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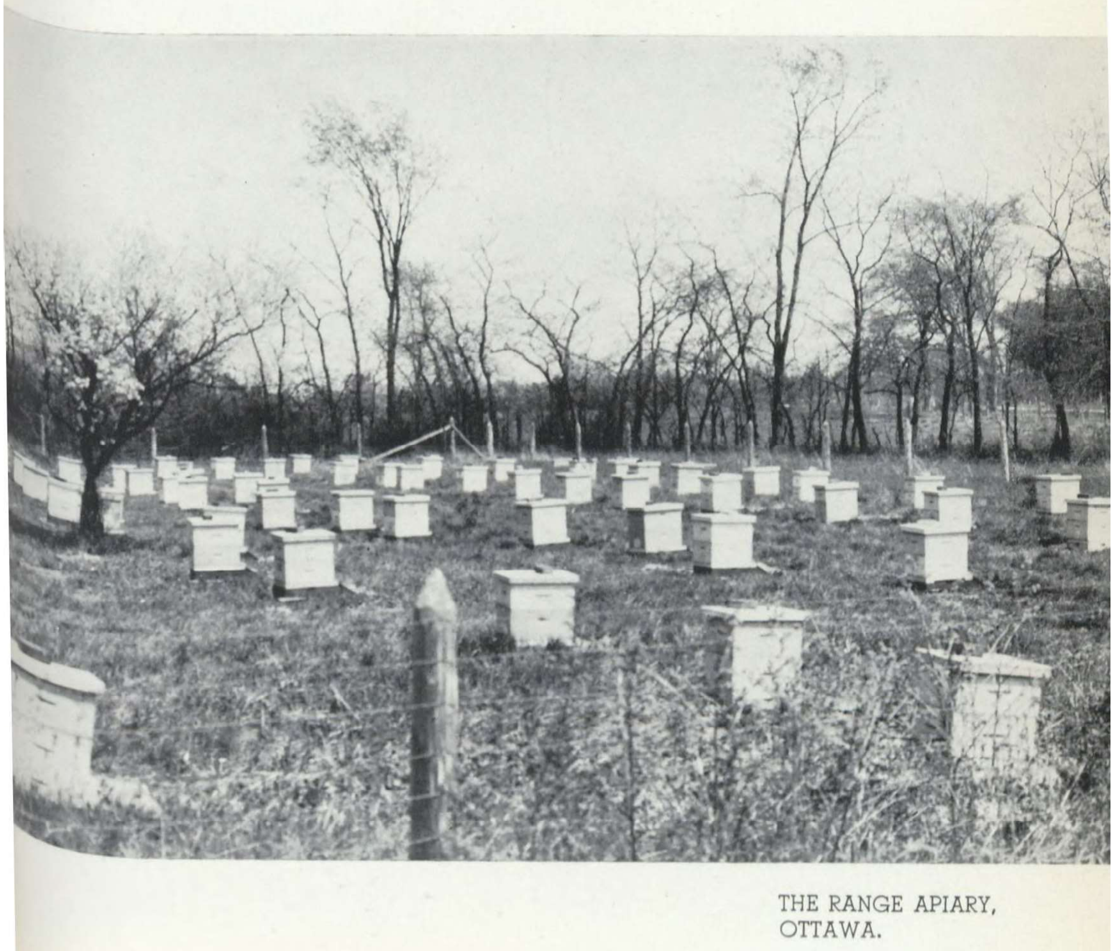
CANADA
DEPARTMENT OF AGRICULTURE
EXPERIMENTAL FARMS SERVICE

BEE DIVISION

CENTRAL EXPERIMENTAL FARM
OTTAWA, CANADA

C. B. GOODERHAM, B.S.A., DOMINION APICULTURIST

PROGRESS REPORT
1937 - 1948



THE RANGE APIARY,
OTTAWA.

Published by authority of the Rt. Hon. JAMES G. GARDINER, Minister of Agriculture,
OTTAWA, CANADA.

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CONTENTS

BEE DIVISION

CENTRAL EXPERIMENTAL FARM

Progress Report - 1937-1948

INTRODUCTION

This report summarizes the work done by the Bee Division, Central Experimental Farm, Ottawa, during the years 1937-1948. Some projects started prior to 1937 and mentioned in the progress report of 1934-1936 have since been concluded and are further reported upon here.

Work that has been done at the Branch Farm apiaries will be covered in the progress reports of the farms concerned but references to this work also will be found in this report.

During the period under consideration, the work of the Division expanded considerably. W. A. Stephen, C. A. Jamieson and J. H. Arnott joined the staff in 1936, 1938 and 1947 respectively, the first-named resigning in 1946 to take a position in North Carolina. With his resignation, the work on honey yeasts had to be suspended.

Three new apiaries have been established at Ottawa for special projects. The most distant yard is twelve miles from the central office. Several of the newer projects involving the use of bees for pollinating purposes, effects of drugs and antibiotics on bee diseases, the effects of some of the newer insecticides on honeybees, etc. are carried out in co-operation with other divisions, services and institutions. This co-operative work is highly important.

Two new Branch Farm apiaries were started, one at Prince George, B.C., to study the effect of honeybees as pollinating agents for alsike clover. The Prince George district is noted for alsike seed production. The other apiary is at Normandin, Que., to study the honey producing possibilities in the Lake St. John district.

During the past twelve years a great expansion has taken place in the Canadian beekeeping industry. The rationing of sugar during the war period was largely responsible for this. The demand for honey during that period was in excess of the supply in spite of the fact that all export markets for honey were closed.

Shortages of materials due to war conditions created other problems for the beekeeper but co-operative effort between the Canadian Beekeepers' Council and the various governmental boards kept the industry functioning without undue friction.

CANADIAN BEEKEEPERS' COUNCIL

The Canadian Beekeepers' Council is a national body and was created in 1940 for the purpose of uniting the various provincial associations and honey packing organizations into one central body representing the Canadian beekeepers as a whole. The Council has gone a long way in creating a greater spirit of co-operation throughout the beekeeping industry of the whole Dominion.

Table 1 and Figure 1 are presented to show the growth of the industry since 1924 the year in which the first complete statistics are available.

TABLE 1.—NUMBER OF BEEKEEPERS AND COLONIES IN CANADA ALSO HONEY AND WAX PRODUCED[1]

Crop Year Beginning July 1	Number of Beekeepers	Number of Colonies	Av. Yield per colony (lb.)	Total Prod. of Honey '000 lb.	Wax Prod. in '000 lb.	Total Value Honey and Wax in $'000
1924-25	22,200	280,000	60	16,840	253	2,183
1925-26	22,600	309,400	65	19,977	300	2,528
1926-27	22,300	307,500	64	19,526	293	2,520
1927-28	22,800	323,800	72	23,231	348	2,883
1928-29	22,700	335,700	66	22,225	333	2,556
1929-30	22,300	345,900	67	23,164	348	2,228
1930-31	24,200	362,100	84	30,260	454	2,527
1931-32	24,000	350,500	89	31,324	470	2,518
1932-33	24,600	349,300	75	26,213	393	2,034
1933-34	23,100	328,200	98	32,094	481	2,785
1934-35	24,300	328,400	104	34,216	513	3,201
1935-36	24,800	357,000	94	33,646	505	2,870
1936-37	26,300	370,800	102	37,995	570	3,330
1937-38	27,900	386,400	70	27,012	405	2,524
1938-39	27,300	394,000	116	45,702	686	3,626
1939-40	28,000	406,000	85	34,376	516	3,074
1940-41	27,200	398,500	71	28,215	423	3,036
1941-42	27,400	409,700	81	33,221	498	3,952
1942-43	28,400	427,000	66	28,049	421	4,029
1943-44	34,200	449,600	88	39,492	592	6,371
1944-45	40,700	508,500	71	36,264	544	5,784
1945-46	43,300	522,500	63	33,020	487	5,665
1946-47	43,200	541,800	43	23,185	327	4,307
1947-48	39,200	588,700	63	37,078	425	9,360
1948-49	32,100	569,800	79	45,145	666	....

(1) Table from Report of Bureau of Statistics.

The fluctuations in production from year to year are mainly due to variations in climatic conditions.

Increase in production has been proportionally greater in the western provinces than in the East. Table 2 shows the increase made for the 24-year period; also the record crop of each province and the year produced. For yearly details see Report of Honey Production by the Dominion Bureau of Statistics.

TABLE 2.—SHOWING TOTAL HONEY PRODUCED BY EACH PROVINCE DURING THE YEARS 1924 AND 1948 ALSO YEAR OF GREATEST PRODUCTION[1]

Province	Production in 1924	Production in 1948	Increase	Greatest Production and Year Produced		Beekeepers 1948
P.E.I.	3,000	64,000	61,000	116,000	1942	110
N.S.	80,000	125,000	45,000	125,000	1948	380
N.B.	61,000	200,000	139,000	232,000	1943	520
Quebec	4,352,000	4,831,000	479,000	5,633,000	1931	4,970
Ontario	10,880,000	15,736,000	4,856,000	24,092,000	1938	5,060
Manitoba	651,000	6,525,000	5,874,000	9,540,000	1938	3,420
Sask.	79,000	6,492,000	6,413,000	7,328,000	1945	8,400
Alberta	55,000	10,254,000	10,199,000	10,254,000	1948	6,600
B.C.	679,000	918,000	239,000	1,584,000	1938	2,640

(1) From tables prepared by the Dominion Bureau of Statistics.

Table 2 indicates a general increase in all provinces, but the trend of greatest production is in the prairie provinces, especially in Alberta.

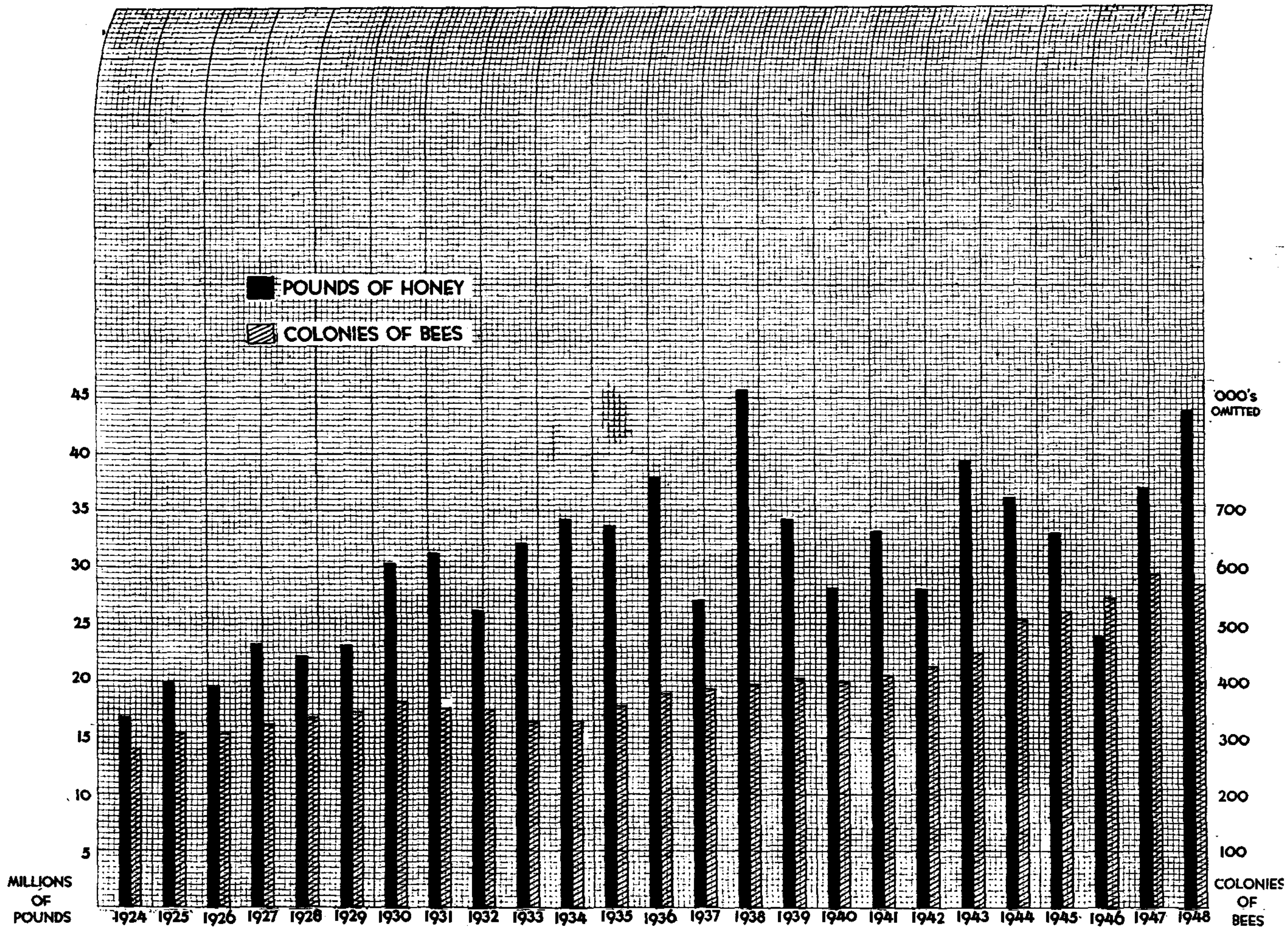

FIG. 1. Showing total poundage of honey produced and total number of colonies in Canada, 1924 to 1948 inclusive. See Table 1.

Throughout the period, contact was made with all Branch Farm apiaries and Provincial Departments of Apiculture through annual visits. Whenever possible, the Division was represented at beekeepers' conventions, field days, etc. throughout Canada and in the United States.

LABORATORY SERVICES

During the period under review, the Division has maintained a service whereby any beekeeper could obtain an analysis of samples of honey, bees or brood free of charge. In all 1,777 samples were examined. Table No. 3 shows the grouping of them.

The first three column headings of the table might be explained further.

The pollen analysis was asked for as an indication of the source of the honey. Identification of the pollen grains would identify the flowers worked.

Samples of honey graded involved colour and moisture determinations as required by the honey grading regulations.

The test for sterility (freedom from honey yeasts) required the culturing and counting of active yeast cells per gram of sample. These tests were largely confined to samples of pasteurized honey.

The question of *Nosema apis* disease did not arise until 1944 when a survey was started, the latter accounting for the large number of samples examined during 1944 and 1945. The survey showed the disease to be widespread throughout Canada.

