1. The Currant Fruit Fly, Epochra canadensis Loew, in Manitoba.

2. Optimum Feeding Temperatures for the Dark-sided Cutworm, Euxoa messoria Harris.

by

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The Currant Fruit Fly in Manitoba

Epochra canadensis, Loew

Diptera: Trypetidae

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The currant fruit fly, Epochra canadensis, Loew, attacks red and white currants (Ribes rubrum L.), flowering currant (Ribes aureum, Pursh) and probably black currant (Ribes nigrum L.) in Manitoba. Instances have been reported of injury to black currants but it was impossible to verify these reports. In other parts of America where this insect is found, black currants and also gooseberries are included in the list of host plants.

The currant fruit fly is probably the most destructive insect attacking red and white currants in Manitoba. The damage is caused by the females ovipositing in the partially grown currants. The developing maggots cause many of the currants to ripen prematurely and drop from the bushes. Other infested currants may remain on the bushes until the uninfested fruit is ripe. Usually, however, there is a heavy drop from the bushes before the uninjured portion of the fruit is ripe. In some instances as much as fifty per cent of the currant crop falls from the bushes (Fig. 1) due to the injury caused by this insect. If small white maggots are found within the prematurely ripening currants one may be certain of the identity of the insect as no other insect attacks this fruit in a similar manner in Manitoba.

Severin (19) was unable to find any records of the presence of Epochra canadensis outside of United States and Canada. Gillette (7) says that it is probably the worst currant and gooseberry pest in Colorado and that in that state it also attacks wild currants and gooseberries. Severin (19) says that the currant fruit fly is so serious a pest in the state of Maine that frequently the crop of currants and gooseberries is a total loss. In Montana, Cooley (3) reports that in several cases the entire crop fell to the ground due to currant fruit fly injury. According to Severin (19) the currant fruit fly occurs in the following additional states: New York, South Dakota, Utah, Idaho, Washington, Oregon and California. Fletcher (6) reported the insect from B. C., Edmonton, Winnipeg and Nova Scotia. Hewitt (11) mentions the currant fruit fly from Lebret, Sask. Macoun (14) says the insect occurs in B. C., Northwest Territories and Manitoba. Ross and Caesar (15) mention it from Dryden, Ont.

The distribution of this insect in Manitoba is somewhat extended. Records of injury are at hand from practically all of the municipalities adjoining the city of Winnipeg as well as for Winnipeg itself. We also have records from Boissevain, Gilbert Plains, Miami and Treesbank. It is altogether probable that it occurs throughout the southern part of Manitoba. As currants become more commonly grown in the province we may expect, no doubt, more extensive damage.

Brief Description of Each Stage

The adult fly is yellowish brown in color and is somewhat smaller than the housefly. Its most conspicuous markings are on the wings. These are marked with four dark brown cross-bands and one of a similar nature extending along the apical two-fifths of the front margin of the wing. The eyes are shining green. The females are larger than the males and may also be distinguished from them by the presence of a conspicuous ovipositor (Fig. 2).

The egg (Fig. 2) is a small white object which appears much like a child's elongate toy balloon when examined under magnification. The eggs average one millimeter in length and one quarter of a millimeter in width.

The maggot is white and varies in size according to its stage of development. A pair of black hooks may be seen lying in the anterior part of its body (Fig. 2).

The puparium is yellowish in color. The average puparium varies from four and one half to five milli eters in length and is two millimeters in diameter (Fig. 2).

Life History

Adult currant fruit flies in a normal year begin to emerge from the soil under the currant bushes about the beginning of the second week in June. In 1925 the first adults were captured on June 10 and in 1926 on June 9. At this period of the year common lilacs are just coming into full bloom. Adults were captured from these dates until July 12. The adults move about most freely on warm days when they may be taken by sweeping with a net. Frequently adult flies may be seen in the center of the bush resting on the leaves where it is shady. The casual observer would in all probability overlook the presence of these flies in the currant patch and would learn that they have been there only when the infested fruit began to turn red and drop.

