DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
DOMINION EXPERIMENTAL FARMS

BEE DIVISION

PROGRESS REPORT OF THE DOMINION APIARIST

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FOR THE YEARS 1934, 1935 AND 1936

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REPORT OF THE BEE DIVISION

For the Years 1934-1936 Inclusive

INTRODUCTION

This report summarizes briefly the work done by the Bee Division, Central Experimental Farm, Ottawa, during the years 1934-1936 inclusive. The work of the branch farm apiaries will be recorded in the reports of the farms or stations to which these apiaries are attached. References to their work, however, will appear in this report so far as it is related to the work done in the central apiary.

GENERAL

The drought conditions that prevailed in Western Canada during the years 1931 to 1933 continued throughout the period covered by this report; 1936, however, was the driest of them all and a larger area was affected. This extremely long period of dry weather seriously affected the major sources of nectar over the greater part of the Dominion. New seedings were killed off and old stands dried up in many places. In 1932 the total honey crop of Canada was approximately one third less than in 1931, since then, however, there has been a slow but steady increase from 19·4 million pounds in 1932 to 24·2 million pounds in 1935. This increase was mainly due to a larger number of colonies rather than to increased colony production. In 1936 phenomenal colony production in certain areas of the Prairie Provinces raised the total crop of that year to approximately 28·2 million pounds as against the record of 29·7 million pounds in 1931. The extraordinary crops secured in western Manitoba, Saskatchewan and parts of Alberta were gathered mainly from sweet clover and alfalfa which yielded well in spite of hot, dry weather. In other sections of the same provinces, however, these plants were a complete failure so far as nectar secretion was concerned. Ontario was affected the most seriously by dry weather during 1936, the total honey crop of that province being about 2·8 million pounds less than in 1935.

In spite of low crops, honey prices declined on both the export and domestic markets, but during the last few weeks of 1936 there was a slight trend upwards.

A steady increase was noted in the number of package bees imported from the Southern States, the value of the importations rising from $149,161 in 1934 to $175,815 in 1936, the price per unit remaining the same for the three years.

EXPERIMENTAL WORK

Italian versus Caucasian Bees

A comparative test of these two races of bees has now been carried for a period of seven years. Four colonies of each race and housed in permanently packed ten frame Langstroth hives are kept under identical conditions in the same apiary. During the summer months this apiary is visited once every ten days except on special occasions when new supers are required, or a colony needs requeening. In order to keep the races pure, all queens are purchased from a reliable breeder and spare queens are kept in nuclei for emergencies. In the fall all colonies are fed by adding to each a full depth super of well capped clover honey. After feeding, this apiary is seldom seen again until the following spring.

During the seven years only one colony has been lost outright, this was an Italian colony to which mice gained entrance after it had been prepared and fed for the winter. The same year one of the Caucasian colonies was found weak and queenless, therefore, both were replaced with others of average strength.

While some variation existed in the strength of the colonies at the first examination in the spring, the difference between the two groups was not at all great, indicating that both races are quite capable of withstanding the severe winters of the Ottawa district, especially if proper care is given to the preparation of the colonies for the winter.

During the first four years of the experiment the Caucasian bees showed a greater inclination to swarm than did the Italians, but after that little or no difference was discerned. Although preparations for swarming were made by both groups, actual swarming was easily prevented by simple manipulation.

From the standpoint of gentleness the Caucasian bees proved to be the easiest to handle, but owing to their dark colour the queens are more difficult to find on crowded combs than are the bright-coloured Italians. Another objectionable feature of the Caucasians is their excessive use of propolis. The frames of the hives are usually glued solidly together and often the entrances of the hives are reduced to single bee passages by large sheets of propolis.

The beekeeper measures the value of his bees by the amount of surplus honey they produce. Table No. 1 shows the total and average colony production of the colonies in this experiment.

TABLE 1.—COMPARATIVE HONEY CROP OF ITALIAN AND CAUCASIAN BEES

Races of Bees	Number of Colonies	1930		1931		1932		1933	
		Total	Aver.	Total	Aver.	Total	Aver.	Total	Aver.
		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Italians	4	925·00	231·25	1,125·00	282·25	510·00	127·50	836·50	209·13
Caucasians	4	612·50	153·13	911·00	227·75	387·00	96·75	669·75	167·44
Difference		312·50	78·12	214·00	54·50	123·00	30·75	166·75	41·69

Races of Bees	Number of Colonies	1934		1935		1936	
		Total	Aver.	Total	Aver.	Total	Aver.
		lb.	lb.	lb.	lb.	lb.	lb.
Italians	4	1,153·50	288·38	752·50	188·13	801·50	200·38
Caucasians	4	904·00	226·00	591·00	147·75	876·50	219·13
Difference		249·50	62·38	161·50	40·38	75·00	18·75

The above table shows that for six successive years the Italian colonies produced the greatest amount of honey, but in 1936 the Caucasians were slightly in the lead.

A similar test, but including the Carniolan race is being conducted in the branch apiaries at Charlottetown, P.E.I., and Brandon, Man.

Upper versus Lower Supering for the Honey Crop

When a colony is in need of additional supers for the storage of nectar, the common practice is to place these supers between the brood chamber or chambers and the supers that may already be present on the colony. This procedure, however, requires a great deal of time and labour lifting off already filled supers and then replacing them after the new ones are given. In 1932 an experiment with two other methods was started.

Three groups of six colonies each were selected and supered for the flow as follows:—

1. Each additional super was placed immediately above the brood chamber or chambers as is the common practice.
2. Each additional super placed on top of the colony.
3. Each additional super placed immediately below the brood chamber.

Method 3 was abandoned after the second year as being unsatisfactory.

In 1934 eleven colonies were placed in groups 1 and 2, while in 1935 and 1936 the number was increased to 12. Each group consisted of colonies in Modified Dadant hives, ten frame Jumbo and ten frame Langstroth hives. All colonies were of average strength and as nearly equal as possible. All colonies received two examinations during the main honey flow to check swarming and to supply supers as required. Average colony production of all groups is shown in table No. 2.