TABLE 3.—NUMBER OF SAMPLES OF BEES, BROOD AND HONEY RECEIVED AND EXAMINED BY THE DIVISION 1937 TO 1948

	Honey for Pollen Analysis	Honey for Grading	Honey for Sterility Tests	Brood Diseases				Adults	
				A.F.B.	E.F.B.	Sac-brood	Disease Free	Spray Poison	Nos-ema
1937	....	....	....	25	5	0	17	....	....
1938	....	....	....	13	7	0	23	....	....
1939	4	10	38	31	11	0	28	....	....
1940	5	17	62	21	8	0	28	....	....
1941	13	42	85	28	10	6	38	....	....
1942	27	36	110	28	5	3	18	....	....
1943	5	30	112	39	13	10	39	....	....
1944	8	51	....	39	12	9	41	....	72
1945	5	54	....	27	3	0	23	....	33
1946	3	16	....	51	8	0	59	8	19
1947	4	40	....	17	3	3	28	1	7
1948	....	37	....	12	3	1	21	....	9
Total	74	333	407	331	88	32	363	9	140

The testing of honey samples for sterility (freedom from honey yeasts) was discontinued by the Division in 1944 because of the Honey Specialist leaving to take up further studies at the University of Wisconsin. The work was taken over by the Division of Bacteriology.

Immediately the analysis of any sample was completed, the sender was notified of the results.

EXPERIMENTAL WORK

Overwintered Colonies vs. Package Bees for Orchard Pollination

This project was started in 1932 to determine the comparative value of overwintered colonies versus package colonies of three different sizes for pollinating purposes only. The experiment was carried for a period of six years, 1932-37.

In the spring of each year, a definite number of overwintered colonies of average strength were selected and a corresponding number of 2-, 3-, and 5-pound, queenright, packages of bees imported from the southern states. These packages were shipped so as to arrive in Ottawa well before the period of apple bloom.

The overwintered colonies varied in strength from year to year as would be expected but the size of the packages remained constant. In some years, the weight of bees in the larger packages actually equalled or excelled that of the overwintered colonies.

Special traps to entrap all incoming bees were constructed and thoroughly tested before actual counting was commenced. Enough traps were made so that one colony in each group could be trapped and counted simultaneously. The object of having several colonies in each group was that no one colony would be trapped twice in succession and thereby disturb the morale of the bees unduly. All trapping was done at time of optimum bee flight during the period of apple bloom.

The colonies were within one-quarter of a mile from the main orchards of the Central Experimental Farm, Ottawa.

When the orchards were well in bloom, trapping and counting were commenced. Traps were placed on four colonies, one in each group simultaneously, and left on for exactly four minutes. At the end of the four minutes, the traps were removed, taken to the honey house and the trapped bees counted as released. Two counters were at each trap, one to count the total number of bees caught, the other to count the pollen carriers.

Ten counts of 4 minutes each were made from each colony each year with one exception when only six were made. In all, 168 counts for each group were recorded during the six-year period. Table 4 gives the results.

TABLE 4.—SHOWING AVERAGE NUMBER OF BEES, AND THE AVERAGE NUMBER OF POLLEN CARRIERS TRAPPED PER COLONY EACH YEAR FOR THE SIX-YEAR PERIOD. ALSO AVERAGES OF EACH PER MINUTE.

Group	Total Cols. per group	Av. Number Bees Trapped per Col. each Yr.	Av. Number Pollen carriers Trapped per Col. each Yr.	Av. Number Bees Trapped per Minute	Av. Number Pollen carriers Trapped per Minute
Overwintered col.	17	3,506	968	94·3	26·0
5-lb. packages	17	2,435	459	65·5	12·3
3-lb. packages	17	1,751	424	47·1	11·3
2-lb. packages	17	1,073	297	28·8	7·9

The table shows that over the period of six years the overwintered colonies sent out a larger force of field bees and pollen gatherers than did any of the packages. The force sent out by the packages was proportional to their original strength. The difference in number of pollen gatherers from the 3-pound and 5-pound packages was not so great as that between the 2-pound and 3-pound packages.

The conclusions to be drawn from the table are that overwintered colonies of average strength are of greater value for orchard pollinating purposes than are package bees. If, however, overwintered colonies are not available and packages are used instead, the larger the package the better.

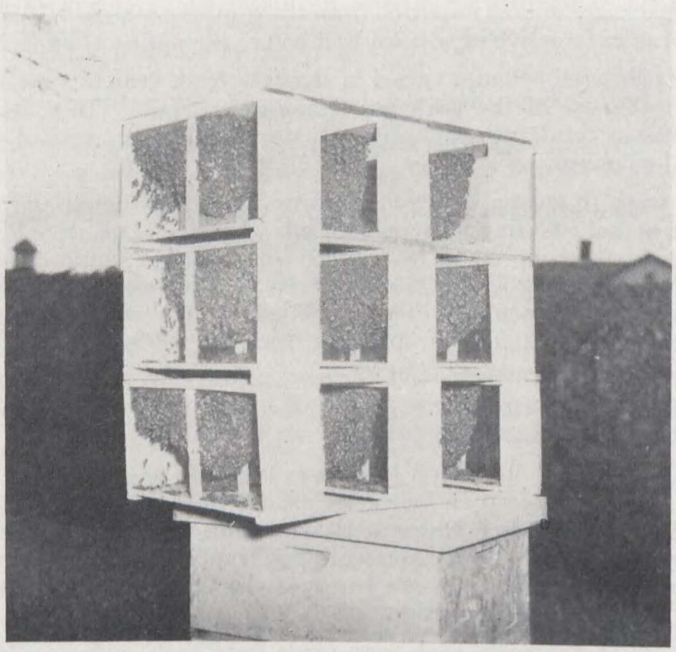

FIG. 2. A shipment of Package Bees by air. Installed at Ottawa within 48 hours after leaving Alabama.

POLLEN SUBSTITUTES

The protein food required by bees is supplied by the pollen they gather from the flowers. In some areas and in some seasons, the supply of pollen is inadequate for the maximum development of the colony. A shortage of pollen results in lower brood production and weak colonies.

In the past, many attempts have been made to find a suitable substitute for pollen, and many materials have been tested with little or no benefit. The advent of soybean flour, however, held promise but it alone proved of little value even though the bees gathered it quite readily.

In 1945, two mixtures containing soybean flour were tried: 75 per cent soybean flour plus 25 per cent natural pollen, and 80 per cent soybean flour plus 20 per cent skim-milk powder. The ingredients were mixed dry and to this mixture was added enough 2:1 sugar solution to form a stiff paste.

Early in the spring (March 14), freshly made paste was fed to a number of colonies by placing the paste on top of the combs beneath the hive cover. These cakes were untouched by the bees at the end of a week. The old cakes were then replaced by fresh ones with the same results. At the end of the second week, the cakes were again replaced but the bees refused to touch them. This test was a failure.

In 1946, the soybean flour plus skim-milk powder mixture was replaced by one containing 80 per cent soybean flour plus 20 per cent medicinal brewers yeast.

Four groups of 10 colonies each, of as near equal strength as possible, were selected in the fall of 1945 and treated as follows:

Group 1: Pollen reserve unknown. No pollen substitute to be given for winter or fed the following spring. (Checks).

Group 2: All pollen reserves removed. These colonies to be fed a soybean flour + yeast mixture the following spring.

Group 3: All pollen reserves removed. These colonies to be fed a soybean flour + natural pollen mixture in spring.

Group 4: Approximately 250 sq. in. of pollen reserves to be left in these colonies but no substitutes to be given in spring.

The same grouping of colonies also was made for 1947 with the exception of Group 1 from which all pollen reserves were removed in 1947. Fifteen colonies were placed in each group for the second year and 12 colonies in 1948.

In 1946, the feeding of substitutes was begun on March 4, while in 1947 the first cakes were given on April 3. Natural pollen was available on March 24 and May 3 respectively, which in 1946 was approximately 3 weeks earlier than normal and from 2 to 3 weeks later than normal in 1947.

Six feedings of the substitute were given at approximately 7-day intervals. In both years, the first cakes of substitute were untouched by the bees, and it was not until after the bees had taken their first good cleansing flight of the season that the substitutes were readily consumed whether natural pollen was available or not.

As production is the beekeeper's measurement of successful management, the total and average production of each group of colonies in this experiment are given in Table 5.

TABLE 5.—TOTAL ANNUAL PRODUCTION OF EACH GROUP AND INDIVIDUAL COLONY AVERAGES FOR EACH OF THREE YEARS.

Year	Group 1		Group 2		Group 3		Group 4	
	Total lb.	Av. lb.	Total lb.	Av. lb.	Total lb.	Av. lb.	Total lb.	Av. lb.
*1946	806·0	115·1	911·0	130·1	760·0	108·5	830·0	118·5
**1947	1,740·0	174·0	1,741·0	174·1	1,801·0	180·1	1,630·0	163·0
***1948	1,079·0	90·0	877·0	73·0	1,111·0	93·0	....	....

*The pollen reserves of the colonies in Group 1 were unknown when going into winter quarters.
**All pollen was removed from Groups 1, 2 and 3 before going into winter quarters.
***No pollen was removed from any of the groups before going into winter quarters.

The greatest difference between any two groups of colonies for any one year was 21·5 lb. This difference is insignificant and indicates that the feeding of pollen substitutes in the Ottawa district is unnecessary. The bees did not use the substitutes before weather conditions permitted them taking their first good cleansing flight in the spring, and shortly following that, natural pollen was apparently available in sufficient quantities for normal colony development.

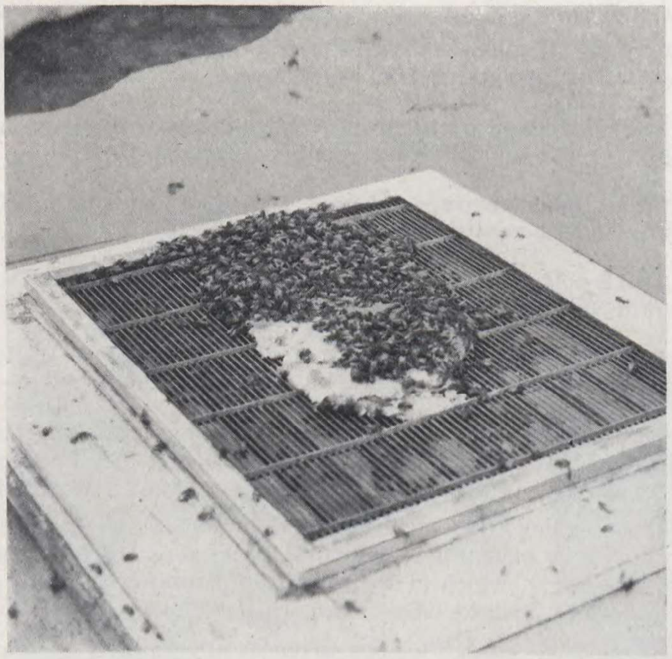

FIG. 3. Pollen substitute above Queen Encluder. Bees working this well.

OUTDOOR WINTERING OF BEES

In recent years, cellar wintering of bees has been largely superseded by outdoor wintering.

The success of outdoor wintering depends upon several factors, one of the most important being, protection against extreme changes in weather conditions, usually associated with Canadian winter. Variations in weather conditions from year to year and in different areas must also be taken into consideration.

An experiment to test a few methods of protection for the Ottawa region was devised in 1940 and has been carried on for a period of seven years. During the period a few changes were made, certain types of protection were discontinued, others added. The number of colonies used in the tests also varied from year to year.

The success of each method was measured by the condition of the colonies the following spring and not by the crops produced because once the active season opens several other factors, quite apart from wintering, affect the producing ability of the colony. Any colony that did not have sufficient bees to cover more than three standard-size combs at the first examination in the spring was considered lost.

Table 6 gives a summary of results for the 7-year period.

TABLE 6.—COMPARATIVE RESULTS FROM WINTERING IN DIFFERENT TYPES OF PROTECTION, 1941 TO 1947.

Type of Protection	Year	Number Cols. in Group	Number Living Colonies* in Spring	Per cent Loss
Quadruple case plus 4" packing.	1941	12	9	25·0
One thickness of insulating paper covered by a waterproof paper. No packing. Double colonies.	1941	18	14	26·6
	1942	10	6	40·0
	1943	10	6	40·0
Not tested since 1943 as losses were consistently high.				
Paper wrap plus 4" cut straw packing. Double colonies.	1941	18	18	0·0
	1942	10	10	0·0
	1943	10	7	30·0
	1945	....	....	....
	1946	3	3	0·0
	1947	30	27	10·0
Not tested during 1944 and 1945.				
Double colony case plus 4" cut straw packing.	1941	18	16	13·3
	1942	12	10	16·6
	1943	10	9	10·0
Not tested since 1943 mainly because of drifting both in fall and spring.				
Permanently packed hives. Single colonies.	1941	15	14	6·6
	1942	15	14	6·6
	1943	20	18	9·0
	1944	32	30	6·3
	1945	30	27	10·0
	1946	20	18	10·0
	1947	6	16	0·0
Corrugated paper cases. Double colonies.	1942	10	9	10·0
	1943	10	7	30·0
Unprotected. Single colonies.	1944	5	5	0·0
	1945	5	5	0·0
	1946	5	5	0·0
	1947	15	10	33·3
Single case plus 4" cut straw packing. Single colonies.	1944	10	9	10·0
	1945	40	37	7·5
	1946	60	60	0·0
	1947	60	56	7·0

*Weak colonies with three or less frames were united and considered lost.

Table 6 shows a tendency towards the use of single colony units not necessarily because of a higher mortality in the multiple cases but rather because of wide variation in strength of colonies in the spring through a drifting of bees from one colony to another when wintering in close proximity. Drifting occurred both in late fall and early spring. This drifting, of course, can be considered as a factor in the higher mortality in these cases.

Of the multiple cases, the paper plus insulation gave fairly good results over the whole period in spite of the fact that the losses were quite heavy in 1943.

The unprotected group is difficult to analyse. For three years, no losses occurred but in the fourth year one third perished outright while those that survived never built up into strong producing colonies. In the Ottawa district, it is wise not to consider this type of wintering.

The single colony units with four inches of packing material are the most satisfactory for this district. They are easy to handle, drifting of bees from one colony to another is eliminated, and bees winter well in them.

In the divisional apiary at Brandon, Man., a large number of colonies have been successfully wintered for several years by wrapping them with a material known as "balsam wool". See Publication No. 689 and the Ten Year Progress Report of the Brandon Experimental Farm. This material is in the form of a blanket approximately 1 inch thick and must be covered by a waterproof paper. It is easy to apply but, unfortunately, difficult to obtain. Some of the permanently packed hives shown in Table 6 have a sheet of "balsam wool" between the double walls of the hive.

Comb vs. Foundation

The secretion of wax is apparently an involuntary action but is the result of honey consumption. If such wax is not used in drawing out new comb it is wasted, either falling to the floor board or used in building brace or burr comb.