When a female wishes to oviposit, she selects a currant about three quarters grown. Currants of this size are the largest on the bunch at the time the first adults emerge. Evidently currants must be about this size in order that the female may be in an advantageous position to use her ovipositor when she grasps the currant with her feet. On smaller currants the upper side of the berry would be too close to her body for her to do effective work with her ovipositor. After a currant has been selected she bends her ovipositor back underneath the abdomen and slowly inserts it through the skin of the currant. The time required to do this by the females under observation varied from ten to eighteen minutes. After inserting the ovipositor, the mouth parts of the female then begin to work back and forth and continue to do this for nearly a minute after which she leaves the currant. The egg which is left in the currant is so near the surface that it can be seen through the thin skin of the berry if looked for carefully. During 1925 and 1926 the hatching time required for each of 29 eggs was noted. The average time in the egg stage was about 6 days. Evidently the time, which varied from five to eight days, was determined largely by the temperature of the atmosphere during the egg state. In late June the eggs required less time to hatch than they did in mid June. The young maggot is very small and can be seen with difficulty. Its location is most easily determined by locating the two minute black mouth hooks which can be distinguished from the surrounding part of the fruit. As soon as the egg hatches the young maggot tunnels along underneath the skin of the currant leaving a white winding air-filled passage. In a very short time, however, it burrows into the center of the fruit and attacks a seed. Usually young maggots may be located feeding on the seeds. The average period spent in the maggot stage is about 13 days, the extremes being from eleven to sixteen days. When full grown the maggot makes an exit hole through the surface of the currant and emerges. At this time the currant may be either lying on the ground or still hanging to the cluster on the bush. In either case the maggot wriggles out and enters the ground where pupation takes place. If the currants are too badly dried up before the maggot attempts to emerge it may become stuck in the hole and perish. The maggot enters the soil under the bush upon which it developed. Puparia have been recovered at soil depths varying from a half inch to three or four inches. The puparia lie in all positions in the soil. The pupal stage lasts for about eleven months.

There is only one brood per year. The following tabulation shows some details of the life history of the currant fruit fly.

DATA ON LIFE HISTORY

1926

Adults introduced	Egg Found	Egg Hatched	Maggot Pupated	Time in Egg Stage	Time in Maggot Stage
-	-	June 23	July 6	-	13 days
-	-	June 23	July 5	-	12 days
-	-	June 26	July 8	-	12 days
June 21	June 22	June 28	-	6 days	-
June 21	June 22	June 28	Maggot died	6 days	-
-	June 22	June 28	Maggot died	6 days	-
June 22	June 23	June 29	Maggot died	6 days	-
-	June 23	June 29	Maggot died	6 days	-
June 21	June 22	June 29	July 12	7 days	13 days
June 23	June 24	June 29	July 12	5 days	13 days
June 23	June 24	June 29	July 12	5 days	13 days
June 24	June 25	June 30	July 16	5 days	16 days
June 24	June 25	July 1	July 12	6 days	11 days
June 29	June 30	July 5	-	5 days	-

An examination of many prematurely ripening currants failed to reveal the presence of a maggot or an exit hole from which the maggot had escaped. All of these berries showed evidences of holes made by the ovipositor of the fruit fly. Different lots of ripe and fallen berries were collected from time to time and placed on sifted soil in large glass jars. All of the currants collected had been visited by the female fruit fly as they showed the marks of her ovipositor. In all some 1700 currants were collected. Maggots issued from only 12% of this number. It would seem, therefore, that either the flies do not actually lay eggs in every currant punctured or many maggots perish within the currants before they reach maturity. In any event, currants so punctured ripen prematurely and fall from the bushes with a resultant loss to the grower.

The work outlined above was carried out at Manitoba Agricultural College, Winnipeg, during the years 1925 and 1926. No parasites were reared from any of the material under observation during that time. The work was carried out in the field, in the laboratory and in a screened outdoor insectary.