TABLE NO. 2.—AVERAGE COLONY PRODUCTION

Year	Average Colony Production					
	Group 1		Group 2		Group 3	
	lb.	oz.	lb.	oz.	lb.	oz.
1932	56	5	70	8	38	0
1933	134	13	162	11	103	10
1934	172	6	162	7		
1935	88	8	82	12		
1936	118	13	132	4		
Colony Average for 5 years	158	0	164	12		

The above table shows that although the colony average of group 1 was higher for 1934 and 1935, the average of group 2 was higher for 1932, 1933 and 1936 and also for the entire period of five years. It is true that the surplus produced by group 2 did not exceed that of group 1 by many pounds, but the time and labour saved in supering this group was the important feature. To super the colonies in group 1 required the removal of every super on the colony before a new one could be given and then their replacement above the

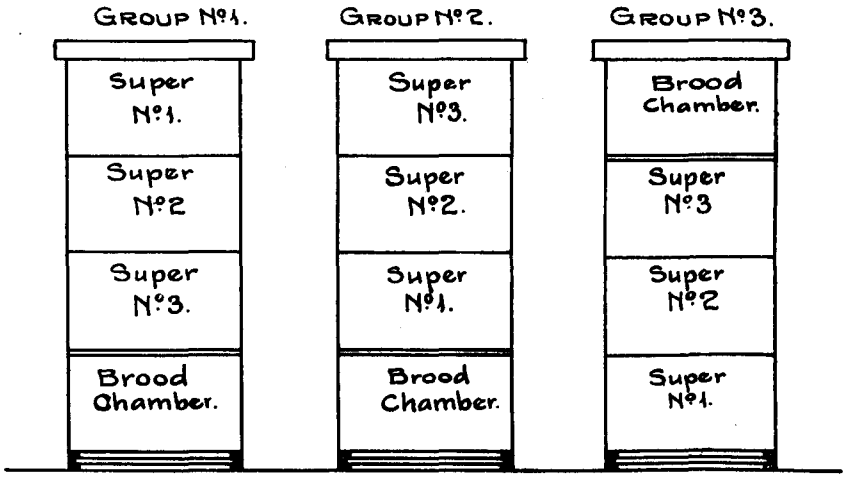


FIG. 1 — Showing three different methods of supering colonies for honey flow.

new one after it was added. In good seasons there may be several supers, weighing approximately 80 pounds each, to move twice whenever an additional super is needed. Supering in group 2, however, required no such labour because each new super was placed on top of the colony without moving a single one of those already present. It will be readily seen that in an apiary of 25 or more colonies the saving of time and labour would be enormous and that this saving is not likely to reduce the crop produced, in fact the time saved will easily permit of more colonies being kept.

During the five-year period only one swarm emerged and that from a colony in group 1 indicating that top supering is not apt to increase the swarming tendency.

Over-wintered versus Package Bees for Orchard Pollination

This experiment was continued through 1934-36 and for the test three 2-pound; three 3-pound and three 5-pound packages of bees were imported from the southern United States during the month of May each year. Six over-wintered colonies of average strength were selected each spring to compare with the packages.

In 1934 the packages arrived on May 1, 21 days before apple blossoms opened. In 1935 and 1936 the packages were received on May 16 and 18 respectively, or five days before the blossoms were opened. Prior to 1935 when the packages arrived several days ahead of the apple bloom, it was found that the bees dwindled badly, thus reducing the strength of the packages considerably by the time the apple blossoms opened. It was thought that if the packages arrived just prior to the bloom there would be more bees available to work the blossoms, hence the reason for importing them later in 1935 and 1936 than previously. Although the dwindling took place during the blooming period in 1935 and 1936 rather than before it, the late arrival apparently had little or no effect on the number of bees sent out to the orchards. The average strength of over-wintered colonies and package bees by weight at the beginning of apple bloom is shown in table No. 3.

TABLE NO. 3.—AVERAGE WEIGHT OF BEES IN OVER-WINTERED COLONIES AND PACKAGES AT COMMENCEMENT OF APPLE BLOOM

Year	Over-wintered Colonies	5-pound Packages	3-pound Packages	2-pound Packages
	lb.	lb.	lb.	lb.
1934	4·12	3·25	2·44	1·31
1935	6·31	5·00	3·00	2·00
1936	5·06	5·00	3·00	2·00

Except for the package bees in 1935 and 1936 the above figures were obtained by actual weighings. In the years 1935 and 1936, however, the packages arrived so near to the blossoming time and were in such excellent condition that the stipulated weight of the bees as shown on the package was taken for granted. It was also thought that the manipulations required for weighing them so soon after being installed in their hives might have a detrimental effect on the work of the bees themselves.

It will be noted that in 1934 when the packages arrived 21 days prior to the bloom, the bees had dwindled considerably by the time the bloom was ready to be worked. The average loss for the 5-pound packages was 35 per cent, for the 3-pound packages 18·75 per cent and for the 2-pound packages 34·37 per cent. In 1935 and 1936 the dwindling was practically the same but it took place during the period of bloom rather than before it.

The table also shows that the over-wintered colonies contained the greatest force of bees at the time apple bloom was beginning to open, although this advantage was small when compared with the 5-pound packages in 1936. The over-wintered colonies, however, had an important advantage not shown in the table, for when the package bees arrived the over-wintered colonies already had a large amount of brood present and young bees were emerging from their cells daily, whereas the package bees could not expect emerging brood for at least 22 days after their arrival. Thus while the force of the latter was decreasing, that of the former was increasing daily.

During the period of fruit bloom, whenever weather permitted of bee flight, specially constructed traps were placed in front of certain colonies of each group so that all outgoing and incoming bees were caught for periods of four minutes each. All traps were placed in position and moved simultaneously, and the bees caught were then counted and allowed to return to their hives. When the traps were emptied they were placed on another set of colonies, three sets were used, so that each colony had at least two periods of normal flying for each period of trapping.