This experimental project, carried for a 5-year period, was designed to determine to what extent a colony could build new comb without reducing its honey crop.

Each year a number of colonies of as near equal in strength and vigour as possible were selected just prior to the main honey flow. These were divided into three groups and supered during the flow as follows:

Group 1: Checks, each super as added contained 9 drawn combs. No foundation.

Group 2: Each super contained 6 drawn combs plus 3 frames fitted with full sheets of foundation.

Group 3: Each super contained 3 drawn combs plus 6 frames of foundation.

In groups 2 and 3 the foundation frames were placed alternately between the drawn combs in each super.

Of the five years during which the project was carried only one, 1938, was considered to be a good honey producing season in the Ottawa district. The other four, 1936, 1937, 1939 and 1942 were below average.

Table 7 shows the data secured from this experiment.

TABLE 7.—FIVE-YEAR DATA ON COMB VS. FOUNDATION EXPERIMENT

Year	Number Col. in each group	Group 1 9 drawn combs		Group 2 6 combs + 3 foundation		Group 3 3 combs + 6 foundation	
		Honey lb.	Combs drawn	Honey lb.	Combs drawn	Honey lb.	Combs drawn
1936	3	462·0	....	342·0	15	354·0	18
1937	3	240·5	....	171·5	9	216·0	16
1938	3	919·0	....	962·5	9	820·0	18
1939	3	486·5	....	470·0	6	585·5	30
1942	7	658·0	....	622·5	51½	443·0	43
Totals	19	2,766·0	....	2,568·5	90½	2,418·5	125
Averages	....	145·6	....	135·2	4·8	127·3	6·5

Considerable variation is shown in the amount of honey produced by the different groups. In 1938, Group 2 produced 43 pounds more honey than Group 1 and in addition produced 9 new combs. In 1936, 1937 and 1939 Group 3 produced more honey than Group 2 and also built 64 new combs as compared with 30 for Group 2, while in 1939 Group 3 yielded more honey than either groups 1 or 2 besides producing 30 new combs.

Considering the production over the whole period, there is some indication that a limited number of new combs may be drawn each year without seriously affecting the honey crop. Considering the value of drawn comb and the necessity of annual replacements, the wise beekeeper will endeavour to have a few new combs drawn each year by each of his colonies especially in years of heavy nectar secretion.

An experiment also was carried out to determine the amount of wax added by bees in building the combs for section honey.

Fully capped 4″ x 5″ sections, Grade No. 1 were used with the following results shown in Table 7B.

TABLE 7B.—WEIGHT OF COMPONENT PARTS OF SECTION OF HONEY.

Weight	No. 1	No. 2
Weight of section	412 gm.	458 gm.
Weight of wood	17 gm.	17 gm.
Weight of honey and wax	394 gm.	436·5 gm.
Weight of honey	376 gm.	418·5 gm.
Weight of wax (by difference)	18 gm.	18 gm.
Weight of foundation (average)	$4\frac{1}{3}$ gm.	$4\frac{1}{3}$ gm.
Weight of wax added	$13\frac{2}{3}$ gm.	$13\frac{2}{3}$ gm.

In the building of comb honey sections and in the capping of the cells these results would indicate that the bees add 13 2/3 grams of wax or nearly 1/2 ounce—about three times the weight of the foundation used.

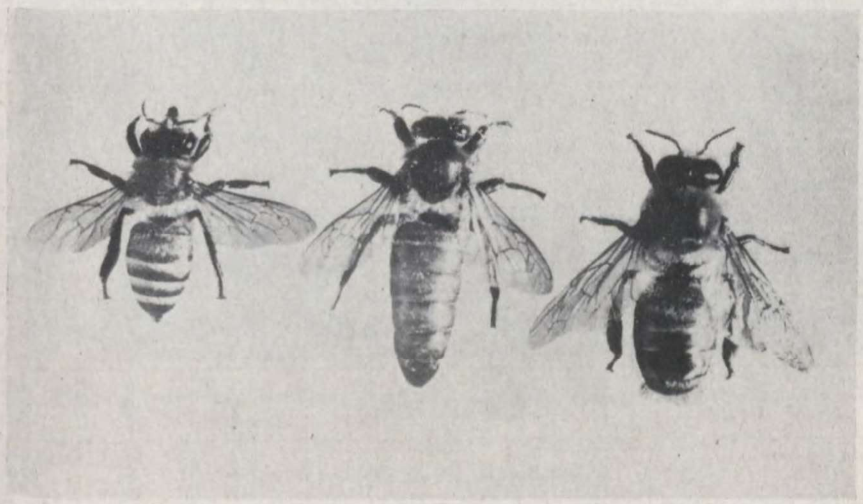

FIG. 4. A colony of bees consist of: one Queen, a few hundred drones, and up to one hundred thousand workers. (Left)—Worker. (Centre)—Queen. (Right)—Drone.

Hive Entrances for Winter

As honey is consumed by wintering bees, moisture is given off in volume approximately equal to the amount of food consumed. For example, for each gallon of food consumed a gallon of moisture is released. The accumulation of this moisture within the colony is detrimental to the bees, therefore, must be removed in some way. In the past, the main method of getting this moisture out of the hive has been to allow it to escape through a porous cover, on top of the hive, into the insulating material above. There are two objections to this method, however, (1) that it also allows the heat generated by the bees to escape and (2) the escaped moisture condenses in the packing above the colonies and destroys its insulating value.

To overcome these objections, it was originally decided to provide a definite number of colonies with a small entrance at the top of the hive only and this entrance so constructed to carry the hive moisture directly to the outside of the wintering case. To do this, an ordinary inner cover, or honey-board, as it is sometimes called, with a 3 x 1½ inch hole in its center was placed over each colony. This hole was connected with the outside by a tunnel (See Publication No. 681, "Wintering Bees in Canada") which provided an outside entrance of 1 x 3 inches. The colonies were checked with a similar group having the orthodox lower entrance plus upward ventilation.

Preliminary experiments, however, indicated that little or no advantage was gained by the top entrance insofar as the wintering of the bees was concerned except that it did carry off some of the moisture to the outside. This kept the top packing dry and it also prevented mice or other small rodents from entering the colonies in the fall. The bees in the check colonies with the lower entrances plus upward ventilation, however, appeared to winter equally as well as those with the top entrances.

In the fall of 1939, a third group having a combination of entrances was added. This combination of entrances consisted of: a lower entrance having two ¾" holes, and a top entrance having two ⅜" holes.

Table 8 shows the data secured each year over a period of five years while Table 9 summarizes the total period. Unfortunately, it was necessary to suspend the project during the winters of 1944-45, 1945-46, and 1946-47.

TABLE 8.—ANNUAL COMPARISON OF COLONIES WINTERED WITH TOP, BOTTOM AND COMBINATION ENTRANCES.

Winter of	Number Col.	Type of Entrance	Av. Number Combs Covered in Fall	Av. Number Combs Covered in Spring	Number Living Colonies	Per Cent loss of Colonies
1940-41	27	Top	7·7	8·3	24	11·1
	27	Bottom	7·7	8·5	24	11·1
	27	T & B	7·6	7·1	23	14·8
1941-42	12	Top	8·3	8·7	9	25·0
	12	Bottom	8·0	7·3	10	16·6
	12	T & B	8·3	5·9	11	8·4
1942-43	10	Top	9·8	3·2	10	0·0
	10	Bottom	9·5	3·8	10	0·0
	10	T & B	10·5	4·2	10	0·0
1943-44	10	Top	10·7	5·1	10	0·0
	10	Bottom	10·8	7·5	8	20·0
	10	T & B	7·1	5·3	10	0·0
1947-48	16	Top	9·2	9·4	14	12·5
	16	Bottom	9·4	9·5	14	12·5
	16	T & B	9·4	10·6	15	6·3

TABLE 9.—COMPARISON OF THE THREE GROUPS FOR THE COMPLETE PERIOD OF FIVE YEARS.

Period	Number Col.	Type of Entrance	Av. Combs Covered in Fall	Av. Combs Covered in Spring	Av. Loss in Colony Strength	Number Living in Spring	Per Cent Loss
Five years	75	Top	8·8	7·5	14·85	67	10·7
	75	Bottom	8·8	7·7	11·41	66	12·0
	75	T & B	8·4	7·0	16·48	69	6·7

Table 8 shows considerable variation in the spring condition of the colonies from year to year. The group showing the greatest loss in 1940-41 suffered the least the following year when factors other than position of entrances no doubt played a part in this variation.

Table 9 summarizes the colony conditions for the entire period. It will be observed here that the complete loss of colonies was less in the group having the combination of top and bottom entrances than in the other two groups. On the other hand, the two groups having a top entrance suffered most in loss of colony strength. This loss can at least be partially explained by the fact that the bees of these colonies were taking frequent flights during late winter and early spring while those in the lower entrance group were still inactive. Many bees were lost during these early flights because the outside air temperature was too low for sustained flight.

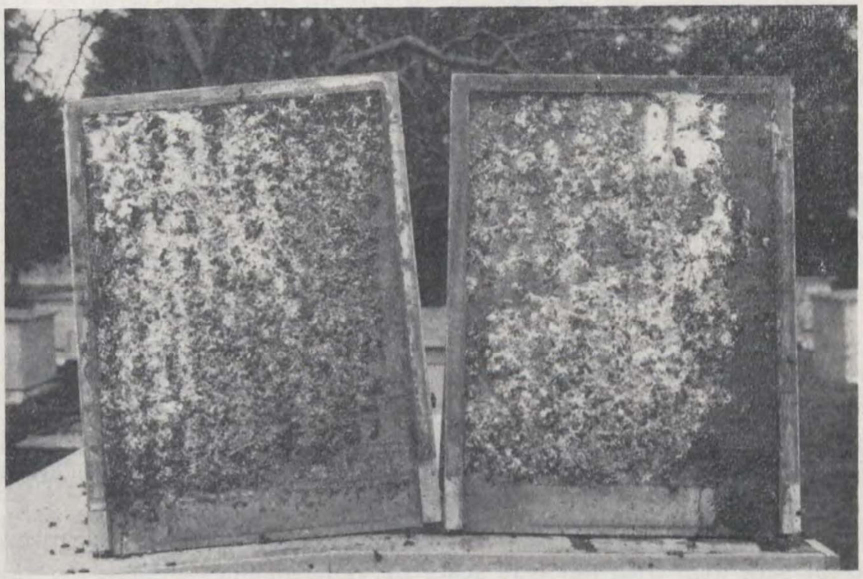

FIG. 5. Two floor-boards showing dead bees and mould in Spring. The result of too much moisture in hive during the winter.

SUPERSEDURE OF QUEENS

The loss of queens through supersedure is a serious problem for those importing package bees, the loss often reaching 100 per cent within a few weeks after installing the bees in hives. This is especially true in the Prairie Provinces.

The cause of supersedure is unknown but it is suspected to be a combination of several factors. In order to obtain all the information possible on the matter, 4,000 questionnaires were sent from the Division's laboratory at Brandon, Man., to private beekeepers, but only 357 replies were returned. Of these, 95 did not import packages during that year (1937) but the remaining 262 replies involved 7,734 packages. Supersedure of these packages ranged from 0—100 per cent. From the information supplied, no definite cause of supersedure could be determined.

At Ottawa only one factor, the method of shipping the queen, was studied. The usual method is to enclose the queen in a small travelling cage and to suspend this cage among the bees in the package. The cage in which the queen travels may be provisioned with food or not and she may or may not be accompanied by a few attendant bees. The queens received in this experiment arrived in three ways:

(1) Accompanied by attendants and with food within the cage A. (see Table 10.)

(2) Without attendants or food, U. (see Table 10.)

(3) By mail separate from the package altogether, but arriving at the same time as the packages of bees.

All packages were installed by placing the queen cages between the top bars of the combs, shaking a few bees from the package on to the cage and then placing the package within the hive. In all cases, the empty package was removed 12 hours later and the hive filled with drawn comb. The results are shown in Table 10.

TABLE 10.—SHOWING THE NUMBER OF PACKAGES RECEIVED AND THE NUMBER AND PERCENTAGE OF QUEENS SUPERSEDED DURING THE PERIOD OF 11 YEARS.

The earliest and latest date on which packages were installed.	Kind and number packages. Queen shipped. (U) Unattended (A) Attended (S) Mailed separate from package.			Totals	Number of queens superseded and length of time between time installed and time of supersedure.
	2 lb.	3 lb.	5 lb.		
Apr. 20-May 21............	78-U	19-U	12-U	109	6 superseded within 4 wks.
	10-A	5-A	5-A	20	2 superseded within 8 wks.
	25-S	0-S	0-S	25	None.
Totals....................	113	24	17	154	8—or 5·9%.

The percentage of supersedure shown in the above table is not at all excessive. Although the number of queens received by mail separately from the packages was considerably less than the number received unattended, there is some indication that the incidence of supersedure might be lessened by adopting this method.

At the Brandon apiary several methods of installing the package bees of different ages were tried but here again the difference in percentage of supersedure was insignificant. For details of the procedure used and the results obtained at Brandon see the Progress Report of that Station.

Dual Queens for Honey Production

This experiment was started in 1938 to determine if unit production could be increased by having two queens in each colony during the build-up period of spring and early summer.

It was originally planned to raise approximately 50 per cent of the bees and brood from the original brood chamber to a super on top of the colony, then introduce a young laying queen to the bees and brood in this super. Unfortuately the new queens did not arrive early enough to use in this project. As a result, the small queenright nuclei that had been overwintered were used during 1938, 1939 and 1940. When the nuclei were used, no bees or brood were raised from below.

In 1941, the use of nuclei was abandoned and the original plan of raising brood and bees and introducing a queen only was followed.

The project was suspended during 1945 and 1946 but was resumed in 1947 with a slightly different procedure.

The date on which the divisions were made and the nuclei or queens introduced varied from year to year because of variations in weather conditions. The earliest date was April 19 and the latest May 11.

The procedure of establishing the two-queen colonies was as follows:

As early in the spring as weather conditions permitted, three or four frames of emerging brood with adhering bees were transferred from the brood chamber to a super. One or two combs containing honey and pollen were also transferred to the super. A few bees from the other combs were shaken into the super as well in order to make sure there were enough bees to take care of the brood. Care was taken not to transfer the queen of the colony to the super; she was left below. Both brood chamber and super then were filled up with drawn comb.

A queen excluder was placed on top of the original brood chamber and above it one or two supers of empty combs. A double screen board was put on top of the supers and above the screen was placed the super containing the bees and brood that were taken from the lower chamber. The colony now consists of (1) the original brood chamber containing brood, bees, food and the old queen, above it (2) a queen excluder, above which are, (3) one or two extracting supers and above them (4) a double screen board and on top of all (5) the super containing bees, brood and food. A young queen was introduced to the top chamber twelve hours after dividing the colony.

