DISAPPEARING DISEASE
Part 1 — Effects of Certain Protein Sources Given to Honey-Bee Colonies in Florida

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SUMMARY

A commercial beekeeper's report of "disappearing disease" in his apiaries stimulated an investigation utilizing his colonies. The effects, on population growth and honey storage, of giving 1 comb of pollen, of feeding Fumidil-B, and of feeding soybean flour with yeast and soybean flour alone were observed in an experiment involving 36 colonies of bees. Addition of 1 comb of pollen led to a significant gain in bees and the production of more honey. Fumidil-B had no effect. Feeding of expeller processed soybean flour, from a supply that may have been 3 or 4 years old, especially without yeast, hindered population growth. It seems likely that inadequate amounts of natural pollen along with feeding an inferior pollen substitute were two causes of this beekeeper's losses.

INTRODUCTION

THE NAME "disappearing disease" (DD) probably covers a variety of conditions which have in common a more or less severe decline in colony population with no dead bees apparent. This weakening of colonies may occur in fall, winter, or spring. Until the disappearing phenomenon is better understood, we must keep an open mind with respect to causes, which may vary from case to case. Pathogens, food or lack of it, weather, genetics and management may be involved.

In the winter and spring of 1978, a condition called disappearing disease occurred in the apiaries of a commercial beekeeper in Florida. Colony weakening occurred in the normal build-up period prior to the citrus flow beginning in mid March. About Christmas of 1977, the beekeeper had fed soybean flour as a pollen substitute to stimulate brood rearing. As a result of that stimulation, according to his account, at first the amount of brood and bees increased substantially. In late January and February, however, the honey-bee population decreased drastically, and a substantial number of colonies perished entirely. In most of the colonies still surviving, the worker bees appeared to be young, and no honey crop was harvested.

To investigate this phenomenon more fully, we organized an experiment to be conducted in the beekeeper's apiaries during the winter and spring build-up period of 1979.

MATERIALS AND METHODS

Thirty-six 2-story colonies, in Langstroth-size equipment were prepared in Ohio and moved to Florida in early November. This was the usual practice of the beekeeper who reported losses in Florida from DD. These colonies were owned by him, and were of a genetic stock similar to the colonies he lost the year before. Colony inspections after moving to Florida revealed adequate amounts of honey but inadequate pollen. Pollen stores averaged 0.2 of a comb per colony, but 9 colonies of the 36 had no pollen at all. All colonies had equal access to both pollen and nectar when available in the field. Without any knowledge of colony conditions, the 36 were divided into 3 groups, named, and assigned to treatments as follows:

Honey group (12 colonies).[1]

1. Six given 1 additional comb of pollen each in early January.
2. Six not given additional pollen.

Fumidil-B group (12 colonies).

3. Six given 1 additional comb of pollen each in early January, plus Fumidil-B in sugar syrup.
4. Six not given additional pollen, but given Fumidil-B in sugar syrup.

Pollen substitute[2] group (12 colonies).

5. Six given mixture of soybean flour[3] and brewer's yeast (1:1 by weight) mixed with cane sugar and water in late January.
6. Six given soybean flour[4] mixed with cane sugar and water in late January.

On January 7 or 8, pollen combs, from Ohio, were given as indicated. Fumidil-B was fed with cane sugar syrup as a carrier to the second group. At the same time, the substitute group was supposed to be given the pollen substitute patties. These patties were given first about 2 weeks later, about January 22.

All colonies were carefully inspected over a 2 or 3-day period about November 22, February 16, March 16, and April 17. At each inspection, the amounts of bees, brood, honey, and pollen were estimated in terms of combs covered or filled as appropriate. Buildup of adult bee populations and amount of honey stored are of major interest and only those data are presented here.

The following questions seemed most important:

1. Was any evidence of disappearing disease seen?
2. Did Fumidil-B have any effect on number of combs covered by bees during the experimental period or on combs filled with honey at the end?

3. Did giving one comb of pollen have any effect on these quantities?
4. Did feeding pollen substitute have any effect on these quantities?

