More Honey From Bees

by C. L. FARRAR

RECENT RESEARCH on the problems of the management of bees has opened up new opportunities for regulating the development of bee colonies regardless of the weather. Formerly good weather throughout the spring was necessary for the development of a colony—not only so a variety of plants would produce pollen and nectar, but so the bees could gather these foods for use in raising young bees. We now know how to provide the food required for brood rearing, thus making the colony less dependent upon early sources of pollen and nectar. The main honey plants bloom and produce nectar with fair regularity at a time when the weather is more settled. Successful management demands that colonies be developed for the honey flow rather than on the flow.

Probably less than 10 percent of the available nectar supply is gathered by the 5½ million colonies of bees in the United States. Beekeepers have an opportunity and a challenge to contribute more fully in the development of our agricultural resources by supplying the bees needed for pollination and to make honey available to more people. The pollination of fruit and seed crops will be proportional to the increase in honey production, because both depend upon the number of blossoms visited by the bees.

In the United States the average colony yield of 35 to 40 pounds could easily be raised to 75 to 100 pounds. Man has been the honeybees' worst enemy by his failure to provide adequate food reserves for their overwintering or to supply the needed hive space for the developing colony. The more or less indiscriminate use of insecticides has also caused heavy losses. Few branches of agriculture could withstand the losses experienced by the beekeeping industry and survive. The tremendous reproductive powers of the honeybee have made it possible for the beekeeper to replace his losses in bees, but not his loss of the honey crop.

The opportunity for increasing production may be seen by comparing the 57-pound average yield in Wisconsin for the period from 1938 to 1945 with the maximum yields obtained from 2 classes of colonies operated during the same period by the North Central States Bee Culture Laboratory at Madison, Wis. Single-queen colonies built from 2-pound packages and headed by outstanding queens showed a mean maximum yield of 254 pounds, compared with an over-all average of 109 pounds for 1,227 package colonies. Variations in the productivity of lines of stock were largely responsible for this difference between the best colonies and the over-all average yields. Overwintered colonies managed under a two-queen plan showed a mean maximum yield of 434 pounds, compared with an over-all average of 265 pounds for 261 two-queen colonies.

The available nectar supply in the vicinity of Madison was probably similar to that in Wisconsin as a whole. Furthermore, most beekeepers obtain average yields equal to only one-third those produced by the best colonies in their apiaries. We must conclude that the honey crop is limited more by the condition of the colonies than by the available nectar supply.

The Colony as a Productive Unit

The colony consisting of a queen, 10 thousand to 60 thousand workers, and sometimes several thousand drones should be viewed as a unit organism. The individuals making up the colony are as subject to change as the cells within the animal body. Their ability to function apart from the colony is extremely limited. The object of management is to maintain the colony in a maximum state of productivity, even though this means that both the queen and workers will wear out more quickly.

The honey production for any given number of bees increases as the population of the colony increases. For example: While 4 colonies each with 15,000 bees are producing 100 pounds of honey, 1 colony with 60,000 bees will produce more than 150 pounds of honey. A larger proportion of the total population engages in brood rearing in the small colony than in the full-strength colony. The greater gain made by the large colony is due to the larger proportion of field bees available to gather nectar.

The colony population is limited by the queen's capacity to lay eggs, the time of development from egg to the adult, and the duration of life of the bees. A colony's development may be further limited by insufficient food (both pollen and honey), by insufficient space for the rearing of brood, or by disease. Insufficient space or its improper organization may seriously affect the working morale.

The most important recent advance made in colony management came from a study of the pollen requirements. Experiments on wintering bees demonstrated that the survival of overwintering populations was largely proportional to the amount of reserve pollen present in the hive. Surveys of pollen reserves in widely separated geographical areas showed that most colonies did not have enough pollen for the overwintering of highly productive colonies.

Further investigations showed us a way to supplement pollen with soybean flour. No satisfactory complete substitute for pollen has yet been devised, but when 3 pounds of expeller-processed soybean flour is mixed with 1 pound of pollen, approximately 30 thousand bees can be reared, as compared with 4,500 bees from 1 pound of pollen alone. The pollen for supplemental feeding is trapped by forcing the bees to pass through a grid that has 5 openings to the inch. From 1 colony approximately 20 pounds of pollen can be obtained; that is enough to supply the critical needs of 50 colonies when 3 parts of the soybean flour are added.