The bees in the top chamber were provided with access to the outside by cutting a notch, about an inch wide, in the front, upper rim of the screen board.

As the upper queen expanded her brood nest another super was placed above her. Other supers were added for the storage of honey as needed.

The two queens were left in the colony until the first week of the main honey flow and then one of them was removed.

From 1938 to 1940. The bottom brood chamber containing the old queen was removed and the upper brood chamber containing the young queen was lowered to the floor board. The chamber that was removed was placed on a new stand as increase.

From 1940-44. The upper chamber containing the young queen was the one removed to a new stand as increase.

When the project was resumed in 1947 the upper queen only was removed and used elsewhere. In this way all brood and bees were left on the original stand.

The number of colonies used in the experiment varied from year to year but in every year an equal number of single queen colonies of equal strength were used as checks as shown in Table 11.

TABLE 11.—SHOWING NUMBER OF COLONIES USED EACH YEAR AND THE CROPS PRODUCED.

Year	Number Cols. in each group	Two Queens (lb.)	Single Queens (lb.)
1938	5	1,407·0	1,138·0
1939	5	925·0	685·0
1940	5	880·0	798·0
1941	10	1,415·0	771·0
1942	10	930·0	891·0
1943	10	2,364·5	2,050·0
1944	10	135·5	187·5
1947	13	3,561·0	2,699·0
1948	20	5,825·0	3,906·0
Totals	88	17,443·0	13,125·5
Average	....	198·21	149·15

The annual variation shown in crop produced was mainly due to weather conditions. The years 1947 and 1948 were exceptionally good.

Over the 9-year period, the two-queen colonies produced an average of 49·06 pounds more honey than the single-queen checks. Apparently little or no advantage was gained from the addition of bees as was done during the first three years. It may be assumed that the extra crop was secured by the extra bees the second queen was able to produce prior to the beginning of the main honey flow.

Prior to 1947, the extra crop of honey did not represent all that was secured from the dual queen colonies for each one of them produced another colony as increase.

It has been assumed generally that the division of colonies into separate units is not feasible under eastern conditions, but could only be recommended for areas where the build-up period between the break-up of winter and the main honey flow is of longer duration and where the main flow extended well into late summer or early fall. Such conditions exist in the Prairie Provinces.

At the Experimental Farm, Brandon, Man., a system of dividing colonies into separate units has been under trial for several years with remarakble success. See Publication No. 774, "Dividing Over-Wintered Colonies for Increased Honey Production", by E. Braun and also the Ten-Year (1938-1947) Progress Report of that Station.

It was decided to give the system a trial under Ottawa conditions.

The procedure was to divide the bees and brood of a colony as nearly equal as possible placing one half into a new hive and introducing a new queen to it. From then on the two units, parent and increase, were treated as separate colonies. The divisions were made on May 12, about six weeks before the main honey flow commenced. As the divisions were made the bees in the new units were confined to their hives for 24 hours before the new queen was introduced.

In 1948, ten colonies of equal strength were divided as outlined above, ten other colonies of equal strength were selected as checks to be run with single queens only. In addition, ten colonies, also of equal strength like the others, were set aside to be run as two-queen colonies as described above. Table 12 shows the crops and increase produced by the three groups.

TABLE 12.—SHOWING PRODUCTION OF *(a)* TWO-QUEEN COLONIES IN WHICH THE TWO QUEENS WERE HOUSED IN A SINGLE COLONY. *(b)* SINGLE-QUEEN COLONIES AS CHECKS AND *(c)* TWO-QUEEN COLONIES BUT HOUSED IN SEPARATE UNITS.

	(a) Two Queens in Single Unit	*(b)* Single Queens Checks	*(c)* Two Queens in Separate Units		
			Parent	Increase	Total
Number Colonies	10	10	10	10	20
Col. Max. lb.	337	291	239	181	420
Col. Min. lb.	239	156	38	110	148
Total Crop lb.	3,009	2,339	1,702	1,436	3,138
Av. per Col.	301	234	170	144	314
Incr. in Col.	0	0	....	10	....

The table shows that the ten two-queen colonies divided into separate units gave an average of thirteen pounds more honey than did the two-queen colonies that were divided but kept within a single unit. In addition Group (*c*) gave an increase of ten colonies whereas Groups (*a*) and (*b*) gave no increase.

The single-queen colonies, Group (*b*), produced an average of 67 and 80 pounds less than Groups (*a*) and (*c*), respectively.

No definite conclusions can be drawn from the latter part of this Experiment as it has been carried only one year. Furthermore, weather conditions were exceptionally good in the Ottawa district during the year concerned and certainly favoured both the two-queen groups.

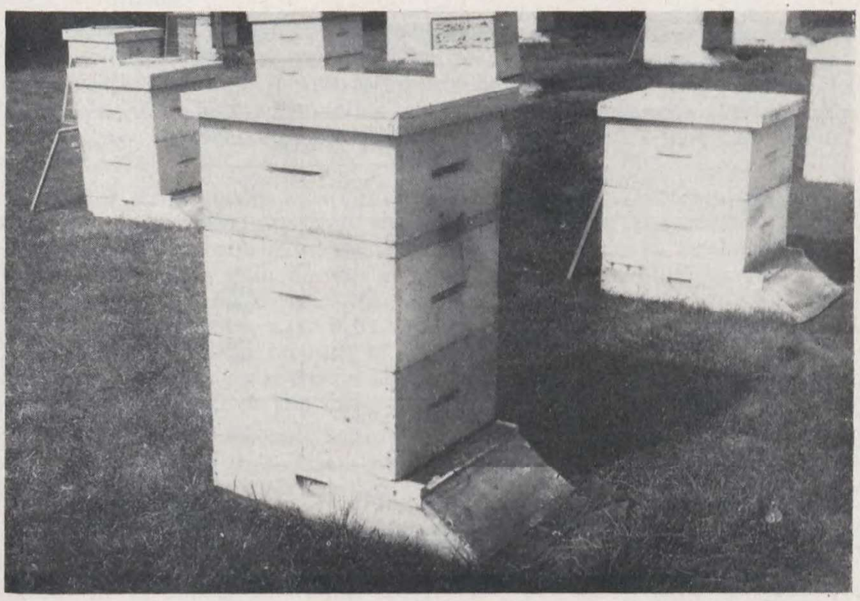

FIG. 6. A Dual-Queen Colony. The young queen, with raised brood, is in the top Super. Note top entrance cut in rim of screen division board.

ITALIAN VS. CAUCASIAN BEES.

A comparative test of the Italian and Caucasian races of bees was carried for a period of eight years, 1930–1937.

Four colonies of each race were established in permanently packed, ten-framed Langstroth hives and kept under identical conditions and management. During the active season, all colonies were examined once every ten days and records kept of colony conditions. In order to keep the races as pure as possible all queens used during the eight-year period, were purchased from breeders specializing in these particular breeds. Spare queens were kept in nuclei for use in emergency requeening. In the fall, all colonies were fed by giving a full super of honey to each colony. After feeding, the apiary was seldom seen again until the following spring.

During the eight years, two colonies only were lost, one of each race. The Italian colony was destroyed by mice, while the Caucasian colony became queenless sometime after fall feeding and was too weak to be of any value the following spring.

Preparations for swarming were stronger in the Caucasian colonies than in the Italian colonies during the first four years of the experiment but were approximately equal during the second half. Simple methods of manipulation, however, suppressed these preparations to such an extent that no swarm actually emerged.

It was found that the Caucasian bees were more gentle than the Italians under manipulation. The main objections to the Caucasian race were that being dark in colour the queens were more difficult to find than in the lighter coloured Italians; also, the Caucasians made excessive use of propolis, glueing the frames of their hives tightly together with this material and often closing the hive entrances almost completely with it.

As the beekeeper measures the value of his bees by the honey they produce, Table 13 shows the production of the two races over the eight-year period.

TABLE 13.—YEARLY YIELDS OF HONEY FROM ITALIAN AND CAUCASIAN COLONIES.
8-Year Period: 1930-1937

Year	Cols. in Group	Italian		Caucasian	
		Prod. (lb.)	Av. (lb.)	Prod. (lb.)	Av. (lb.)
1930	4	925	231	613	153
1931	4	1,125	281	911	228
1932	4	510	128	387	97
1933	4	837	209	670	168
1934	4	1,154	289	904	226
1935	4	753	188	591	148
1936	4	802	201	877	219
1937	4	821	205	819	205
Totals	32	6,927	....	5,772	....
Average	....	....	216·5	....	180·4

Table 13 shows that the average annual increase over the 8-year period was 36·1 pounds in favour of the Italians for the Ottawa district.

A ten-year test of the two races, conducted at the Experimental Station, Charlottetown, P.E.I., showed very little difference either in hardiness or productiveness.

The project has been enlarged and transferred to the Experimental Farm at Brandon, Man., where three races, Italian, Caucasian and Carniolan, are being tested.

As the Carniolan race of bees is given to excessive swarming, this race has not been popular. At Brandon, it has been found that a different system of management is needed to get the most out of this particular breed of bees.

The Carniolan bees build up much more rapidly in the spring and early summer. Hence, they reach maximum strength too early and the swarming fever becomes intense just when the main honey flow comes on.

To overcome this, a system of management has been developed whereby all strong colonies are divided about six weeks prior to the beginning of the main honey flow and a new queen introduced to the new unit. This technique makes use of the extreme prolificacy of the race and instead of allowing the single unit to build up to maximum strength and develop the swarming instinct early, it is divided and two producing units are formed. By reducing the strength of the original unit by 50 per cent, the swarming instinct is also kept subordinate to the storing instinct.

Tests are under way to determine whether or not production can be further increased and swarming more completely controlled by even a greater number of divisions.

Similar tests are being made with the Italians and Caucasians. Indications are that the same technique as used for the Carniolan race will also increase the productivity of both these races but not to the same degree.

For further information, see Publication No. 774 and also Ten-Year Progress Report of the Experimental Farm, Brandon, Man.

Wintering over Surplus Queens

As it is not always possible to secure southern-bred queens early enough in the season for emergency requeening in the spring, it was thought advisable to find some method whereby surplus queens in the fall could be safely carried through the winter.

The usual method of handling weak colonies in the fall is to kill one of the queens and to unite the bees of two colonies to make one strong colony. Instead of following this method, it was decided to bring two of these weak colonies together into a single hive with a thin but solid division between the two colonies. Thus, not only the bees but the queens also were saved. The experiment was highly successful.

Later on, single hives were divided into three and four compartments and small nuclei established in each compartment during the main honey flow. A ripe queen cell, virgin or laying queen was given to each nucleus. A laying queen is preferred as such queens are more readily accepted by the bees and assured a more rapid build-up of the nuclei. These nuclei built up quite strongly during late summer and early fall, and quickly covered their quota of combs, besides storing a certain amount of surplus honey, but not enough, however, for their winter needs. To ensure they had enough food for winter, a 2:1 sugar syrup was given them in the fall.

The bees in each nucleus were provided with a separate entrance for it is highly important that there is no communication between compartments otherwise all queens but one will be killed.

The two-queen units were wintered outside in packing cases while the three- and four-queen units were wintered in the bee cellar. Table 14 shows the results.

TABLE 14.—SHOWING THE NUMBER OF QUEENS PUT AWAY FOR THE WINTER AND THE NUMBER ALIVE THE FOLLOWING SPRING.

Winter of	2-Queen Nuclei		3-Queen Nuclei		4-Queen Nuclei	
	Number Queens put away for winter	Number alive in spring	Number Queens put away for winter	Number alive in spring	Number Queens put away for winter	Number alive in spring
1935-36	6	5	9	8	12	8
1936-37	8	8	9	7	12	10
1937-38	8	8	9	8	12	8
1938-39	8	8	9	9	12	10
1939-40	8	8	9	5	12	11
1940-41	8	8	9	5	12	9
1941-42	....	....	9	9	12	8
1942-43	12	12	12	10	12	5
1943-44	12	11	12	4	12	6
1944-45	12	10	12	11	....	....
Totals	82	78	99	76	108	75
Per cent Loss	....	4·9%	....	23·2%	....	30%

With the exception of 1940, 1941 and 1944 the three-queen units wintered exceedingly well but the percentage loss of queens was 23·2 per cent as against 4·9 per cent for the two-queen units.

The quadruple units also wintered well in 1937, 1939 and 1940 but over the whole period the percentage loss of queens was 30 per cent, almost one-third.

The double or two-queen units wintered remarkably well throughout the whole period.

Over the ten-year period, 229 spare queens were safely wintered for emergency requeening in the spring if needed. If any of the queens were not needed for the requeening of overwintered, producing colonies, the nuclei were allowed to build up until each compartment was almost filled with bees. Then they were transferred to separate standard hives as separate colonies.

The plan of wintering surplus queens in twin nuclei is highly recommended and has now become a part of the routine management of many beekeepers.

Age of Bees in Relation to Wintering

The object of this experiment was to determine whether or not old bees were detrimental to the survival of overwintered colonies.

During the fall of 1941, twenty colonies were selected and divided into two groups of ten colonies each as follows:

Group 1: These colonies remained normal, retaining all their field bees.

Group 2: At the end of the main honey flow, early August, the brood chamber of these colonies were moved to new locations. The supers were left on the old stands to catch all returning field bees from the moved colonies. Later the bees caught in the supers were gassed.

The procedure succeeded in removing practically all of the old bees from the colonies in Group 2.

Both groups were wintered outside in double brood chambers and packed in two-colony cases.

The above grouping with the same number of colonies was repeated in the fall of 1942. Table 15 gives the results of wintering.

TABLE 15.—COMPARATIVE RESULTS OF WINTERING NORMAL COLONIES VS. COLONIES OF YOUNG BEES.

Group	Year	Number Col.	Av. Fall Population	Av. Spring Population	Av. Frames of Brood	Average Food Consumption
			(frames)			
1*..........................	1941	10	8·4	7·1	2·2	....
2**..........................	1941	10	8·7	7·5	2·2	....
1*..........................	1942	10	7·3	6·3	2·4	33·5 lb.
2**..........................	1942	10	7·9	6·6	2·5	30·6 "

*Normal colonies. Young + old bees.
**Young bees only.

The above figures in Table 15 do not indicate any advantage in manipulating colonies of bees in the fall so as to lose the old bees.

During 1944 and 1945, the procedure was changed slightly to include a third group consisting entirely of field bees which were to be wintered instead of being destroyed.

When certain colonies were moved from their stands to lose the field bees, new hives were placed on these stands to catch the returning bees. A laying queen was introduced to these bees. None of the brood produced by these introduced queens was allowed to emerge in these colonies. Table 16 presents the results.