The following table shows the average number of incoming bees trapped at each colony, by groups, in ten periods of four minutes each. It also shows the average number of the bees that were trapped and which were carrying pollen.

TABLE NO. 4.—AVERAGE NUMBER OF INCOMING BEES AND POLLEN CARRIERS PER COLONY FOR EACH GROUP

Group	No. colonies in group	Year	Average No. of bees trapped in 10 counts* of 4 minutes each per colony	Average No. of pollen bearers trapped in 10 counts* of 4 minutes each per colony	Average No. bees trapped per minute from each colony	Average No. pollen bearers per minute from each colony
Over-wintered colonies....	6	1934	2,871	1,071	71·8	26·8
		1935	5,402	1,611	135·06	40·28
		1936	1,546	348	66·4	14·5
5-Pound packages.....	3	1934	2,482	530	62·0	13·2
		1935	3,376	787	84·4	19·67
		1936	932	181	38·8	7·5
3-Pound packages.....	3	1934	2,233	563	55·8	14·1
		1935	1,870	541	46·76	13·52
		1936	780	165	32·5	6·9
2-Pound packages.....	3	1934	1,233	345	30·8	8·6
		1935	1,520	502	38·01	12·57
		1936	422	92	17·6	3·8

* In 1936 only six counts were made because of unsatisfactory weather conditions during the blooming period.

In the above table it will be noted that the average force of bees returning to the over-wintered colonies was stronger than that returning to any of the package colonies. Also that in the latter the strength was proportionate to the original strength of the packages. The same fact holds true with the pollen carriers, except that in 1934 the number from the 3-pound packages exceeded that from the 5-pound packages.

The results so far obtained from this experiment show that over-wintered colonies of average strength are of greater value for pollination purposes than are package bees, even of the 5-pound size, but when over-wintered colonies are not available the larger the package the better.

Supersedure

The loss of queens through supersedure is a serious problem for those importing package bees, the loss often reaching 100 per cent during the first two or three months after installing the bees in hives.

During the past eight years 103 packages have been received and installed in the apiary at Ottawa, and of the queens which came with these packages only seven or 6·8 per cent were superseded during the first summer after being installed in hives. The following table shows the yearly loss.

TABLE NO. 5.—SUPERSEDURE OF QUEENS DURING PAST EIGHT YEARS

Date received	2-pound Package	3-pound Package	5-pound Package	Number and Date Queens Superseded
April 29, 1929	1—A	.....	.....	None superseded..
	6—U	.....	.....	" "
April 28, 1930	1—A	.....	.....	" "
	4—U	3—U	.....	" "
May 5, 1931	5—A	1—A	.....	" "
	5—U	2—U	.....	" "
April 26, 1932	.....	1—A	2—A	" "
	3—U	2—U	.....	1—June 13.
May 1, 1933	3—A	3—A	3—A	2—May 30 and June 23.
May 1, 1934	10—U	3—U	3—U	2—May 5 and May 30.
May 16, 1935	10—U	3—U	3—U	None.
	5—S	.....	.....	"
May 18, 1936	10—U	3—U	3—U	2—June 10 and 12.
	5—S	.....	.....	None.
	68	21	14	7=6·8%

NOTE: A=Queens attended by worker bees.
U=Queens unattended by worker bees.
S=Queens came separate from the packages of bees.

The loss of queens through supersedure at Ottawa has not been heavy. In four years of the eight no loss occurred, the original queens still heading their colonies the following spring. The usual method of handling package bees received at Ottawa is to obtain immediate delivery of them after arrival at the express office, usually at noon, and then to stand the packages in a cool place and feed the bees by sprinkling a thin sugar solution or cold water on to the screening of the packages. During the afternoon the hives are prepared by placing in them five combs, some of which contain honey and pollen. A small pebble or block of wood is placed on the floorboard alongside the combs. The entrances of the hives are reduced to one inch at the corner farthest from the combs. About five o'clock in the afternoon the packages are placed alongside the hives which the bees are to occupy. A package is opened, the feeder can removed and the queen cage is taken out of the package, and if the cage is supplied with candy, the covering over the candy hole is removed and the cage is suspended between the top bars of the two frames nearest to the centre of the hive. If, however, the queen comes unattended and without candy in the cage, the plug is removed and the hole filled with a prepared candy and the cage suspended between the frames as described above. A few of the bees are now shaken from the package on top of the frames near the queen cage; the package containing the rest of the bees is then placed upside down in the hive alongside the combs and one end of the cage rests on the pebble or block of wood previously placed on the floorboard, this allows the bees to escape from underneath the cage and to pass over to the combs. A quilt is then placed over the frames and package with the hive cover in place above it. This procedure is followed until all the packages are installed. The following morning the empty packages are removed from the hives and the latter filled with drawn combs and the hive again covered. Twenty-four hours after the packages are installed

the queen cages are examined to determine whether or not the queens have been released. If not, a hole is pushed through the candy and the cage replaced. If the queens are released the cage is removed and the hive cover replaced. None of the combs are taken from the hives for examination for at last seven days after the bees are released. Curiosity is largely responsible for supersedure.

Where the queens come by mail separate from the package they are introduced to the package bees in the hive in the usual manner.

It has been suggested that supersedure might be the result of the bees having no brood at the time they are released in their hives and that the queen becomes injured through balling. To test this a number of the packages were released on open brood taken from very strong colonies. It was thought that this brood would draw the attention of the bees from their queen until she was able to establish a brood nest of her own and thus possibly avoid supersedure.

FIG. 2 — Installing Package Bees, showing position of package and queen cage.

Another test was to import queenless packages of bees and to have the queens come separately by mail so as to arrive approximately the same time as the packages and then to introduce the queens to the bees after they were installed.

Of the seven queens that were superseded, five were in packages introduced in the regular manner and two in packages installed on open brood. So far no supersedure has occurred in those packages where bees and queens arrived separately.