The supplemented pollen is fed in cake form by mixing 1 part of dry matter (1 part pollen and 3 parts soybean flour) with 2 parts of sugar sirup (2 parts sugar and 1 part water).

Brood rearing, which is the basis for colony development, can be regulated independent of weather conditions by feeding these pollen cakes. Thus, we have a means of timing the development of the colony so that it can reach full strength for any expected honey-flow period.

Because brood rearing increases the consumption of honey by the colony, it is necessary to provide more reserve honey for colonies that are to be developed early through pollen feeding. In most northern locations, a reserve of 90 pounds is desirable to carry the colony from the end of brood rearing in October until the spring honey flow. The problem is not how much a colony consumes but how much it produces over and above consumption. The higher consuming colonies produce the largest surplus.

Supplemental pollen feeding is equally important for the development of new colonies from package bees. Packages installed in April should be provided with all the pollen cakes and reserve honey they will consume to insure uninterrupted brood rearing before the honey flow. In most seasons they will require 25 to 40 pounds of honey and more or less continuous pollen feeding if they are to be built to full productive strength for a June honey flow.

The high-producing colony must be headed by a queen that can lay 1,500 or more eggs a day. The queen's physical development, as well as her genetic constitution, determines her capacity to produce eggs.

The mating habits of bees have made it difficult to improve honeybee stock. Selective breeding has been limited to the queen, because there was no way of choosing the drone or male with which she mates. Progress has been made, however, since production tests have shown some commercial lines of stock to yield two to five times as much honey as other lines. The great variability within both high- and low-producing lines is suggestive of the progress that may be made through careful selection and controlled breeding.

The market demand for queens and the ease with which they can be reared have established standards of quantity rather than quality. Great variation in the physical development of sister queens is evidence that they are subject to environmental influences while they are being reared. The best small queen is never so productive as the best large queen. Before real progress can be expected through selection and controlled breeding, it will be essential to establish standards for rearing that will insure full physical development of the queens.

The Importance of Good Stock

Improvement of stock promises to be an important coming development in beekeeping. A technique for the artificial insemination of queen bees has been available since 1925, but until 1943 very few artificially inseminated queens were capable of laying a sufficient number of fertile eggs to build full-strength colonies. Recent improvements in the technique by Otto Mackensen and William C. Roberts enable us now to mate queens that perform as well as naturally mated queens.

Prolific queens and long-lived workers are essential in a superior strain of bees. Also, large, industrious bees that can carry more nectar may add to the productivity. Some progress has been made through selection and breeding for resistance to American foulbrood. Improvements in resistance to this and other brood or adult diseases may be hoped for. A superior bee must not be nervous or inclined to sting without provocation, or prone to swarm. We have opportunities for breeding a bee for beauty of color or one for fine capping of the combs where fancy section honey is to be produced.

Selection for the desired characteristics among the extremely variable honeybee stock requires intensive inbreeding. Honeybees that have been closely inbred lose vigor rapidly and the viability of the queen's eggs decreases. Preliminary studies on the hybridization of inbred lines are suggestive that a program of breeding not unlike that used in the production of hybrid seed corn may be necessary. Two selected inbred lines may have to be combined to produce a hybrid queen to establish vigor for egg laying. The hybrid queens may be top-crossed with a third male line to produce double-hybrid worker progeny.

In 1945 the highest producing stock used was a double-hybrid line that averaged 266 pounds of surplus honey, but the bees were intolerably vicious. When sister queens of this line were top-crossed with another line of drone stock, the disposition of the workers was equal to the gentler strains of bees.

Bee breeding should gain momentum because of the opportunity for applying genetic principles worked out in other fields. The relatively short life of the breeding stock is a disadvantage, but it may be offset by the rapidity with which successive generations can be obtained.