TABLE 16.—COMPARATIVE AVERAGE RESULTS OF WINTERING NORMAL COLONIES VS. COLONIES OF YOUNG BEES AND COLONIES OF OLD BEES.

—	Colonies of Young Bees		Colonies of Old Bees		Normal Colonies	
	1944	1945	1944	1945	1944	1945
Number Colonies	8	6	8	6	8	6
Fall Pop. (per 1,000)	16·6	22·5	24·5	22·5	29·5	24·5
Spring Pop. (per 1,000)	7·7	19·7	13·7	13·3	12·5	18·5
Per Cent Fall Pop	45·8	87·8	54·5	59·2	42·0	75·7
Area Brood (sq. in.)	171·0	1,202·0	302·0	754·0	325·0	1,051·0
Food Used (lb.)	23·2	....	30·9	....	28·2	....

The data presented in Table 16 do not indicate that the old bees present in the normal colonies were in any way detrimental to the welfare of the colonies during the winter. In fact, when separated into colonies by themselves, they were able to build up into creditable colonies. Neither Table 15 nor 16 indicates that any advantage is obtained in manipulating colonies in the fall so as to lose the old bees. There are, however, some indications that the consumption of stores was the least in the colonies of young bees and greatest in those containing only old bees.

Upper vs. Lower Supering

When a colony needs additional supers for the storage of honey, the common practice is to place them immediately above the brood chamber or chambers. This procedure, however, involves considerable time and labour lifting off already filled supers and then replacing them after the new ones are given. Furthermore, a close check cannot be kept of the rate the new supers are being filled without again removing the heavy supers above them.

In 1932, an experiment with two other methods of supering was started. Three groups of six colonies each and of approximately equal strength were selected and supered for the main honey flow as follows:

Group 1: Each additional super was placed immediately above the brood chambers as is common practice.

Group 2: Each additional super was placed on top of the colony.

Group 3: Each additional super was placed immediately below the brood chamber.

Group 3 was abandoned after the second year because the removal of the brood chamber when adding new supers caused confusion to the flying bees and furthermore the whole colony had to be taken apart before the filled supers could be removed from the colony for extracting the honey.

Groups 1 and 2 were enlarged after Group 3 was removed.

TABLE 17.—TEN-YEAR PRODUCTION RECORDS OF COLONIES SUPERED BELOW VS. THOSE SUPERED ABOVE.

Year	Number of Col. each in Group	Supered Below		Supered Above	
		Total Prod. (lb.)	Average (lb.)	Total Prod. (lb.)	Average (lb.)
1932	6	338·3	56·0	423·0	70·5
1933	6	808·8	134·8	976·3	162·7
1934	11	1,896·5	172·4	1,787·0	162·5
1935	12	1,062·5	88·5	993·5	82·8
1936	12	1,426·0	118·8	1,587·0	132·3
1937	11	822·0	74·7	759·5	69·0
1938	12	2·969·5	247·5	2·997·0	249·8
1939	18	2,595·0	144·2	2,579·0	143·3
1940	12	1,510·5	125·9	1,795·0	149·1
1941	20	1,062·5	53·1	867·5	43·4
Ten Years	120	14.491·6	120·8	14.764·8	126·5

As shown in Table 17, the colonies that were supered above produced an average of 126·5 pounds of honey as compared with 120·8 pounds produced by those supered in the orthodox manner. This difference of 5·13 pounds is insignificant other than to show that the crop was not reduced by the newer method of supering.

The main significance of the experiment is the difference in time and labour required by each method. While the actual time for the handling of every colony in the experiment was not measured, a few timings indicated that the time required per colony was reduced by at least 80 per cent. Furthermore, a closer check on the activities of the bees in the supers could be made.

The argument advanced againt top supering is that the brood chamber of the colony does not receive the proper attention while the main honey flow is on and that swarming may occur because of this neglect. Over the ten-year period, 5 of the 120 colonies swarmed, 2 of these were from the colonies supered below and 3 from those supered above. The question of swarming, therefore, is insignificant.

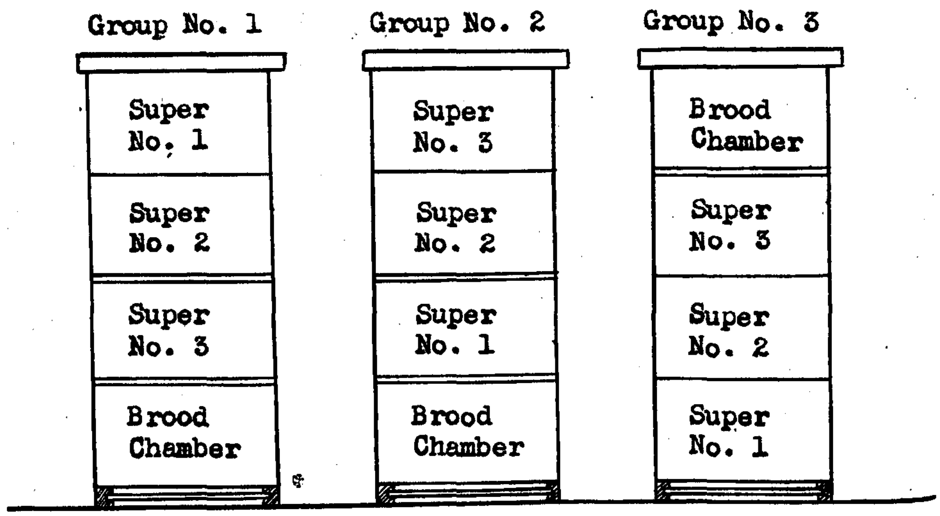

FIG. 7. Showing three methods of supering colonies. Group 1 is the common method. Group 2 is now known as top supering. Group 3 was abandoned for reasons given in text.

HONEYBEES AND ORCHARD SPRAYS

This project was conducted in co-operation with the Divisions of Entomology, Horticulture and Chemistry, and the object was to test the toxic effect of DDT on honeybees.

Prior to the opening of apple bloom in 1946, three colonies of bees were placed in the Russian orchard at the Central Experimental Farm, Ottawa. Since this orchard covers an area of approximately four acres and consists of several varieties of apples, the blossoming period, therefore, is extended over several days. The delayed dormant, pre-pink, and pink sprays had been applied before the introduction of the bees.

Specially constructed traps were placed in front of each colony to catch dead bees.

Owing to the difference in flowering dates, the orchard was divided into two parts, one half being sprayed on May 23 and the other on May 28. These, and succeeding sprays containing DDT, were made up as suspensions of two pounds 50W Deenate per hundred gallons. These sprays were applied at the rate of two hundred gallons per acre.

On May 31, calyx spray containing the same concentration of DDT but with sulphur added, was applied at the rate of 335 gallons per acre.

The first cover spray was applied on June 12. This was identical to the calyx spray but 400 gallons were applied to each acre. A second cover spray was applied on June 24 but this did not contain DDT. The buckwheat cover crop on part of the orchard was also sprayed three times, with DDT, while in full bloom.

The bees were working the bloom of both apple and buckwheat at time of spraying. Bees were also observed working in the blossoms almost immediately after the spray had been applied, even before the blossoms had become dry. Little or no repellent action was observed.

Frequent observations were made on bee activity and the colony condition. Daily counts of the bees caught in the traps were made. These bees were collected and submitted to the Division of Chemistry for analysis.

TABLE 18.—NUMBER OF DEAD BEES COLLECTED AFTER TREES WERE SPRAYED, FROM THE TRAPS IN FRONT OF COLONIES IN THE RUSSIAN ORCHARD

Date of collection of dead bees	Colony No.			Date	Colony No.			Date	Colony No.		
	132	133	93		132	133	93		132	133	93
May 25	30	19	27	June 15	55	33	77	Aug. 1	10	7	14
27	5	......	......	18	86	40	87	2	10	7	20
28*	4	5	9	19	17	8	14	5	9	7	34
29	6	11	9	21	20	18	45	7*	40	59	140
30	29	14	23	24*	170	25	38	8	14	9	100
June 1*	45	12	28	26	23	37	35	10	68	73	156
3	150	10	28	28	10	23	35	14	24	24	49
4	81	7	27	July 2	23	20	35	20	28	62	67
5	41	8	43	10	79	101	260	......	......	......	......
7	33	14	24	17	78	85	240	......	......	......	......
9	32	19	66	27*	59	89	333	......	......	......	......
10	13	4	27	29*	16	26	73	......	......	......	......
12*	13	12	31	30	7	4	34	......	......	......	......
13	7	6	?	31	12	6	63	......	......	......	......

*Dates on which eprays applied.

Table 18 shows that no abnormal numbers of dead bees were taken on the days immediately following the date on which the sprays were applied. As the sprays were applied on bright, warm days when bee activity was at its maximum the greatest mortality should have occurred on those days.

A somewhat increased death rate occurred during the first week in June. An analysis of the bees gathered during that week, however, showed arsenical poisoning which was traced to a nearby orchard in which arsenical spray had been applied.

Of seven composite samples of dead bees analysed by the Division of Chemistry, only one sample showed DDT in excess of the lethal dose of 4·6 micrograms per bee.

At no time were there any ill effects on the brood of the colonies.

The test was continued in 1947 but since no cover crop was grown in the orchard, both spraying and observations, therefore, were confined to apple bloom alone. No arsenical sprays were used in nearby orchards; in 1947 DDT was the only poison used.

As in 1946, the bees were placed in the orchard prior to the opening of the bloom. On June 4, the bees were observed working the blossoms freely.

On June 6, when about 80 per cent of the bloom was fully open, the first spray containing DDT was applied.

On June 12, the calyx spray also containing DDT was applied.

Dead bees were collected from the traps and also a few were collected from beneath twenty of the largest trees in the orchard.

Table 19 shows total number of bees collected from the traps and from beneath trees.

TABLE 19.—DATES, AND NUMBERS OF DEAD BEES COLLECTED FROM TRAPS AFTER SPRAYING

Colony No.	65	1	12	Beneath Trees
Date collection made				
June 7	12	3	12	10
10	26	48	62	5
11	11	7	9	0
12*	......	......	......	......
16	148	102	210	0
18	107	78	127	0
21	38	21	27	0
24	27	19	28	0
26	Colonies moved from orchard.			

*D te on which sprays were applied.

The average death rate in the test orchard was no greater than that observed in the apiaries outside the danger zone.

At no time was there any mortality in the brood nests of the exposed colonies.

Four composite samples of dead bees were submitted to the Division of Chemistry for analysis and, as in 1946, only one sample showed DDT slightly in excess of the lethal dose.

The test was a drastic one in that the sprays were all applied during full bloom, a condition that would never exist in regular orchard practice. Under this condition a heavy death rate would be expected in the exposed colonies but this, however, did not occur. The conclusions are that no serious poisoning of bees may be expected in orchards where DDT is applied in conformity with normal orchard practice.

In 1948, Parathion replaced DDT in the experiment. As in previous years the three colonies of bees were placed in the orchard prior to the opening of bloom, May 10, and traps placed in front of them.

A "pink spray" containing Parathion was applied to the orchard on May 20. On that date only 16 of the trees showed open bloom and it was estimated that these trees were from 10-50 per cent in bloom.

On the morning of May 20, before the spray was applied the dead bees were collected from the traps and counted, 549 in all or an average of 54·9 per day from the day they were moved in.

Table 20 shows dates and number of bees collected.

TABLE 20.—TOTAL NUMBER OF DEAD BEES COLLECTED FROM TRAPS AFTER TREES WERE SPRAYED

Date of Collections	Spray	Number Dead Bees
May 21*	Pink (Parathion)	602
22		208
25		12,000
26		169
29		189
June 1		315
3		268
5*	Calyx (Parathion)	366
8		144

*Dates on which sprays were applied.

The table shows that a very heavy killing of bees took place immediately following the first application of Parathion. The death rate was not quite so heavy following the calyx spray. This perhaps was due to the fact that practically all bloom had fallen.

Composite samples of dead bees sent to the Division of Chemistry for analysis failed to show traces of Parathion. As the analysis was not made for several weeks after the bees had been collected, and as Parathion is an unstable product, it was thought that all traces of it had disappeared from the sample by the time the analysis was made.

From the field results it would appear that Parathion in orchard sprays is deadly to honeybees. This test is to be repeated.

Sulphathiazole and American Foulbrood

Treatment of Infected Colonies

Early in 1946, an outapiary of ten colonies was established for the purpose of testing sulphathiazole and penicillin for the control of American foulbrood.

All ten colonies were inoculated with the disease by inserting heavily-infected combs into the brood chamber of each colony during May and early June. As soon as the disease became well established and had spread to the new brood, the colonies were divided into three groups as follows:

Group A: Six colonies to be treated with sulphathiazole.

Group B: Three colonies to be treated with penicillin.

Group C: One colony untreated, as check.

Treatment of the colonies consisted of feeding them a syrup made of equal parts sugar and water from honey-pail feeders.

Both the sulphathiazole and penicillin were incorporated with the syrup at the rate of one-half gram per gallon of syrup.

The feeding of the medicated syrup to the bees was begun on June 12 and continued, at weekly intervals, until July 3, which meant that each colony was fed four times and each received two and a half gallons of syrup. The check colony was given an equal amount of unmedicated syrup.

All colonies were examined weekly and the progress of the disease was carefully watched and measured. The condition of the colonies at each examination is shown in Table 21.

TABLE 21.—NUMBER OF DISEASED CELLS APPEARING IN COLONIES INOCULATED WITH AMERICAN FOULBROOD

Date	Treatment									Check
	Sulphathiazole						Penicillin			
Col. No.	73	117	31	97	125	53	62	110	158	54
June 19	91	......	49	142	40	281+	125	......	......	......
24	187	155	66	266	43	221+	181	27	68	8
July 2	122	151	49	141	58	268	65	27	74	156
9	68	143	24	82	29	245	129	76	254	343
17	38	59	30	54	19	220	288	66	408	454
24	87	22	36	57	41	......	62	174	113	369+
31	......	......	......	......	......	......	......	......	......	......
Aug. 7	132	48	33	125	24	85	245	108	162+	277+
14	66	53	11	43	19	28	303+	415+	273+	+++
21	7	12	7	19	8	3	280+	537+	325+	1,200+
30	0	0	6	29	3	0	700+	800+	1,100+	1,600+
Sept. 13	0	0	0	2 scale	1	0	++++	++++	++++	++++

+Indicates that numerous cells were present other than those counted.

Table 21 shows clearly that the colonies treated with sulphathiazole were able to clean up the disease so that there was little or no visible sign of American foulbrood in their brood nests at the end of the season.