At the Brandon apiary nine different methods of installing package bees are being tried, and to date supersedure has occurred in all methods but one. For details the reader is referred to the summary report from the experimental farm, Brandon, for 1931-1936.

In order to obtain further information regarding supersedure, questionnaires were sent out from the experimental farm, Brandon, Man., to 4,000 private

beekeepers last summer but only 357 replied. Of these, 95 had not purchased package bees in 1937, but the remaining 262 replies involved 7,734 packages. Supersedure in these packages ranged from 0-100 per cent. From the information supplied no definite cause of supersedure could be determined.

Dual Colonies for Honey Production

Originally the object of wintering two queens in one colony was to provide a surplus of young queens for replacement purposes the following spring, but during the past three years these double colonies have been tested out for production purposes.

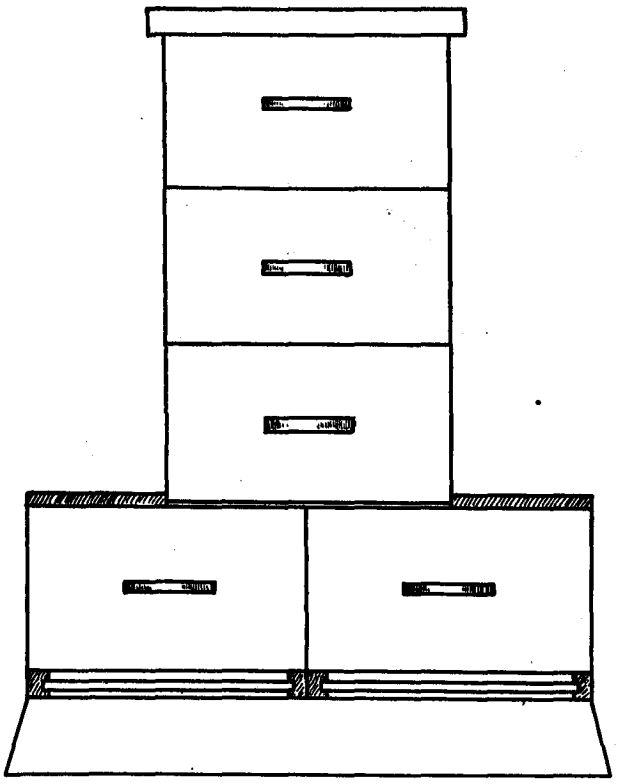


FIG. 3 — Duo Colony. Two colonies supered as one.

When going into winter quarters each hive contained two, 5-frame nuclei, each headed with a queen of the current year's production. The following spring when the nuclei exhibited signs of overcrowding, one nucleus from each double hive was removed and placed in another hive alongside the original and on the same side from which the nucleus was removed. The division board from the double hive was removed and both hives filled up with drawn combs. At the beginning of the main honey flow from clover the two nuclei were drawn close together, a queen excluder placed so as to cover half of each hive and supers placed above the excluder (see Fig. 3), in this way the bees of both hives were working in one tier of supers. A group of single colonies having only one queen each was used as a check against the double colonies.

TABLE NO. 6—SHOWING AVERAGE COLONY PRODUCTION FOR SINGLE AND DOUBLE COLONIES

Group	1934		1935		1936	
	lb.	oz.	lb.	oz.	lb.	oz.
Single colonies	229—	0	122—	9	135—	0
Double colonies	197—	0	101—	1	135—	6

The figures given in the above table show that no advantage was gained by having two queens in the one hive, even though the population of the colony was increased by such procedure. During 1934 considerable trouble was experienced with these colonies through swarming. A swarm from one side of the double invariably induced the bees from the other side to swarm also.

It has already been stated that the original object of wintering two queens in one hive was for the purpose of carrying over a surplus of young queens. In 1935 an attempt was made to determine if more than two queens could be wintered in a single hive, consequently three hives were divided into three compartments and three into four compartments with bee-tight division boards between each compartment. During the summer a small nucleus was started in each compartment and each nucleus given a ripe queen cell. In the fall the nuclei in the triple colonies contained approximately three frames of bees each, while those in the quadruple hives covered two frames each. All nuclei were fed sugar syrup between September 10 and 24, and placed in the cellar on November 19 where they remained until April 27 the following spring. The average weight of each hive when placed in the cellar was 65·4 pounds.

At the first examination in the spring it was found that of the nine queens wintered in triple hives, only one had died during the winter. Four were lost from the quadruple hives, three from one and one from another, while in the third hive all four queens wintered safely. The following table shows the losses.

TABLE NO. 7.—SHOWING NUMBER OF QUEENS THAT SURVIVED THE WINTER IN COMPARTMENT HIVES

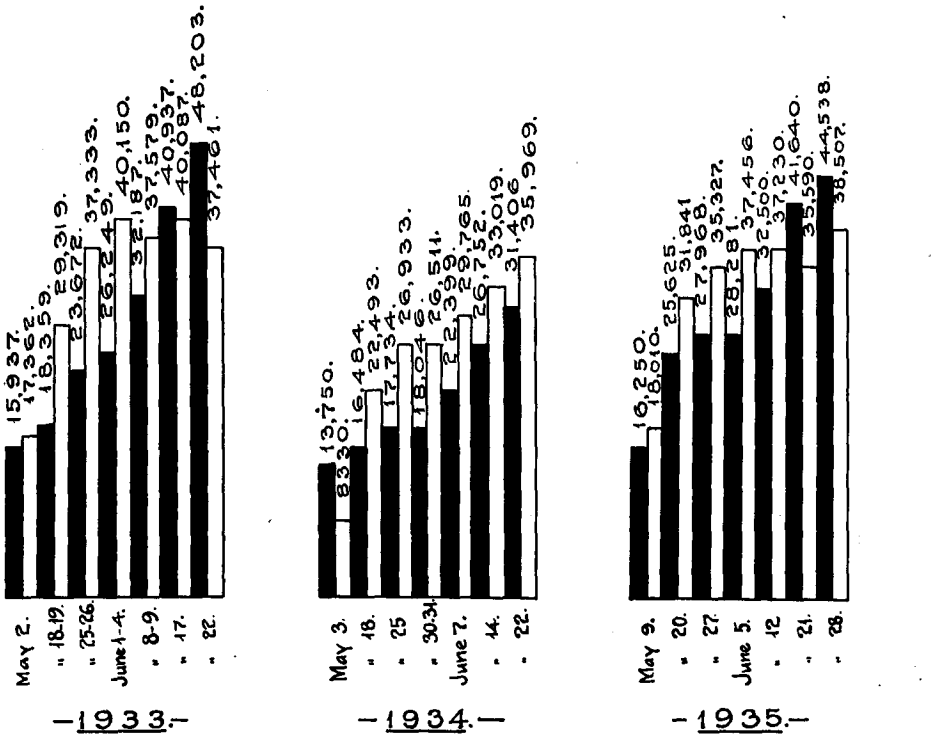
Hive Letter	D	E	F	G	H	J
Number of nuclei in each hive	3	3	3	4	4	4
Number of queens that survived the winter	3	3	2	4	1	3