RESULTS, ANALYSES, AND DISCUSSION

Figure 1 presents graphically the average of the six colonies in each treatment group with respect to the number of combs densely covered by bees. The average gain in population made by colonies in each treatment, during each period, was calculated and is presented in Table 1. Table 2 presents the average effects of each treatment on honey storage during the last period — the only period when surplus nectar was available.

Answer to Question 1. No colony was lost for any reason, and the only suggestion of disappearing disease was the population decrease in one period in the substitute group (to be discussed later). In the beekeeper's non-experimental apiaries, loss of several colonies occurred that was called DD.

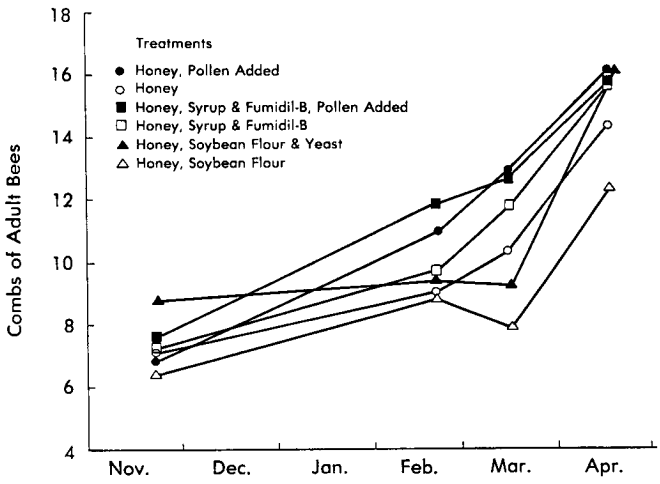

Fig. 1. Average colony size, in combs covered by bees, of 6 groups of 6 colonies given the indicated dietary treatments.

Analyses of variance compared the honey group (Treatments 1 and 2) with the Fumidil-B group (3 and 4), and the pollen-added colonies (1 and 3) with the no-pollen-added colonies (2 and 4), with respect to gain in bee population and gain in combs of honey.

Answer to Question 2. Using the 5 per cent level of probability, there was no significant difference between the Fumidil-B and honey groups in any of the periods, for bees gained. There was also no difference between these groups in combs of honey stored. Since Fumidil-B in syrup did not lead to any observed differences, nosema was apparently not harmfully present.

Answer to Question 3. Colonies that received 1 comb of pollen in early January (1 and 3) gained about twice as many bees in the first test period (Nov. to Feb.) as colonies that received no pollen (2 and 4, Table 1). This was significant at the 5 percent level. There was no significant difference in gains attributable to pollen added in the second and third periods. If pollen had been added periodically, until pollen was abundantly available in the field, increased gains in bees might have occurred during the second and third periods. About 27 per cent more honey was stored by the colonies given pollen than by the colonies not given pollen ($p<0.05$). This amounted to an additional 4.5 combs of honey, about 22 lbs. No significant interaction was detected among the foregoing variables.

Answer to Question 4. The comparison of colonies given pollen substitute (5 and 6) with those not given pollen (2 and 4) is particularly important. A 1-way analysis of variance was performed on these data for each test period. Gains in bees during the November to February period were not different as expected. Differences in population growth were not significant for the March to April period ($p = 0.0985$). By this time pollen was becoming available to all bees from spring flowers. The important result came in the second period (Feb. to Mar.). Colonies given substitute actually lost bees whereas all other colonies

TABLE 1. AVERAGE COLONY POPULATION GAINS ($\bar{x}\pm SE$), IN COMBS COVERED WITH BEES, DURING THE INDICATED PERIODS, IN COLONIES GIVEN THE INDICATED TREATMENTS.