It is equally obvious, that both in the check colony and those treated with penicillin the infection progressively increased as the season advanced. In order to save these colonies, it was necessary to treat them also with sulphathiazole.

In order to test for the possible spread of the disease through the honey stored by the treated colonies, four healthy colonies were moved into the disease apiary on October 25.

All colonies were in double brood chambers when prepared for winter and were fed as shown in Table 22. After feeding they were all packed singly in tar paper cases with four inches of cut straw as insulating material.

TABLE 22.—SHOWING THE KIND OF FOOD AND MEDICATION OF SAME THAT EACH COLONY RECEIVED FOR THE WINTER OF 1946-1947.

Col. No.	Treatment 1946	Fall Treatment 1946
117	Sulphathiazole	Sulphathiazole in syrup.
73	"	Unmedicated syrup.
125	"	" honey.
17	"	" "
97	"	Sulphathiazole in syrup.
53	"	Unmedicated syrup.
158	Penicillin	Sulphathiazole in syrup.
110	"	" "
62	"	" "
54	Untreated	" "
137	Healthy colony moved in during Fall 1946.	S.S.* of honey from 54 plus unmedicated honey.
93	Healthy colony moved in during Fall 1946.	S.S.* of honey from 62 plus honey from penicillin-treated colonies.
132	Healthy colony moved in during Fall 1946.	S.S.* of honey from 53 plus honey from sulphathiazole-treated colony.
142	Healthy colony moved in during Fall 1946.	S.S.* from 97 plus honey from sulphathiazole-treated colonies.

*S.S. means shallow super of honey.

Table 22 shows that the check (untreated in 1946) colony and those treated with penicillin in 1946 are now wintering on syrup medicated with sulphathiazole. It also shows that the four healthy colonies moved in during the fall are wintering on honey produced by colonies that have been treated for disease.

Because of the failure of penicillin to check the disease during 1946 it was not used again in the experiment.

Second Year Following Treatment

The first examination of the colonies during 1947 was made on April 25.

At that time, one of the penicillin-treated colonies was found dead and was immediately destroyed.

Scales of dead brood were also found in the lower brood chamber of another penicillin-treated colony. As the bees of this colony had established what appeared to be a healthy brood nest in the upper chamber, the lower chamber only was removed and destroyed.

All other colonies were found to be living but they varied considerably in strength. One of the colonies moved in during the fall was queenless and therefore was united to another weak but queenright colony.

All colonies were examined at ten-day intervals from April 25 until July 14. Because there was no visible sign of disease on July 14 and also because of a heavy honey flow during July and August, no further examinations of the brood nests were made until October 2. The result of these examinations are shown in Table 23.

TABLE 23.—SHOWING RECURRENCES OF DISEASE DURING 1947, THE SECOND YEAR OF THE EXPERIMENT.

Col. No.	April 25	May 12	May 23	June 6	June 16	June 23	July 4	July 14	Oct. 2	Crop (lb.)
117										170
73										138
125										72
17				+						209
97				+	+	+				152
53					+					181
158	dead									
110				+						116
62	scales			+	+					185
54				+						83
137	United to 54.									
93			+		+		+			96
132										154
142										62

Table 23 shows a recurrence of the disease in three of the colonies that had been treated with sulphathiazole during 1946, and also in the check (no treatment) and penicillin colonies in spite of the fact that some of these also had wintered on syrup medicated with sulphathiazole. Table 23 also shows that one of the healthy colonies moved in during the previous fall, and given honey from a thiazole-treated colony, developed the disease. Colonies 117, 73, 125, 132, and 142 remained free of disease throughout the season.

As recurrences of the disease were found, the infected colonies were again fed syrup, medicated with sulphathiazole, until all visible signs of the disease had disappeared. No disease was found on or after July 14.

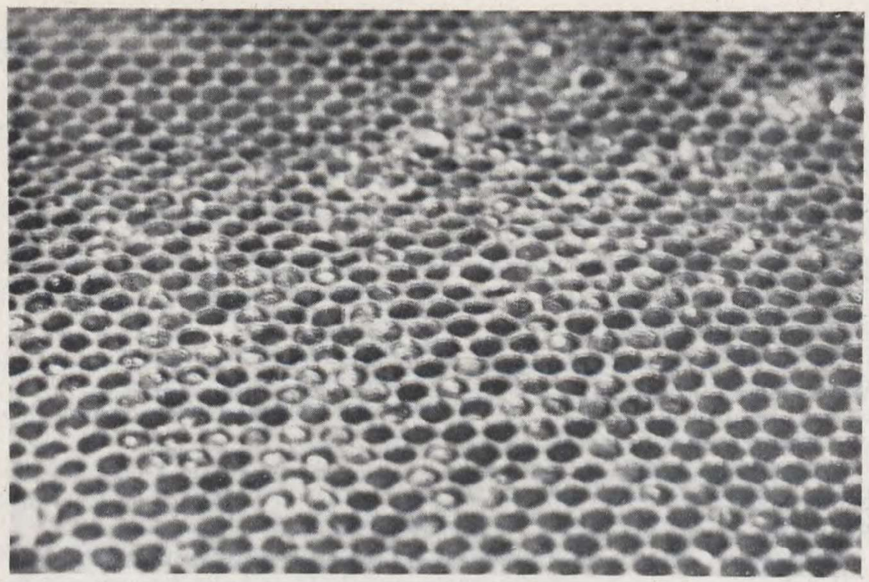

FIG. 8. Comb badly infected with A. F. B. Note Scales of Dead Larvae on floor of cells.

All colonies were fed for the winter 1947-48 by leaving with them a full super of honey produced by themselves. No medicated syrup was fed. The colonies were also packed singly in tar paper cases and insulated as in the previous winter.

Third Year Following Treatment

The first examination of this apiary in 1948 was on April 27 when all colonies were found in good condition and with plenty of stores.

Throughout the season of 1948, the colonies were carefully examined at ten-day intervals but no visible sign of disease was found in any colony at any time.

The results of this experiment to date indicate that treatment with sulphathiazole of colonies infected with American foulbrood will assist the bees to eradicate all signs of the disease from their broodnests. Under "Testing for Virulency" which follows in this report, however, it is shown that sulphathiazole does not kill the spores of the causative organism. As it is possible that some of these spores may be present in honey stored within the colony, other than in the broodnest, recurrences of the disease may occur at any time as they did in some of the colonies during 1947. This project then must be considered a long term one which means that this apiary is to remain isolated and under observation for a period of at least five years, longer if any danger of recurrence is expected.

In the spring of 1946, seventeen colonies, infected with American foulbrood, were found in the apiary of Mr. H. Selwyn, Kirks Ferry, Que., and condemned to be burned. Permission was obtained from the apiarist of the province to have these colonies moved to an isolated location for sulphathiazole treatment.

During the season, eleven other infected colonies were moved to the same location making a total of twenty-eight colonies to be treated.

The treatment of these colonies was begun in June, 1946, and consisted of feeding the colonies with syrup made of equal parts sugar and water from honey pail feeders. The syrup was medicated with sulphathiazole at the rate of one half gram to each gallon of syrup.

As the infection in these colonies varied from slight to heavy, the amount of syrup fed to the colonies also varied, ranging from one and a half gallons to six gallons per colony.

Because of distance, the apiary was visited only once every two weeks after the initial treatment. At each visit the colonies were examined and the progress of the disease recorded. Any colony in which visible signs of the disease was found was given its second or third feeding of medicated syrup as the case might be.

The last examination of these colonies was made on September 25 and at that time visible signs of the disease was found in two colonies only.

Unfortunately, bears invaded this yard on several occasions, destroying some of the colonies. After the damage had been rectified, only twenty-two colonies remained for wintering.

All colonies were fed heavily for the winter with a syrup made of two parts sugar to one part water, and the syrup was medicated with sulphathiazole, one tablet to one gallon of syrup. After feeding, the colonies were packed in tar paper cases and insulated with straw.

At the first examination in the spring of 1947, two colonies were found dead. These were destroyed immediately. The remaining twenty colonies were moved to another location to avoid bear trouble, and each was given 5/8 of a gallon of medicated syrup.

During the summer, the colonies were carefully examined periodically but on no occasion were any visible signs of disease found. The twenty colonies produced approximately 6,000 pounds of honey during the season.

For the winter of 1947-1948, the colonies were divided into two groups of ten each. One group received plain sugar syrup as winter food, while the second group received medicated syrup. After feeding, the colonies were packed and protected as for the previous winter.

The apiary was again under close observation during the summer of 1948, but up to the time of writing no visible sign of disease has been found.

Unlike the apiary described previously no recurrences were found during 1947 and 1948, indicating that continuous and careful treatment with sulphathiazole may eventually eradicate the disease from an apiary.

For the same reasons as given under the first Experiment, this apiary will still be kept under continuous observation for at least five years.

Testing Virulency of American Foulbrood Spores

Another experiment was conducted in co-operation with the Division of Bacteriology.

During the winter of 1947-1948, the Division of Bacteriology made up suspensions of A.F.B. spores in:

(1) distilled water.
(2) distilled water plus sulphathiazole.
(3) diluted honey.
(4) diluted honey plus sulphathiazole.

On April 13, 1948, ten 2-pound packages of bees with queens were installed on dry, clean combs in standard hives and the bees fed plain sugar syrup.

On April 20 the colonies were divided into five groups of two colonies each for the following treatment:

Group A: To be fed one gallon sugar syrup inoculated with A.F.B. spores from suspension (1).

Group B: To be fed one gallon of syrup inoculated with spores from suspension (2).

Group C: To be fed one gallon of syrup inoculated with spores from suspension (3).

Group D: To be fed one gallon of syrup inoculated with spores from suspension (4).

Group E: To be fed plain sugar syrup as checks.

The spores from all suspensions were centrifuged out and those suspended in sulphathiazole were washed carefully to remove all traces of the drug.

The inoculated syrup fed to the bees contained approximately two billion spores per gallon of syrup.

Treatment of the colonies began on April 20 and continued until the full gallon of syrup was given.

An examination of the colonies was made every third day, from the time of the first feeding, for signs of infection and Table 24 shows the results.

TABLE 24.—DEGREE OF INFECTION FOUND AT EACH EXAMINATION.

Col. Number	Date of Examination				
	May 3	May 10	May 20	May 27	
		Suspension 1			
217	+	++	+++	+++	United and fed Sulphathiazole.
231	+	++	+++	+++	
		Suspension 2			
225	+	+++	+++	+++	United and fed Sulphathiazole.
233	+	+++	+++	+++	
		Suspension 3			
226	+	+++	+++	+++	United and fed Sulphathiazole.
220	+	+++	+++	+++	
		Suspension 4			
228	–	+	+	+	Light infection.
223	–	+	+	+	
		Checks			
224	–	–	–	–	
218	–	–	–	–	

\+ = Mild Infection
++ = Medium Infection
+++ = Heavy Infection

Table 24 shows that all colonies on suspensions (1), (2), and (3) developed the disease within thirteen days from the time they received the first feeding of inoculated syrup on April 20 and that the infection spread rapidly as the season advanced.

In the two colonies fed suspension (4), the disease developed much more slowly. The first visible signs were found on May 10, or twenty days from the first feeding. Infection in these colonies was light at all times. It was thought that traces of the sulphathiazole may have remained with the spores after they were removed from the suspension and washed, thus having an inhibitory effect on the growth of the spores.

No disease developed at any time in the check colonies. They remained free of infection for the entire season and developed into strong colonies for the winter.

The results obtained in this experiment show clearly that the spores of American foulbrood were not killed even after suspension in a one per cent solution of sulphathiazole for a period of four months.

As the test was to determine whether or not the spores remained virulent after being suspended in sulphathiazole solutions, the appearance of the disease in the treated colonies provided the answer. As soon as the disease was firmly established, the colonies were united and given the drug treatment.

Two other experiments with sulphathiazole were started during the summer but insufficient data has been collected for reporting here.

In all the experiments under this project the dead larvae found were submitted to the Division of Bacteriology for microscopical examination and culture tests for A.F.B.

Testing Sulphathiazole as an Inhibitor of American Foulbrood

Another experiment with sulphathiazole was carried out in co-operation with the Division of Bacteriology.

On April 13, 1948, four 2-pound packages of bees were installed on dry, clean combs in standard hives. The bees were immediately fed a 1:1 solution of sugar and water.

On April 20 the colonies were divided into two groups of two colonies each for treatment as follows:

Group A: To be fed one gallon of sugar syrup inoculated with approximately two billion spores of American foulbrood.

Group B: To receive the same amount of inoculated syrup as Group A, but the syrup also to contain sulphathiazole at the rate of one-half gram per gallon of syrup.

The treatment of these colonies began on April 20 by giving each of them one quart of prepared syrup. The feeding was continued until the full gallon was taken.

The first examination of the brood nests of these colonies was made on May 3, twenty days after they had been installed. Dead larvae were found in both colonies of Group A but none in Group B. A microscopical examination of the dead larvae showed the causative organism of American foulbrood.

TABLE 25.—SHOWING DATES OF EXAMINATIONS AND FIRST DISCOVERY OF DEFINITE DISEASE

Treatment	Inoculated Syrup				Inoculated Syrup Plus Sulphathiazole					
Dates of Examinations	May 3	May 10	May 20	May 27		May 3	May 10	May 20	May 27	Oct. 6
Col Number.					Col. Number					
217	+	++	+++		230	....	....	....	....	....
231	+	++	+++		229	....	....	....	....	....

\+ = Mild Infection
++ = Medium Infection
+++ = Heavy Infection

The table shows that definite signs of A.F.B. appeared in the inoculated colonies and steadily increased as time advanced. Those receiving inoculated syrup plus sulphathiazole remained free of disease for the entire season.

While no definite conclusion can be drawn from a one-year test only, the indications are that sulphathiazole has an inhibiting effect on initial infection.

Sterilization of American Foulbrood Combs with Formalin Gas

The object of this project was to determine whether or not formaldehyde gas is effective in sterilizing combs infected with American foulbrood.

A small gas-tight chamber of wood and masonite board, having an area of 5·6 cubic feet, was constructed. A small hole was cut in the top through which the gas could be passed.

About twenty-five badly infected combs were secured through the co-operation of the local bee inspector. Six of these, containing approximately 11,200 cells of dry scale, were used in the test. Samples of these scales were taken from each comb for cultural tests before placing the combs in the gas chamber. All scales taken showed positive growth.

The combs were placed in the chamber and subjected to formalin gas for five days in succession. The gas was released into the chamber, through a rubber tube, for fifteen minutes every 24 hours. At each fumigation period, 155 c.c. of formalin was evaporated, a total of 775 c.c., or approximately $1\frac{1}{4}$ pints over the five-day period. In order to facilitate the penetration of the gas, the air moisture was increased by placing dishes of water within the chamber. The temperature inside the chamber during fumigation varied from 70 to 80 degrees F.