It will be seen that 16 of the 21 queens placed in winter quarters were alive the following spring.

Relation of Bees and Brood in a Normal Colony

In 1932 two weak colonies were selected and at approximately seven-day intervals from May 4 to June 25, the bees were weighed and the number computed on a basis of 5,000 to the pound. At the same time the amount of brood present was measured and the number of cells occupied estimated on the basis of 25 cells per square inch. All measurements taken that year showed the number of unhatched bees to be in excess of the adult bees. From 1933 to 1935 measurements were taken of four normal colonies each year. The first measurements were taken on May 2, May 3 and May 9 respectively. At the first counts of each year there was very little difference between the number of adult bees

in the hives and the number of cells occupied with eggs and brood, but at the next count the number of cells occupied by brood was far in excess of the adult bees. This condition existed until approximately the middle of June when the adult bees outnumbered the cells occupied by eggs or brood. As the main honey flow at Ottawa commences shortly after June 15, the counts were not continued much beyond that date because of the number of supers that would have to be shaken and weighed, and to avoid interference with the normal gathering functions of the bees. It is not known whether or not the maximum strength of the colonies was reached at the time the counts were discontinued, but it is suspected that they were very close to it for there appeared to be a general levelling off in brood production at that time, although some were still showing an increase, indicating that the maximum strength of these colonies had not been reached by the time the main honey flow commenced.



The accompanying chart shows the approximate average number of bees and cells occupied by brood in four colonies during the early part of 1933, 1934 and 1935. It will be noted that for 1933 and 1935 there was very little difference in the amount of brood present at the last four counts, while in 1934 it would appear that the peak of brood production was not reached by June 22 when counting ceased. The number of bees, however, was still on the increase in all three years.

Normal versus Lighted Hives

In 1934 a five year test of hives in which sunlight was allowed to enter through glass panels at both sides and ends of the hive was completed. Five hives of Langstroth dimensions were used in the experiment, three of them were

fitted with ordinary window glass and two of them with special glass which permits the passage of the violet rays of light. Five colonies in ordinary Langstroth hives were used as checks.

TABLE NO. 8.—AVERAGE PRODUCTION FOR THE 5 YEARS

—	1930	1931	1932	1933	1934	Average
	lb.	lb.	lb .	lb.	lb.	lb.
Sunlit hives	100·56	84·19	38·88	141·50	171·13	107·25
Ordinary hives	130·75	91·25	41·50	131·06	176·44	114·19

It will be noted that in one year only did the bees in sunlit hives exceed those in ordinary hives, in so far as production was concerned. From the general observations it appeared as if the bees in the sunlit hives were very restless because of the light entering the hives through the glass and many of them were continually running over the glass in an apparent effort to escape from the hives in that direction. The results of the experiment show no advantage gained by the use of glass panels in the hive.

Relation of Strength of Syrup Fed to Amount of Food Stored

At the time of feeding the bees for winter, four colonies of equal strength were selected for special feeding and weighing. The weight of colonies taken just prior to feeding indicated that the amount of natural food present in the colonies was exceedingly small, therefore, this was not removed but supplemented by sugar solutions of different strengths.

Each colony was given as much syrup as it would take and the syrup was of the following proportions:—

STRENGTH OF SYRUP GIVEN

Colony No. 1—Syrup made of 1 part water to 1 part sugar.
Colony No. 2—Syrup made of 1 part water to 1½ parts sugar.
Colony No. 3—Syrup made of 1 part water to 2 parts sugar
Colony No. 4—Syrup made of 1 part water to 2½ parts sugar

From the first day of feeding until the colonies registered a constant loss of weight, the weight of the colonies was taken daily. In 1934 this period was from October 9 to 22; in 1935 from October 1 to 15 and in 1936 from October 5 to 23. Each colony was standing on tested platform scales for the entire period so no disturbance was caused by moving the colonies for weighing.

During the early part of each period the colonies took down the following amounts of syrup and its equivalent in sugar.

TABLE NO. 9.—AMOUNT OF SYRUP AND ITS EQUIVALENT IN SUGAR TAKEN

Year	Colony No. 1		Colony No. 2		Colony No. 3		Colony No. 4	
	Amount of syrup taken	Equivalent in sugar	Amount of syrup taken	Equivalent in sugar	Amount of syrup taken	Equivalent in sugar	Amount of syrup taken	Equivalent in sugar
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1934	74·75	37·81	69·69	42·0	62·25	42·0	58·31	42·0
1935	68·50	33·63	71·25	42·0	63·0	42·0	48·75	35·44
1936	83·25	42·0	66·19	39·44	62·50	42·0	57·75	42·0

It will be seen in the above table that with one exception only, colony No. 2, 1935, the stronger the solution given the less the amount taken down by the bees. This of course would be expected as more of the weaker solution would have to be taken in order to secure equal amounts of sugar. Furthermore, as more work was required to handle the larger amount of weaker solutions, more food would be required to furnish the extra energy necessary for this work.