Two-Queen Colonies

A practical way of increasing colony populations is through the use of two queens. By dividing a strong overwintered colony 5 to 7 weeks before the honey flow and introducing a young queen to the division, it is possible nearly to double the yield of honey. The colony is reunited to a single-queen status about a month before the end of the honey flow.

Between 1935 and 1945, 287 two-queen colonies averaged 270 pounds, with a mean maximum of 434 pounds. The yields obtained over a period of years indicate there is sufficient nectar available in most areas now supporting commercial beekeeping to permit first-class two-queen colonies to produce an average in excess of 400 pounds a year. This would be more than 10 times the national average yield.

Hive Equipment

The standard beehive of today is essentially like the original movable comb Langstroth hive developed in 1851. The size of the hive has been increased by adding more bodies of comb. The increased production obtained through the use of supplemental pollen feeding and improved queens or two queens has emphasized a need for hive equipment adaptable to intensive management. In the Intermountain States, where the work with two-queen colonies was started, satisfactory results were obtained by using 7-story hives. When the project was transferred to the Central States, the character of the honey flow in the more humid atmosphere there made it necessary to increase the hive capacity to 9 and 10 stories. Similar yields were obtained in both areas, but a need for a hive providing greater capacity nearer to the ground became a necessity.

Preliminary experiments, started in 1940 with a shallow type of hive, have demonstrated the opportunity for improving hive equipment. To be practical, any style of hive must use the same size of frame for both brood chambers and supers. A shallow-type square hive taking 12 frames 6¼ inches in depth has shown practical advantages. Besides reducing the height of the hive, it allows greater flexibility of manipulation for proper colony control. The full supers are easier to handle as they weigh 15 to 17 pounds less than the standard-depth supers. These are usually finished 7 to 10 days sooner than the standard-depth supers, so that honey can be extracted and the combs returned for refilling. Most colony manipulations can be made by interchanging the position of hive bodies instead of manipulating frames. The disadvantage of the shallow type of hive is its slightly greater cost because more frames are used. The added cost is offset by better colony control that favors increased production.

THE AUTHOR

C. L. Farrar, an apiculturist in the Bureau of Entomology and Plant Quarantine, is in charge of the North Central States Bee Culture Laboratory, which is maintained in Madison by the Bureau and the University of Wisconsin. He is professor of apiculture in the University of Wisconsin. Dr. Farrar, a graduate of Kansas State College and Massachusetts State College, was associate apiculturist at the Intermountain States Bee Culture Laboratory from 1931 to 1938 and specializes in the behavior, development, and management of the honeybee colony, the causes of queen supersedure, and stock testing for honey production.

FOR FURTHER READING

Farrar, C. L.: *Influence of Pollen Reserves on the Surviving Population of Over-wintered Colonies,* American Bee Journal, volume 76, No. 9, pages 452–454, 1936.

Farrar, C. L.: *The Influence of Colony Populations on Honey Production,* Journal of Agricultural Research, volume 54, No. 12, pages 945–954, 1937.

Farrar, C. L.: *Nosema Disease Contributes to Winter Losses and Queen Supersedure,* Gleanings in Bee Culture, volume 70, No. 11, pages 660–661, 701, 1942.

Farrar, C. L.: *An Interpretation of the Problems of Wintering the Honeybee Colony,* Gleanings in Bee Culture, volume 71, No. 9, pages 513–518, 1943.

Farrar, C. L.: *Nosema Disease,* Gleanings in Bee Culture, volume 72, No. 1, pages 8–9, 35, 1944.

Farrar, C. L.: *Productive Management of Honeybee Colonies in the Northern States,* U. S. D. A. Circular 702, 1944.

Farrar, C. L.: *Two-Queen Colony Management,* Bureau of Entomology and Plant Quarantine Circular E–693. Processed, May 1946.

Roberts, William C.: *The Performance of the Queen Bee,* American Bee Journal, volume 86, No. 5, pages 185–186, 211, 1946.

ALSO, IN THIS BOOK

Artificial Breeding, by Ralph W. Phillips, page 113.
Genetics and Farming, by E. R. Sears, page 245.
News About Bee Diseases, by A. P. Sturtevant, page 674.
A Bonus from Foulbrood, by E. C. Holst, page 686.