SUMMARY

The currant fruit fly has one brood per year. It is injurious to red and white currants and flowering currants in particular in Manitoba and probably attacks black currant and possibly gooseberry. The injury is caused by currants being attacked by the females. They ripen prematurely and fall from the bushes. Fully 50 percent of the currants may be lost in this way in certain seasons. The egg hatches in about 6 days, the maggot develops in about 13 days and the insect is in the pupal stage about 11 months. The adults occur from about the beginning of the second week of June until about July 12 in a normal year. No practical method of controlling this insect has as yet been successfully demonstrated.

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Fig. 1. Infested currants ripen prematurely and fall to the ground.

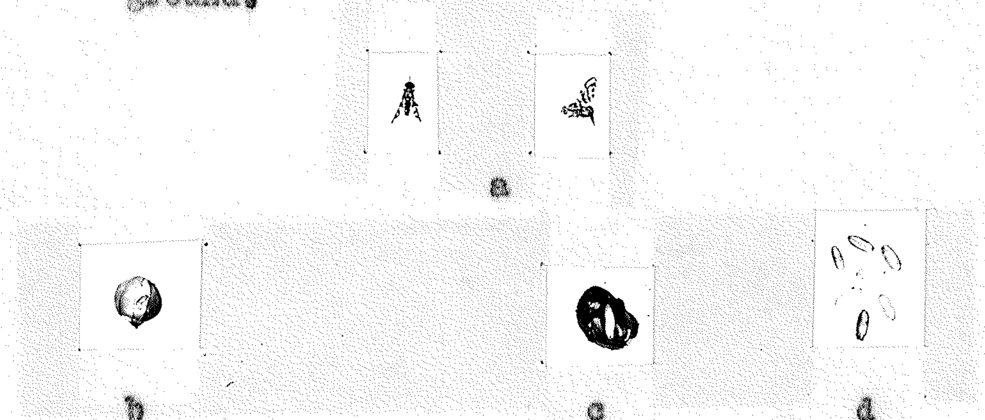

Fig. 2. (a) Male and female currant fruit flies.
(b) Egg showing through skin of currant.
(c) Part of currant removed to show maggot.
(d) Puparia of currant fruit fly.
(slightly reduced)

2 Optimum Feeding Temperatures for the Dark-sided Cutworm, *Euxoa messoria* Harris.

OPTIMUM FEEDING TEMPERATURES FOR THE DARK-SIDED CUTWORM, *Euxoa messoria* Harris#.

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During the seasons of 1925 and 1926 several species of cutworms were involved in an outbreak on the Canadian prairies. Wheat, oats, barley, rye, flax and garden plants were attacked. Large fields of grain were eaten off and large and small gardens were more or less ruined. The damage done was considerable in amount and extent. In 1925 the dominant species throughout Manitoba was the Red-backed Cutworm, *Euxoa ochrogaster* Gn. In 1926 the Dark-sided Cutworm, *Euxoa messoria* Harris almost entirely replaced the former in the eastern part of the province. In the vicinity of Winnipeg the Red-backed Cutworm was conspicuous by its relative scarcity, while the Dark-sided Cutworm was very abundant. Another cutworm, *Polia lorea* Gn. was common especially on alfalfa at Manitoba Agricultural college, Winnipeg, during 1926. This is a very early cutworm appearing partly grown as soon as there is any food available. This species ceased feeding in 1926 about the middle of May so that probably it will never be very destructive to cereal crops. The Dark-sided Cutworm, however, is one which develops late in the season. This species was first noticed as very small larvae about the middle of May. They continued to feed until about the fourth week in June. Thus it can be seen that this cutworm is capable of doing great damage to both field and garden crops. Specimens of other species were found in association with *Euxoa messoria* but only in limited numbers in the vicinity of Manitoba Agricultural College.