The gain in weight made by each colony from the date of feeding until they had reached a constant loss of weight and this gain shown as a percentage of the sugar given is shown in the following table:—

TABLE NO. 10.—WEIGHT AND PERCENTAGE OF SUGAR FED AND STORED FOR WINTER USE

Year	Weights and Percentages	Colony 1	Colony 2	Colony 3	Colony 4
		lb.	lb.	lb.	lb.
1934	Gain in weight	30·25	37·44	39·56	40·19
	Per cent of Sugar Fed	80%	89·1%	94·2%	95·6%
1935	Gain in Weight	28·50	38·75	35·75	32·0
	Per cent of Sugar Fed	84·75%	92·26%	85·1%	90·0%
1936	Gain in Weight	34·88	33·44	38·25	39·25
	Per cent of Sugar Fed	83·03%	84·73%	91·07%	93·45%

It will be noted that in general the colonies given the higher concentrated solutions of sugar made the greatest gains in weight, this of course would be expected had the amounts of syrup given been equal, but as previously stated the colonies receiving the weaker solutions took down the most syrup but made the least gains.

The main point in the experiment, however, was the percentage of the sugar given that was apparently stored for winter use. With one exception, colony No. 2 in 1935, the percentage food stored from the sugar given increased as the strength of the solution was increased, indicating that less work was performed and consequently less sugar consumed by the bees in the storage of these solutions. It was noted, however, that in the solution of 2½ parts of sugar to 1 part of water there was a tendency for the sugar to re-granulate when the sugar became cold, this did not occur in the 2:1 solution, indicating that the latter is the safer and therefore, the most economical solution to use.

Drawn Comb versus Foundation

The question often arises as to how much foundation can be given to a colony without affecting the honey crop of that colony. Obviously there are several factors such as colony strength, crop prospects and management that influence the answer to this question.

In order to find out what normal colonies would do under normal conditions, 12 colonies of equal strength were selected in 1935 and divided into four groups. To harvest the main crop of honey these groups were supered as follows, each super containing the same quota of combs and foundation:—

Group 1..... 3 colonies..... 9 drawn combs
Group 2..... 3 colonies..... 8 drawn combs + 1 frame foundation
Group 3..... 3 colonies..... 7 drawn combs + 2 frames foundation
Group 4..... 3 colonies..... 6 drawn combs + 3 frames foundation

In 1936 the supers contained greater amounts of foundation.

Group 1..... 3 colonies..... 9 drawn combs
Group 2..... 3 colonies..... 6 drawn combs + 3 frames foundation
Group 3..... 3 colonies..... 3 drawn combs + 6 frames foundation

The honey crop of the district was good each year and the production of the groups in the above experiment was as follows:—

TABLE NO. 11.—AVERAGE COLONY PRODUCTION OF GROUPS

Year	Group 1		Group 2		Group 3		Group 4	
	Honey	Comb Drawn	Honey	Comb Drawn	Honey	Comb Drawn	Honey	Comb Drawn
	lb.		lb.		lb.		lb.	
1935	102·7	.....	126·7	1	72·7	2	112	1
1936	154·0	.....	114·0	5	118·0	6	.....	.....

It will be noted that production varied somewhat between groups, the actual colony production showed even a greater variation indicating that factors other than strength of colonies influence production, for these colonies were chosen just prior to the main honey flow for their apparent equality of strength.

The number of new combs drawn in 1935 was negligible and apparently had little or no effect on the crop produced. In 1936, however, an average of five to six drawn combs per super was very good, but contrasting the crops of honey produced by these colonies with that of the colonies that were given a full complement of combs it would appear that the new comb was produced at the expense of the honey crop, to what extent, however, cannot be definitely stated because of other factors that might possibly have affected the results.

Nuclei versus Package Bees

The object of this experiment is to establish two small nuclei in double hives as early in the season as it is possible to obtain ripe queen cells, usually early in July when the main honey flow is at its peak. Each nucleus as made is given a ripe queen cell and then stood to one side of the apiary and allowed to build up without further attention until fall when it is fed and placed in the cellar for winter.

On July 4 and 5 of 1934, twelve nuclei were made in six double ten frame Langstroth hives. Each nucleus consisted of one comb containing a very small patch of brood taken from strong colonies. As the honey flow was at its peak the removal of this small patch of brood from a strong colony would not in any way affect the crop of that colony. The remaining space in each compartment of the double hive was filled with drawn comb containing a little honey and pollen. A ripe queen cell was then attached to the comb containing the brood in each nucleus. Apart from looking to see that the nuclei were queenright they received no further attention. On September 29 each nucleus was given 16 pounds of sugar made into a solution of two parts sugar to one part water, and on November 12 they were placed in the cellar for winter.

Six nuclei were again made up on June 29, 1935 and the same number on the same date in 1936.

On April 23, 1935 the 12 nuclei made up in 1934 were removed from the cellar, all alive and queenright. When weighed it was found that the actual consumption of stores during the winter was eight pounds of sugar and that sufficient stores were left for spring use. Six of these nuclei were left to build up without assistance, to test their honey producing abilities, and they were compared with an equal number of 2-pound packages imported on May 16. The average production of the six nuclei was 61·25 pounds, while that of the packages was 61·19 pounds, therefore, the production of the two groups may be considered equal. It must be remembered, however, that the packages arrived late in the season, therefore, were no doubt much weaker when the flow commenced than they would have been had they arrived from three to four weeks earlier, the normal time for packages to arrive.

The nuclei made up in 1935 were fed during the latter part of September and placed in the cellar on November 19. On April 27, 1936 they were removed from the cellar and weighed. One of the nuclei was found to be dead. The average consumption during the winter was 6·19 pounds. On June 23 one nucleus was found to be infected with American foul brood, therefore, was destroyed, this left but four nuclei as producers. These four were again compared with five 2-pound packages that arrived on May 18 and were not in as good a condition as those obtained in 1935. The average production of the four living nuclei was 68·25 pounds, while that of the packages was 65·69 pounds a difference of 2·56 pounds. Again it must be remembered that the packages arrived too late in the season to give the best results.