At the end of five days, the combs were removed from the chamber and more scales were taken for cultural tests. These all gave negative results.

Fig. 9. Swarming is the Bee's method of increase. A swarm being rehived.

After removing the combs from the gas chamber, they were subjected to a thorough airing for about five days and were then given to a strong colony of bees. The brood produced in these combs were examined every week. On two occasions, dead brood was found but a microscopical examination of the dead material showed no sign of the disease. A sample of what appeared to be a melted scale was cultured by the Division of Bacteriology but no growth developed.

This colony has now been on the treated combs for almost four years but no sign of disease has appeared yet.

Unfortunately, this project had to be suspended. It is hoped, however, that it will again be undertaken on a much larger scale as the data so far secured indicated that formalin gas may prove highly efficient for the sterilization of disease-infected material.

Honey Pollens

The object of this project was to identify and record the different kinds of pollen found in Canadian honey. These records, when obtained, are to be used for further identification of honey samples.

During 1938, one hundred and eighty-four species of pollen, representing 48 plant families, were collected in the Ottawa district. This group includes pollen from plants known to be of major and minor importance as sources of nectar and pollen to honeybees. The following records were kept of each plant from which pollen was collected:

(1) Date of first and last bloom.
(2) Is flower worked for nectar, pollen, or both?
(3) Did bees work it freely or otherwise?

As gathered, the pollen was dried and washed and then permanently mounted and sealed on microscopic slides.

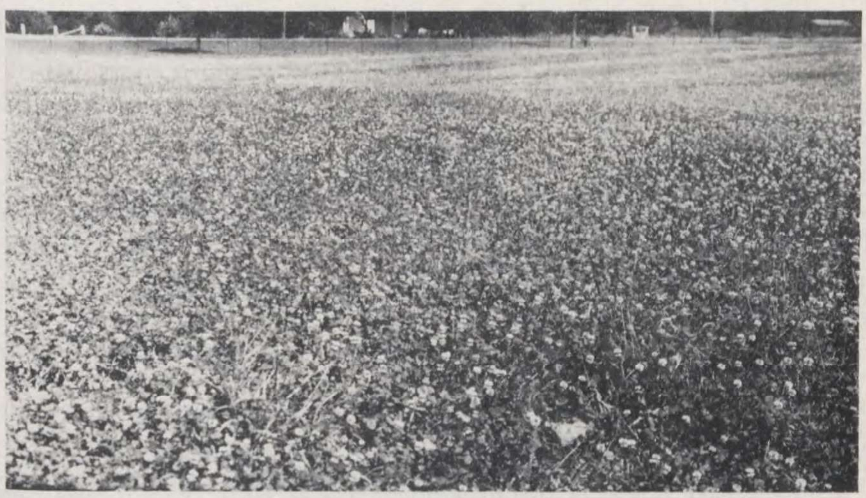

Fig. 10. A field of Ladino Clover. The legumes are an important field-crop. They are also the major nectar-secreting plants of Canada. They need the service of the honeybee in order that they may set seed.

During 1939, an additional 190 species of pollen were collected and treated in a similar manner. All mounted specimens were checked with fresh, unmounted specimens as collected directly from the flowers.

When checking pollens found in honey with the mounted specimens, the procedure was to dilute the honey with two parts distilled water, mix thoroughly, and then centrifuge. Then the sediment was examined for pollen grains.

During 1938 and 1939, one hundred and ninety-two samples of honey, representing all provinces, were examined and listed according to pollen they contained.

Of the 192 samples examined, the predominating pollens in 189 of them were one or more of the three clovers: alsike, sweet and white Dutch. In the other three, maple and dandelion predominated. Alfalfa and buckwheat pollens appeared in 19 samples and 13 samples respectively.

In addition to the seven pollens mentioned, 67 other species were found in varying quantities. Only 2 samples showed 100 per cent of a single species of pollen. With so many varieties of plants blooming at any given time a multiplicity of pollens in any one sample of honey could be expected.

Examination of the honeys, however, does show that the major sources of honey across Canada are the clovers.

Nectar Concentration Studies

A preliminary study was made of a few of the nectar secreting plants in the Ottawa district. The nectar was extracted from the plants by finely drawn, glass pipettes and the concentration of sugar determined by use of a refractometer and converted by means of Schonrock's table for determining water in sugar solutions.

TABLE 26.—AVERAGE SUGAR CONCENTRATIONS OF THE NECTAR AND THE PLANTS STUDIED

Plants	Average Sugar Concentration
	%
Alfalfa *(Medicago sativa)*	43·7 (34-55)*
Alsike Clover *(Trifolium Hybridum)*	66·0
Basswood *(Tilia americana)*	45·6
Vipers Bugloss *(Echium vulgare)*	51·2
Buckwheat *(Fagopyrum esculentum)*	28·9
Burdock *(Arctium minus)*	27·2
Milkweed *(Asclepia syriaca)*	23·9 (8-48)*
Purple Loosestrife *(Lythrum salicaria)*	51·9
Red Clover *(Trifolium pratense)*	43·9
Spreading Dogbane *(Apocynum androsaemifolium)*	24·6
Sweet Clover *(Melilotus alba)*	48·2
Vetch *(Vicia angustifolia)*	65·7
White Dutch Clover *(Trifolium repens)*	61·7

*The two figures indicate the range in the species.

Moisture Content of Capped vs. Uncapped Honey[1]

A preliminary report of this experiment was given in the Progress Report of this Division for the years 1934 to 1936 inclusive.

Further work on this project has verified the results originally obtained, namely, that considerable variation exists in the moisture content of honey as stored in the combs irrespective of whether it is capped over or not. Generally speaking, capped honey contains less moisture than uncapped honey. It does not follow, however, that capped honey will meet the moisture requirements of

(1)Variation in Moisture Content of Honey Within the Supers, by W. A. Stephen. Scientific Agriculture. 21:2; 80-88. 1940.

The results of this experiment led to a new experiment being planned having in view the removal of excess moisture from the honey while it is still in the supers.

a Grade 1 honey as set forth in honey grading regulations. Table 27 shows the percentage of moisture found in both capped and uncapped honey taken from different combs and from different supers during 1938 and 1939.

TABLE 27.—MOISTURE CONTENT OF CAPPED AND UNCAPPED HONEY TAKEN FROM COMBS IN AVERAGE FILLED SUPERS

Year	Super Number	Per cent Moisture Capped Honey	Per cent Moisture Uncapped Honey	Difference
		%	%	%
1938	1	16·76	18·52	+1·76
1939	202	17·53	17·99	+0·46
	336	16·69	19·40	+2·71
	324	16·23	19·90	+3·67

Table 28 shows minimum and maximum amount of moisture in both capped and uncapped honey during 1939.

TABLE 28.—VARIATION IN PER CENT MOISTURE CONTENT OF CAPPED AND UNCAPPED HONEY

Super Number	202		336		324	
	Capped	Uncapped	Capped	Uncapped	Capped	Uncapped
	%	%	%	%	%	%
Maximum	26·0	*20·0	21·6	20·6	20·2	22·2
Minimum	15·3	16·6	14·9	16·6	14·8	16·2
Difference	10·7	3·4	6·7	4·0	5·4	6·0

*The maximum amount of moisture that is allowed in honey.

Table 28, presenting minimum and maximum moisture readings for both capped and uncapped honey, shows that the maximum of all samples, but one, of both capped and uncapped honey was above the legal limit. Furthermore, the maximum moisture in uncapped honey was lower than in capped honey in two out of three cases.

The minimum amount of moisture in the uncapped honey was always slightly higher than it was in the capped honey but in all cases the minimum was below the requirements for a Grade 1 honey.

Removal of Moisture from Unextracted Honey by Artificial Means

The moisture content of honey is one of the main factors in determining the grade of the honey. Unfortunately, large quantities of honey that would otherwise grade high fail to do so because its moisture content is above the legal limit.

In the past, several methods of reducing the moisture content of honey have been tried with very little success. All of these methods attempted to remove the moisture after the honey had been extracted. A new approach to the problem was developed in 1940 when it was attempted to remove the moisture before the honey was extracted from the combs.

Preliminary experiments of driving warm air through supers containing combs of both capped and uncapped honey indicated that the problem could be solved by forcing a large amount of heated air through the supers by forced draught.

A steam radiator was placed in a horizontal position and a box built around it. A multivane fan was placed beneath the radiator to drive the heated air from the radiator up through the supers of honey placed above it.

The average temperature of the air entering the supers after leaving the radiator was 105°F. The temperature had dropped to 97°F. by the time the air had reached the top of the pile of seven supers. The average rate of flow of the air between the combs was 760 feet per minute. The average relative humidity of the air entering the supers was 33 per cent.

TABLE 29.—*REFRACTOMETRIC DETERMINATIONS OF MOISTURE CONTENT OF HONEY IN COMBS SET ABOVE STEAM HEATED RADIATOR FOR 12 HOURS AT 97° TO 103°F. RATE OF AIR FLOW 760 FEET PER MINUTE.

Super Number	Amount Capped	MOISTURE CONTENT IN PER CENT						
		Before			After			
		Capped	Uncapped	Wght. Av.	Capped	Uncapped	Wght. Av.	Loss
256	4/5	17·6	19·7	17·9	17·3	16·8	17·2	0·7
335	1/2	17·6	20·8	19·0	17·2	14·7	16·2	2·8
309	3/4	16·9	17·2	16·9	16·7	15·3	16·4	0·5
229	2/3	17·6	19·3	18·3	17·4	15·7	16·7	1·6
314	1/2	18·7	21·0	19·6	18·3	15·9	17·3	2·3
338	1/4	15·7	18·5	16·9	15·3	14·2	14·8	2·1
334	1/8	17·7	19·4	19·2	17·1	15·9	16·1	3·1
Average	....	17·6	19·7	18·3	17·1	16·1	16·5	1·8

*The refractometer is an instrument devised for measuring the sugar content of solutions.

Table 29 shows that the average loss of moisture from all honeys used in the experiment was 1·8 per cent, enough to raise a grade 3 honey to grade 1 insofar as moisture content is concerned. The table also shows that moisture was removed from both capped and uncapped honey but the loss was greater from the latter.

The rate of evaporation from the honey decreases with length of time. Twelve hours was found sufficient time to expose the combs to the blast of heated air.

The method offers a cheap and easy method of converting honey of high moisture content to a honey of first grade.

Since the above work was done several commercial apiarists have adopted the principle here presented.

Studies on Thermal Resistance of Honey Yeasts[1]

The purpose of this project was to determine if there were any fundamental differences in the thermal resistance of the different species of honey yeasts, and to determine the relationship of these properties to the sterilization of honey.

Samples of sterile honey, heavily inoculated with the different species of yeasts found in honey, were subjected to heat at different temperatures, and for varying lengths of time.

(1)Scientific Agriculture. Vol. 22, No. 11. July, 1942. W. A. Stephen.

An analysis of over 1,000 samples of Canadian honey had shown that very few of them contained more than 100,000 yeast cells per gram, which meant that all inoculations used in this experiment were made to approximate this number.

Commercial sterility, which tolerates 10 yeasts per millilitre, was used as the basis for estimating time–temperature relationships.

Based on the experimental data, it would require between 1 hour and 40 minutes and 5 hours and 30 minutes to reduce the count to less than 10 yeasts per millilitre at 50°C. (122°F.) depending upon species and initial inoculation. Different species acted differently in rate of dying, so this, too, is a factor. At 60°C. (140°F.) the time necessary to affect commercial sterility was less than 30 minutes.

To obtain commercial sterility by flash pasteurization methods at least 80°C. (165°F.) is needed but this will vary according to the length of time needed to bring the honey to this temperature.

TABLE 30.—THE TIME REQUIRED AT DIFFERENT TEMPERATURES TO EFFECT YEAST STERILITY OF HONEY

Time in Minutes	Temperatures						
	140°F.	145°F.	150°F.	155°F.	160°F.	165°F.	170°F.
25	–						
20	+	–					
15	+	+					
10	+	+	–	–			
5	+	+	+	+	–		
0	+	+	+	+	+	–	–

–Indicating yeast sterility.
+Indicating yeast growth.

Complete sterility was obtained by bringing the honey to a temperature of 165°F. and then cooling it immediately.

The Effect of Storage Temperatures on "Processed Honey"

In December, 1939, 24 one-half pound jars of "processed honey" were obtained from the Ontario Honey Producers' Co-operative, Toronto. These were divided into three groups and placed in storage as follows:

(1) In Kelvinator at 57°F.

(2) In cellar beneath office building.

(3) In honey laboratory. Fluctuating temperature.

Seven samples were stored in each place while three were kept out for tests as to moisture, yeast count and colour. The moisture content was measured by the refractometer, yeast count by plate method, and colour by the Pfund Grader. Records were kept of temperature and humidity of storage. At the end of each 12 months in storage one sample was removed and tested. The physical characteristics of each sample were also recorded.

TABLE 31.—CHARACTERISTICS OF "PROCESSED HONEY" IN STORAGE FOUR YEARS

Characteristics	Year	Storage		
		57°F.	Cellar	Laboratory
Moisture Content	1939	17·6%	17·6%	17·6%
	1940	17·5%	17·6%	17·2%
	1941	17·4%	17·5%	17·0%
	1942	17·4%	17·6%	16·2%
	1943	17·1%	17·1%	16·1%
Yeast Count	1939	Nil	Nil	Nil
	1940	"	"	"
	1941	"	"	"
	1942	"	"	"
	1943	"	"	"
Colour	1939	21·5mm	21·5mm	21·5mm
	1940	27·5mm	29·0mm	34·0mm
	1941	33·0mm	36·0mm	47·0mm
	1942	36·1mm	38·0mm	55·0mm
	1943	41·0mm	44·0mm	67·0mm

The temperatures remained constant to within ±1°F. in the Kelvinator storage, the humidity, however, ranged from 25 to 75 per cent as did that of the cellar. The temperature of the latter storage ranged from 38 to 72°F. according to outside temperatures. In the laboratory, fluctuations in temperature and humidity were very frequent ranging fron 60 to 90°F. and 20 to 80 per cent respectively, the latter being more dependant on the time of the year. Low relative humidity was encountered during the winter.

Table 31 shows that the "processed honey" lost moisture, in all cases, while in storage. As the honey was free of yeasts at the beginning of the period, no change would be expected insofar as this characteristic was concerned. Colour changes occurred in all three storages, being greatest in the laboratory. The only physical change taking place was in the laboratory where the higher temperatures brought about a breakdown in the granulation, resulting in a layer of dextrose at the bottom surmounted by a layer of liquid levulose and a heavy scum on top of the liquid. No fermentation had occurred at the end of the experiment.