The usual recommendation given to farmers and gardeners is

#Noctuidae: Lepidoptera

the use of the poisoned bait. They are advised to scatter this bait on the infested area or the area to be protected in the evening as cutworms feed at night and it is desirable to have the bait fresh when they first begin to crawl about on the surface of the ground in search of food. Very little information is available as to the kind of night that is most suitable for feeding. During the early stages of the late grasshopper campaigns in Western Canada considerable poisoned bait was scattered upon the ground when it was ineffective. The weather conditions under which grasshoppers fed most readily were at that time unknown. When more information was available about the habits of grasshoppers the cost of killing them was reduced materially as the poisoned baits were scattered when they would do the most good. When cutworms became so injurious it seemed possible that cutworms might feed more readily under certain temperatures than others. This investigation was, therefore, undertaken to see if this was the case and if so to determine the optimum temperatures for feeding.

The equipment used in the investigation consisted of a large ice refrigerator whose inside dimensions were 8'x6' 2"x3'3½", three electric ovens and covered tin boxes whose outside measurements were 4½"x2-4/5"x1½". The temperature of the refrigerator during the course of the investigation varied from 6.6°C to 10°C and averaged around 8.3°C.

The Dark-sided Cutworm was used as it occurred in numbers sufficiently great to supply all the living material needed. Cutworms were collected and placed in the laboratory in a large jar partly filled with sifted earth. These were given more food than they would eat over night. Food at all times during the investigation consisted of fresh alfalfa leaves and stems from the growing parts of the plants. The ends of stems which had a similar appearance were selected in all cases for food. In the afternoon following the night that the cutworms had eaten all they would take, units of 30 cutworms were counted out and placed in each tin box used in the experiment. Each tin box was about one-third filled with fresh soil which had been sifted through a sifter made from ordinary wire mosquito netting. The soil usually was reasonably damp as it was taken from the garden just before being placed in the tins. Two or three grams of alfalfa leaves and stems were weighed out and placed in the tin box on the surface of the soil with the cutworms. A piece of white paper larger than the top of the box was then placed over the top and the cover pressed into position. In every case a check tin box complete with all details except the cutworms was used. One of these checks was placed in each warming oven and in the refrigerator itself each day beside the tin containing the cutworms. These were usually placed in their respective temperatures at approximately 5.00 p.m. each day and left there under constant temperature until about 9.00 a.m. the following morning. At this time each check for a certain temperature was weighed and the loss in weight noted. The loss in weight was due to evaporation of moisture from the alfalfa. This loss was higher at higher temperatures than at lower ones. The food left in each box of cutworms was then weighed and the loss noted. The loss in the weight of the check was deducted from this in order to determine the actual amount of food consumed by the cutworms during the night. Temperatures as well as actual food consumed by each lot of 30 cutworms were recorded. These cutworms which had been under observation during the night were all transferred to another large jar similar to the one first mentioned where they were fed all they would eat the next night. Cutworms from the large lots collected were never used until they had had an opportunity to eat all they wanted. In other words lots of cutworms were used each night which had eaten all they wanted the previous night under favorable feeding conditions. The difficulty of removing the cutworms from the soil each morning was overcome by using the sifter. The soil was run through the sifter and the cutworms remained on the screen. They were then dumped out on a piece of paper and then placed in the jar with the general supply. Each afternoon at least four lots and frequently as many as seven lots of 30 cutworms were used. Where more than four lots were taken duplicate lots were used under a certain temperature. For example two tins of 30 cutworms each along with the check would be placed in the refrigerator at 9°C.

The investigation began May 13 and was carried on continuously until June 12, 1926 with the exception of three days, namely, June 5, 6 and 7 when absence from the College prevented records from being taken on those dates. In all, the feeding behaviour of 4110 cutworms of the species *Euxoa messoria* in so far as they could be selected at their various periods of growth ~~were~~ as under observation during the investigation. In addition some 405 individuals of *Polia lorea* were used for another similar set of records for that particular species.