Eight nuclei were prepared for comparison in 1937.

Bee Diseases

While the division has nothing whatever to do with the inspection of apiaries or the control of diseases, it does maintain a service for the diagnosing of samples sent in. During the three years under consideration 267 samples of dead brood were received and examined. Of these 134 samples were infected with American foul brood, 37 with European foul brood, the remaining 96 samples died from undetected causes.

FIG. 4 — Colony with entrance parallel to combs. Known as the "Warm Way Entrance" in Europe.

A number of samples of adult bees were also received for examination. No sign of disease could be detected in any of them, but the information accom-

panying the samples indicated the possibility of death from poisoning, therefore, the samples were sent to the Chemistry Division for analysis. The results showed that in practically all cases arsenical poisoning was the cause of death.

Specific Gravity of Capped versus Uncapped Honey

In 1935 a test was made of four samples of honey, two from capped combs and two from uncapped combs, the object being to determine the moisture content of each sample. The following readings were obtained:—

TABLE NO. 12.—SHOWING REFRACTIVE INDEX, TOGETHER WITH EQUIVALENTS IN SPECIFIC GRAVITY AND MOISTURE CONTENT CALCULATED FROM DR. CHATAWAY'S HONEY TABLES

Type of Honey	Refractive Index	Specific Gravity	Percentage Moisture
Capped	1·48675	1·405	19·45
"	1·48850	1·408	18·75
Uncapped	1·490	1·415	18·15
"	1·490	1·415	18·15

Contrary to expectations the uncapped honey contained the least moisture. This is thought to have been caused by the fact that the honey had been standing in a warm room for approximately 36 hours before extracting, thus permitting a certain amount of moisture to be drawn from the uncapped honey.

In 1935 and again in 1936 tests were made of honey pipetted from different parts of capped and uncapped combs of honey at extracting time. The readings are shown in the following table.

TABLE NO. 13.—SHOWING REFRACTIVE INDEX AND CORRESPONDING MOISTURE CONTENT OF HONEY FROM DIFFERENT PARTS OF COMBS

Type of honey	Position in comb	Refractive index	Temp. at which readings were taken	Per-centage moisture
Uncapped	Middle	1·481	25°C	22·00
"	"	1·481	25°C	22·00
"	Pottom	1·487	25°C	19·35
"	"	1·487	25°C	19·35
"	Chosen at random	1·4872	25·5°C	19·2
"	" "	1·4910	25·5°C	17·7
"	" "	1·4909	25·5°C	17·7
"	" "	1·4900	25·5°C	18·1
"	" "	1·4904	25·5°C	17·9
"	" "	1·4900	25·5°C	18·1
"	" "	1·4892	25·5°C	18·4
"	" "	1·4890	25·5°C	18·5
"	" "	1·4894	25·5°C	18·3
"	" "	1·4880	25·5°C	18·9
"	" "	1·4881	25·5°C	18·9
"	" "	1·4830	25·5°C	21·1
Sealed	Top	1·4805	25·°C	22·20
"	"	1·4780	25°C	24·95
"	Bottom	1·4780	25°C	24·95
"	"	1·4810	25°C	22·0
"	Chosen at random	1·4766	23·5°C	24·0*
"	" "	1·4882	23·5°C	18·8
"	" "	1·4890	23·5°C	18·7
"	" "	1·4876	23·5°C	19·2
"	" "	1·4881	24·°C	19·0
"	" "	1·4888	24°C	18·8
"	" "	1·4898	24°C	18·4

TABLE NO. 13.—SHOWING REFRACTIVE INDEX AND CORRESPONDING MOISTURE CONTENT OF HONEY FROM DIFFERENT PARTS OF COMBS—*Concluded*

Type of honey	Position in comb	Refractive index	Temp. at which readings were taken	Per-centage moisture
Sealed	Chosen at random	1·4910	24·5°C	17·8
"	" "	1·4911	24·5°C	17·7
"	" "	1·4910	24·5°C	17·8
"	" "	1·4908	25°C	17·8
"	" "	1·4905	25°C	17·9
"	" "	1·4894	25°C	18·4
"	" "	1·4897	25°C	18·3
"	" "	1·4887	25°C	18·7
"	" "	1·4885	25·5°C	18·7

* From an open cell about middle of comb.

The above table reveals the great variation in the density of honey taken from different parts of a comb, even though the honey may all be sealed.

Test of Moisture Content Between Top and Bottom Layers of Honey in 1,000-Pound Storage Tanks

During the two years 1935 and 1936 samples of honey were taken from the upper and lower layers of honey from 13 tanks of 1,000-pound capacity. In some cases the top honey was dipped from the surface, while that of the lower layer was taken through the gate of the tank. In other cases the samples were from the first and last honey as taken from the tanks when the honey was being run off into containers. The similarity of the readings taken by both methods indicated that it was not necessary to take samples from the surface by the dipping method, but that the surface layer was the last to leave the tank. The honey had been in the tanks from three to five days when the readings were taken. The results of these readings are summarized in the following table.

TABLE NO. 14.—SHOWING THE AVERAGE READINGS OF 34 SAMPLES OF UPPER AND LOWER LAYERS OF HONEY FROM THIRTEEN 1,000-POUND STORAGE TANKS

Position	Refractive index	Per cent moisture corrected to 20°C.
Top layer	1·4930	17·4
Bottom layer	1·49319	17·3

The above figures show that there was very little difference in the moisture content of the samples taken, even after standing in the tanks for five days. The individual samples showed some variation, but the greatest difference was only 0·4 per cent. It was also noted that in some cases the top layer of honey contained less moisture than the bottom layer, but the reverse was most frequently the case. It should be pointed out that the temperature of the honey house in which the storage tanks were standing was rather high, at all times ranging from 80 to 95 degrees, and that the air was dry, which may have had the effect of taking up moisture from the surface of the honey in the tanks.