The Relationship of Moisture Content and Yeast Count in Honey Fermentation[1]

Duplicate samples of honey representing a fairly even geographical distribution were obtained from the various producing areas of Canada. Records of source, treatment, and method of handling were obtained in each case. One set of the duplicate samples was stored at room temperature, while the other was used for physical, chemical and microbiological analyses.

Storage samples were examined periodically for signs of fermentation, rate of granulation and changes in physical condition. The corresponding samples were treated for colour, moisture, sugar and yeasts. Moisture determinations were made by the refractometer method. Yeast counts were made both by the dilution and plate-count methods.

Table 32 shows the grouping of the honey according to moisture content together with number and percentage fermenting within each year and each group.

(1) Scientific Agriculture 26:6. June, 1946.

TABLE 32.—DISTRIBUTION OF SAMPLES OF CANADIAN HONEY ACCORDING TO MOISTURE CONTENT AND FERMENTATION

Moisture	Samples	1929	1931	1935	1936	1937	1938	All Years
Under 15·1	Number of samples	15	10	2	22	5	8	62
	Number fermented	0	0	0	0	0	0	0
	P.c. fermented	....	....	....	....	....	....	....
15·1-16·0	Number of samples	35	36	12	37	22	38	180
	Number fermented	1	1	0	0	0	3	5
	P.c. fermented	2·9	2·8	....	....	....	7·9	1·8
16·1-17·0	Number of samples	67	32	24	54	42	61	280
	Number fermented	8	3	1	0	4	10	26
	P.c. fermented	11·9	9·4	4·2	....	9·5	16·4	9·3
17·1-18·0	Number of samples	47	27	41	37	52	41	245
	Number fermented	17	19	8	6	21	28	99
	P.c. fermented	36·2	70·4	19·5	16·2	40·4	68·3	40·4
18·1-19·0	Number of samples	13	17	20	14	25	11	100
	Number fermented	6	15	12	7	14	9	63
	P.c. fermented	46·2	88·2	60·0	50·0	56·0	81·8	63·0
Over 19·0	Number of samples	4	3	10	9	14	5	45
	Number fermented	4	2	5	6	10	5	32
	P.c. fermented	100·0	66·7	50·0	66·7	71·4	100·0	71·1
Entire range	Number of samples	181	125	109	173	160	164	912
	Number fermented	36	40	26	19	49	55	225
	P.c. fermented	19·9	32·0	23·9	11·0	30·6	33·5	24·7

Table 32 shows that as moisture content increases the greater the percentage of fermentation. Table 33 shows frequency distribution of 736 samples of honey arranged for moisture content and yeast count.

TABLE 33.—FREQUENCY DISTRIBUTION OF SAMPLES OF CANADIAN HONEY ACCORDING TO MOISTURE CONTENT AND YEAST COUNT

Moisture	Samples	Yeast Count							
		0·1 to 1·0	1·1 to 10	11 to 100	101 to 1,000	1,001 to 10,000	10,001 to 100,000	100,001 to 1,000,000	Totals
%									
14·1-15·0	Number of samples	14	16	10	9	3	0	0	52
	Number fermented	0	0	0	0	0	0	0	0
	P.c. fermented	....	....	....	....	....	....	....	....
15·1-16·0	Number of samples	31	17	18	42	26	4	0	158
	Number fermented	1	0	2	0	1	1	0	5
	P.c. fermented	3·2	....	5·3	....	3·8	25·0	....	3·2
16·1-17·0	Number of samples	20	11	30	74	82	21	0	238
	Number fermented	0	1	1	9	10	1	0	22
	P.c. fermented	....	9·1	3·3	12·2	12·2	4·8	....	9·2
17·1-18·0	Number of samples	12	5	19	35	58	55	9	193
	Number fermented	3	1	5	10	24	29	6	78
	P.c. fermented	25·0	20·0	26·3	28·6	41·4	52·7	66·7	40·4
18·1-19·0	Number of samples	5	2	3	11	18	23	11	73
	Number fermented	0	2	3	6	13	15	10	49
	P.c. fermented	....	100·0	100·0	54·5	72·2	65·2	90·9	67·1
19·1-20.0	Number of samples	1	0	0	1	5	8	7	22
	Number fermented	0	0	0	0	4	5	5	14
	P.c. fermented	....	....	....	....	80·0	62·5	71·4	63·6
Entire Range	Number of samples	83	51	100	172	192	111	27	736
	Number fermented	4	4	11	25	52	51	21	168
	P.c. fermented	4·8	7·8	11·0	14·5	27·1	45·9	77·8	22·8

A study of the relationship of moisture content to fermentation shows that the percentage of fermentation is greater as moisture content increases.

It is also quite apparent that there is a definite relationship between moisture content and yeast count. Higher moisture content, within limits, favours yeast multiplication.

For each increase of 1 per cent in moisture content, yeast count may be expected to increase about 5-fold. Rate of increase in yeast count parallels rate of increase in fermentation.

Both yeast count and fermentation are influenced by length of time which honey takes to granulate. Honey of high moisture content may granulate very slowly, therefore, influencing yeast growth and slowing down fermentation.

Crystallization of Honey

An experiment was started in 1944 to find out whether or not the two main sugars of honey, levulose and dextrose, could be separated by centrifugal force and then to determine if the addition of levulose to normal honey would prevent or retard the granulation of that honey.

The National Research Council allowed the use of a powerful centrifuge. Samples of a semi-granulated honey were passed through this machine and both levulose and dextrose were obtained in a fairly pure form, the levulose as a liquid and the dextrose as a solid dry sugar.

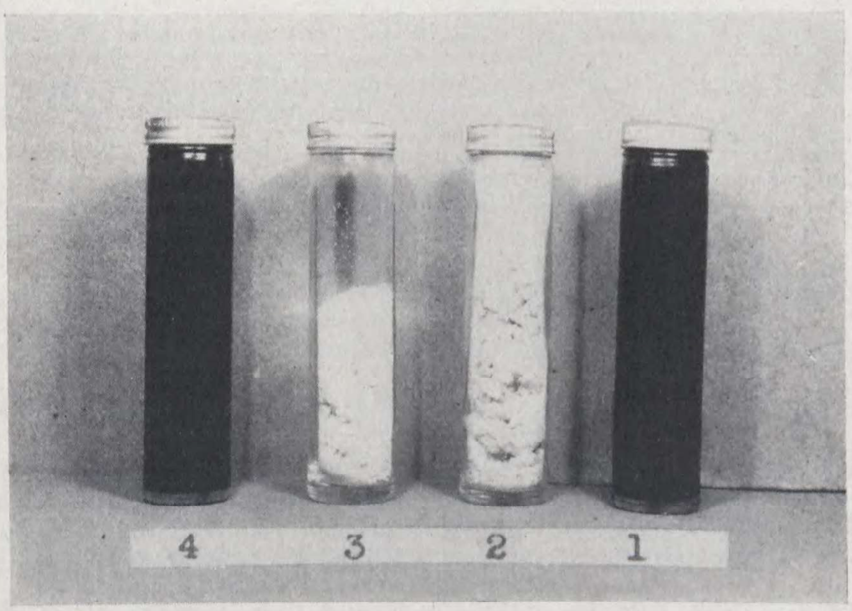

Fig. 11. Separation of Honey Sugars. 1. Buckwheat Honey before centrifuging. 2. Dry Dextrose Sugar. 3. Dextrose Sugar washed. 4. Levulose Sugar.

Unfortunately, W. A. Stephen, who was doing the work, left the Division before the second phase of the experiment could be put into effect.

This project should be resumed at a future date because of the necessity of finding some method of keeping honey liquid indefinitely. As the granulation of honey depends upon the levulo-dextro ratio, it is thought that the addition of levulose might achieve the object of maintaining the liquidity of the honey.

Program of Experimental Work Under Way

The list of projects at Ottawa and Branch Farm apiaries may roughly be divided into seven groups.

The projects in Group 1 are designed, first, for the study of the various plants that secrete nectar and to assess their value from the standpoint of volume and concentration of nectar secreted. Secondly, to study the factors such as conditions of soil, moisture, temperature, sunlight, etc., as they may affect quantity and quality of nectar secretion. Thirdly, to measure time, duration and density of flow from each source.

The second group of projects are designed for the purpose of developing more efficient methods of colony management whereby unit or colony production may be increased and the cost of production lowered.

The object of the third group of projects is to develop safer methods of wintering bees. Winter losses throughout Canada are at least ten per cent,—this constitutes a heavy loss and should be reduced or eliminated if at all possible.

Spray poisoning of honeybees is becoming a more serious problem each year, especially with the development of newer and more deadly insecticides, and also as the use of these insecticides is spreading to field crops other than fruit. Not only is the problem one for the beekeeper but it also affects the fruit, vegetable and seed grower as well, because the use of insecticides is not only destroying honeybees but is also killing off the native pollinators as well. A group of projects testing the effect of certain poisons on honeybees is included in the program at Ottawa, while at one of the Branch Farm apiaries methods of management are being developed so as to reduce or avoid the effects of spray poisoning.

Another group of projects involves elaborate tests of the value of honeybees as cross-pollinating agents in comparison with native or wild pollinating insects. This applies chiefly to the clovers which are important agricultural crops and which are, incidentally, the main honey producing plants of Canada. The most important object of these experiments is to determine to what extent the presence of honeybees will increase the seed yield of these plants.

The sixth group of experiments is to test the value of certain drugs and antibiotics for the control of bee diseases. At the moment, the work is concentrated on the control of American foulbrood and the results to date are highly gratifying, so much so, that three of the provinces are now authorizing the use of sulphathiazole for the inhibition or control of American foulbrood.

The last group involves a study of the different races of bees to determine which race is best adapted to the different producing areas of Canada.

ACTIVE PROJECTS

OTTAWA

Ap.26.......Factors Affecting Nectar Secretion.
Ap.28.......Study of Honey Flows.
Ap.57.......Two-Queen Method of Increasing Field Force of Colony.
Experiment A. Two Queens in Single Units.
Experiment B. Two Queens in Separate Units (Division).
Ap.94.......Wintering Surplus Queens in Single Colonies.
Ap.101......Relative Value of Different Methods of Packing Bees for Winter.
Ap.111......Study of Hive Temperatures and Humidities.
Ap.118......Study of Bee Forage.
Ap.119......Pollen Supplements and Substitutes.
Ap.123......Sulpha Drugs and Antibiotics for the Control of American Foulbrood.
Experiment A. Specific Apiary, inoculated, treated and under continuous observation.
Experiment B. Private Apiary, badly infected with A.F.B. treated and under constant observation.
Experiment C. Imported packages, inoculated. Half of the packages fed sulpha with inoculum to test inhibiting action.
Experiment D. To test longevity of A.F.B. spores in suspensions of Sulpha.
Experiment E. To test effect of certain substances of Sulphathiazole when fed as an inhibiting agent.
Experiment F. To determine the age at which bee larvae are most susceptible to infection from A.F.B.
Ap.124......Poison Sprays and Honey Bees.
Ap.125......Honeybees and Pollinization.
Ap.129......Package Bees and American Foulbrood.
Ap.130......Different Hive Entrances For Winter.

Brandon, Man.

Ap.7........Wintering Bees in Cellar.
Ap.9........Wintering Bees in Two-Colony Cases.
Ap.10.......Wintering Bees in Single-Colony Cases.
Ap.26.......Factors Affecting Nectar Secretion.
Ap.28.......Study of Honey Flows.
Sp.33.......Races of Bees.
Ap.57.......Two-Queen Method of Increasing Field Force of Colony.
Experiment A. Two Queens in Single Units.
Experiment B. Two Queens in Separate Units (Division)
Ap.92.......Honey Pollens.
Ap.94.......Wintering Surplus Queens in Single Colonies.
Ap.96.......Insulation for Outdoor Wintering Bees (Balsam Wool).
Ap.102......Commercial Colonies.
Ap.118......Study of Bee Forage.
Ap.119......Pollen Supplements and Substitutes.
Ap.128......Supplementary Heating of Colonies.
Ap.130......Different Hive Entrances for Winter.

Charlottetown, P.E.I.

Ap.1........Swarm Control by Dequeening and Requeening.
Ap.2........Swarm Control by Separation of Queen and Brood.

Ap.5........Methods of Detecting Preparations for Swarming.
Ap.8........Wintering Bees in Four-Colony Cases.
Ap.9........Wintering Bees in Two-Colony Cases.
Ap.22.......Package Bees as a Means of Starting New Colonies.
Ap.28.......Study of Honey Flows.
Ap.33.......Races of Bees.

Kapuskasing, Ont.

Ap.1........Swarm Control by Dequeening and Requeening.
Ap.2........Swarm Control by Separation of Queen and Brood.
Ap.5........Detecting Preparations for Swarming.
Ap.7........Wintering in Cellar.
Ap.8........Wintering in Four-Colony Cases.
Ap.9........Wintering in Two-Colony Cases.
Ap.10.......Wintering in One-Colony Cases.
Ap.12.......Two-Queen System.
Ap.28.......Study of Honey Flows.
Ap.33.......Comparison of Races of Bees (Italian, Caucasian, Carniolan).
Ap.34.......Queen Rearing.
Ap.63.......Swarm Control by Raising Brood and Dequeening and Requeening.
Ap.89.......Supering for Extracted Honey.

Kentville, N.S.

Ap.7........Wintering Bees in Cellar.
Ap.8........Wintering Bees in Four-Colony Cases.
Ap.28.......Study of Honey Flows.
Ap.34.......Queen Rearing.
Ap.89.......Supering for Extracted Honey.
Ap.120......Spray Poisoning of Bees.

Ste. Anne de la Pocatiere, Que.

Ap.1........Swarm Control by Dequeening and Requeening.
Ap.2........Swarm Control by Separation of Queen and Brood.
Ap.7........Wintering Bees in Cellar.
Ap.8........Wintering Bees in Four-Colony Cases.
Ap.9........Wintering Bees in Double Cases.
Ap.10.......Wintering Bees in Single Cases.
Ap.28.......Study of Honey Flows.
Ap.32.......Spring Protection.
Ap.52.......Swarm Control by Use of Young Queens.
Ap.57.......Two-Queen Method of Increasing Field Force of Colony.
Ap.89.......Supering for Extracted Honey.
Ap.103......Swarm Prevention by Manipulation of Colonies.
Ap.121......Strengthening Weak Colonies by Relocation.

Prince George, B.C.

Ap.22.......Package Bees as a Means of Starting Colonies.
Ap.125......Honeybees and Alsike Clover Seed Production.
Experiment B. Wild Bees and Alsike Seed Production.

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* Appointed December. 1949.

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