Group	Treatment	N	Period Nov-Feb	Feb-Mar	Mar-Apr
Honey	(1) Honey, Pollen added	6	4.1 ± 0.5	2.0 ± 0.8	3.1 ± 1.8
	(2) Honey, No pollen added	6	1.9 ± 0.3	1.3 ± 0.5	4.0 ± 1.6
Fumidil-B	(3) Honey, Fumidil-B, Pollen added	6	4.1 ± 0.9	0.9 ± 0.6	3.1 ± 0.9
	(4) Honey, Fumidil-B, No Pollen added	6	2.4 ± 0.7	2.0 ± 0.7	3.9 ± 1.2
Substitute	(5) Honey, Soybean flour + yeast	6	0.7 ± 0.8	-0.1 ± 0.4	6.8 ± 0.5
	(6) Honey, Soybean flour	6	2.4 ± 0.4	-0.9 ± 0.7	4.3 ± 0.6

TABLE 2. AVERAGE GAIN PER COLONY ($\bar{x}\pm SE$) IN COMBS OF HONEY FROM MARCH 16 TO APRIL 17 IN EACH GROUP OF 6 COLONIES GIVEN THE INDICATED TREATMENT.

Honey Group		Fumidil-B Group		Substitute Group	
(1) Pollen added	(2) No pollen added	(3) Pollen added	(4) No pollen added	(5) Soybean flour + yeast	(6) Soybean flour
22.3 ± 2.2	15.0 ± 1.8	19.6 ± 1.5	17.9 ± 2.0	17.5 ± 1.3	13.9 ± 1.5

gained. The differences were highly significant ($p<0.01$). The magnitude of the loss can be seen in Fig. 1 and Table 1. The colonies fed soybean flour alone suffered the greater loss. We take these results as evidence that feeding some diets can lead to reduced colony population. The loss in colony population reported by this beekeeper may have been due in part to the feeding of soybean flour, that had deteriorated.

In honey gained, colonies fed substitute were not significantly different from the colonies not given additional pollen. Feeding these substitutes was at best a waste of time.

These results confirm the importance of pollen or an adequate pollen substitute. Williams and Kauffeld (1974) thought lack of pollen was a major factor causing DD.

In this experiment, feeding soybean-flour substitute patties showed negative results. Brood was produced but the amount of bees decreased. The senior author observed that few older worker bees were present in colonies. This indicated that the bees' life span was short, and that they disappeared from the hive at an early age. This fact was confirmed in our testing under controlled conditions at the Bee Laboratory in Columbus (unpublished data). Decreased foraging activity of those colonies fed substitute based on soybean flour was noticed by Standifer et. al. (1970) but they gave no explanation of the observation. Perhaps, bees of foraging age were not present because of their early death.

Our substitute-fed colonies, like those of Herbert and Shimanuki (1979) did not exceed the control colonies in honey production. Our colonies that received 1 comb of pollen did exceed the controls.

That soybean flour, used as a pollen substitute, may be affecting longevity is not surprising. Maurizio (1950) has called attention to this fact. More recently Haydak (1970) stated, "Proper nutrition is one of the most important factors influencing longevity of emerged bees," and cited several references in support of his statement. Knox, Shimanuki, and Herbert (1971) showed that different pollens fed to adult bees in cages led to different longevities.

CONCLUSIONS

Answers to the main questions asked in this investigation are the following:

1. The only evidence of a condition like disappearing disease was a population decrease in the group of colonies fed patties of soybean flour or soybean flour plus yeast. Losses called disappearing disease occurred in the beekeeper's apiaries. Adequate nutrition seems to have been important in avoiding the problem in bees we managed.
2. Fumidil-B had no effect.
3. Colonies given one additional comb of pollen made greater gains in population and produced more honey than those not given additional pollen.
4. The pollen substitutes used hindered population growth.

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FOOTNOTES

[1] Called the Honey Group for convenience only. All groups had honey.

[2] Neither substitute or supplement seems correct as commonly defined. The material we gave the bees contained no pollen, so we have chosen to use the term substitute.

[3] The soybean flour used was the material the beekeeper had on hand, was presumably what he had fed the year before, may have been 3 or 4 years old, and was apparently expeller processed by Archer-Daniels.

[4] An anonymous referee points out that neither the beekeeper nor the authors of this paper used soyflour or soyflour-yeast mixture according to existing recommendations. Furthermore, flour not kept in a moisture-tight container will turn rancid after about one year. "There is benefit to be derived from a reminder to follow recommendations and not use outdated or inferior products."

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