Honey Storage

The experiment on honey fermentation, begun in 1929 was continued in 1931, 1935 and 1936. Duplicate half-pound samples of honey were obtained from as many of the producing areas in Canada as possible. In all, 705 samples were obtained in 1,410 containers from the four crops.

A questionnaire asking for information as to the source of the honey, the time and duration of the flow and the methods of handling the honey from the time it was taken from the bees until it was in the final containers was sent to each contributor of samples.

As the samples were received, a gross examination of each was made and its condition, together with the information contained on the questionnaire, was recorded. One container of each sample was then placed in storage at ordinary room temperature, approximately 70° F. The duplicate of each sample was set aside for analysis. The samples placed in storage were examined weekly until granulated, and monthly thereafter until fermentation took place, or until it was evident that there was little danger of fermentation. Records were kept of the condition of the samples at each examination and any sample showing definite signs of fermentation was removed from the experiment.

The following table shows the number of samples received from each province for the four years 1929, 1931, 1935, and 1936. In general, the samples came from separate producing areas.

TABLE NO. 15.—NUMBER OF HONEY SAMPLES RECEIVED FROM FOUR CROPS ACCORDING TO PROVINCE OF ORIGIN

Province	1929	1931	1935	1936
British Columbia	20	14	19	19
Alberta	5	9	12	11
Saskatchewan	25	14	22	33
Manitoba	38	23	24	37
Ontario	55	25	48	54
Quebec	46	26	23	29
Maritimes	10	19	23	22
Totals	199	130	171	205

As the samples were received an analysis was made of each one for moisture content, and on this basis they were graded in accordance with the Regulations under "The Fruit, Vegetables and Honey Act" No. 35, 1936. All moisture determinations were made by the refractometer and calculated from the Honey Tables of Dr. H. D. Chataway, National Research Council. Under the Pure Food Law, honey that contains more than 20 per cent moisture by the above-mentioned tables is not considered as honey, therefore, all such samples are listed as "No grade" in this report.

The following table shows the grading of the samples based on moisture content only, as defined in the Regulations under "The Fruit, Vegetables and Honey Act," 1936.

TABLE NO. 16.—SHOWING PERCENTAGE OF SAMPLES FALLING INTO THE DIFFERENT HONEY GRADES

Grade	Crops			
	1929	1931	1935	1936
	%	%	%	%
1	69·3	66·1	46·2	73·2
2	25·6	28·5	38·6	18·0
3	3·0	4·6	14·0	7·8
No Grade	2·0	0·7	1·2	1·0

The figures given above show that based on moisture content alone there was considerable variation in the grading of the samples from year to year. A high percentage of the samples of 1936 graded as No. 1, and as a matter of fact,

the honey crop of that year was an exceptionally good one throughout the Dominion. On the other hand, the crop of 1935 was an extremely poor one and the density of the honey was low. This is shown above by the small percentage of the samples of that crop graded as No. 1. The crops of 1931 and 1929 were of a better quality than that of 1935, but not so good as that of 1936. It will also be noted that a very small percentage of the samples sent in failed to make any grade at all.

Yeast counts were also made on all samples. Definite dilutions were made of each sample of honey and the yeasts grown on special media for making the counts. These counts showed a variation in the different samples ranging from 0 — 1,100,000 yeast cells per gram. The following table shows the average number of yeast cells per gram for the different grades of honey for each year under consideration.

TABLE NO. 17.—NUMBER OF YEASTS PER GRAM FOR DIFFERENT GRADES AND YEARS

Year	Grades			No Grade
	1	2	3	
1929	5,288	16,717	13,751	21,415
1931	21,224	159,521	425,000	1,100,000
1935	4,180	13,269	31,423	13,000
1936	1,856	7,954	34,320	130,500

The table shows that yeast count like moisture content varies from year to year, and that in 1931 the number of yeasts per gram was notoriously high. It will also be noted that, with two exceptions, Grade 3 in 1929 and No Grade in 1935, there was a general increase in yeast count from the higher to the lower grades, and it will be remembered that the grading here is based on the moisture content which increases as the grade is lowered, indicating that there is a possible relationship between moisture content and yeast count.

The following table shows the percentage of fermentation that occurred among the samples in storage during the first 12 months of storage.

TABLE NO. 18.—PERCENTAGE OF FERMENTATION ACCORDING TO GRADES AND YEARS AT THE END OF 12 MONTHS STORAGE

Grade	1929	1931	1935	1936
	%	%	%	
1	8·0	9·3	8·9	Not yet 12 months in storage.
2	39·2	78·4	34·8	
3	83·3	50·0	58·3	
No Grade	100·0	100·0	100·0	

With one exception, Grade 2, 1931, the percentage of fermentation increased from the higher to the lower grades. Taking into consideration the moisture content of the different grades and the yeast counts for the same, there would appear to be a definite correlationship between moisture, yeast count and fermentation.

Other analyses were made of the samples, but as they did not appear to affect the keeping qualities of the samples in storage, these analyses will not be given in this report.

Moulds in Honey

In an experiment to test the air of the honey house for yeast cells, a number of sterile honey agar plates were exposed for periods of five and ten minutes. While only an occasional yeast cell was caught on these plates, a number of mould colonies developed on them after a short period of incubation. Some of these moulds were identified as *Pericystis alvei,* commonly found on the combs of over-wintered colonies in the spring. This particular mould is of interest because it is closely related to the one causing "Chalk Brood" in Europe. An investigation of the moulds of honey is under way.

Other Activities

During the three years some 21,000 Apiary Reminders were sent out to approximately 3,000 beekeepers. These reminders are really seasonable hints and seven issues are made each year.

The following bulletins were also revised during the period:—

"Bees and How to Keep them."
"Package Bees and How to Install Them."
"Honey and Some of the Ways It May be Used."

Beekeepers' conventions, short courses, field days and other meetings were attended and addresses given in different parts of Canada. The branch farm apiaries throughout Canada were also visited each year.

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