 49. No. 1255, January 17, 1919.
- 1920 GEO. H. BISHOP. Two methods used as in the past.
1. "Queen and drone held in juxtaposition and the extension of the drone's organs brought about by pressure on the abdomen."
 2. "The seminal fluid of the drone was dissected out and injected with a pipette into the organ of the queen." No successful matings. *Jour. Exp. Zool.* 31; No. 2; Aug. 20, 1920, pages 225-266; 267-286.
- 1920 F. W. L. SLADEN. Mating queens successfully with selected drones on Duck Island, Lake Ontario. *Gleanings in Bee Culture*, 48; 80-82, 717-718, 1920.

CHAIRMAN PADDOCK: The next paper is by Dr. J. H. Merrill. Dr. Tanquary will read the paper.

FURTHER NOTES ON THE VALUE OF WINTER PROTECTION FOR BEES¹

By J. H. MERRILL, *Apiarist*

Kansas State Agricultural College and Experiment Station

For the past three years an experiment has been carried on at the Kansas State Agricultural College to determine the best method of wintering bees. The results of the first two years' work were published

¹Contribution No. 61, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 126 of the Agricultural Experiment Station.