The data shown in Table I are compiled for four days periods from May 16 to June 12 with the exception already noted. The temperature of the refrigerator varied from 7°C to 10°C during this period and this temperature range was used for one series for the period of the experiment. Two warming ovens ran with temperatures much alike and the data secured from these have been placed under a

TABLE I

FOOD CONSUMED BY CUTWORMS AT VARIOUS TEMPERATURE RANGES

Date 1926	Temperature Range 7°C to 10°C incl. 44.6°F to 50°F incl.			Temperature Range 20°C to 25°C incl. 68°F to 77°F incl.			Temperature Range 34°C to 39°C incl. 93.2°F to 102.2°F incl.		
	No. of lots of 30 cut-worms used	Total Amount of food consumed by these cutworms	Average amount of food consumed by each lot of 30 cutworms	No. of lots of 30 cut-worms used	Total amount of food consumed by these cutworms	Average amount of food consumed by each lot of 30 cutworms	No. of lots of 30 cut-worms used	Total amount of food consumed by these cutworms	Average amount of food consumed by each lot of 30 cutworms
May 16-19 icnlusive	5	.79 gms	.16 gms	5	1.55 gms	.31 gms	5	3.15 gms	.63 gms
May 20-23	7	2.60 gms	.37 gms	9	6.56 gms	.73 gms	3	4.65 gms	1.55 gms
May 24-27	8	3.80 gms	.47 gms	12	11.92 gms	.99 gms	8	14.48 gms	1.81 gms
May 28-31	8	8.64 gms	1.08 gms	15	28.78 gms	1.91 gms	4	5.40 gms	1.35 gms
June 1-4	4	5.95 gms	1.48 gms	4	9.15 gms	2.28 gms	5	9.85 gms	1.97 gms
June 8	1	1.9 gms	1.9 gms	1	2.25 gms	2.25 gms	2	2.2 gms	1.1 gms
June 9-12	5	7.15 gms	1.43 gms	3	4.95 gms	1.65 gms	5	4.2 gms	.84 gms

Note. CERtain lots were discarded as they did not fall in the above temperature ranges.

temperature range of 20°C to 25°C. The third warming oven where the temperature was not automatically controlled had a temperature range of 34°C to 39°C.

Altogether the effect of temperature upon the relative amounts of food consumed is shown for 3570 cutworms in this table. The temperatures at which certain other lots were maintained did not fall within any of the ranges shown in the table but rather between the respective ranges and consequently were not taken into consideration in the compilation.

Cutworms were also subjected to both lower and higher temperatures than those shown in table I. On June 9 one lot of 30 cutworms was placed along with food in another refrigerator where the temperature was -5°C, and left there from 5.00 p.m. until 9.a.m. June 10. When they were removed they all appeared lifeless. The alfalfa used as food was frozen. When they were examined again at 2.00 p.m. June 10 twenty showed evidences of life while ten of them seemed dead. It is interesting to note without going into detail that some of the cutworms which were subjected to this temperature revived, fed normally thereafter and went into the pupal stage. On June 10 another lot of 30 was subjected for 17 hours to -3°C with the result that 16 out of 30 were killed. The other fourteen revived. By June 20 only 6 of these cutworms remained alive. In both cases mentioned above no food had been eaten by the cutworms during their confinement. Lots of 30 cutworms were also subjected to high temperatures, namely, 41°C., 45°C, and 46°C over night. In all cases, all of the cutworms were killed. The alfalfa used as food was browned by the heat and none had been eaten.

Two facts are brought out in the data shown in table I:

(1) There is a peak period to the food consumed by the Dark-sided Cutworm during its larval life.

(2) The Dark-sided Cutworm has preferences as to the temperature at which it will consume the most food. In order to see these facts more clearly the data are rearranged and shown in Tables II and III.

In table II the average amount of food eaten by each lot of 30 cutworms is shown for 4 day periods throughout the experiment. From May 16 when the cutworms were small until the first four days of June the amount of food consumed increased rapidly. At this latter period the cutworms nightly ate over five times the quantity of food that they consumed during the middle of May. From early in June the amount of food consumed dropped away slowly. Under laboratory conditions we found that Euxoa messoria continued to feed until June 27 although toward the end of the period feeding was slight.

The second fact brought out by the data that the Dark-sided Cutworm has temperature preferences for feeding is more clearly seen in Table III. The data in table III show that in the early stages in the larval life of the Dark-sided Cutworm the warmer it is within natural limits, the more food they will consume. For example from May 16 until May 27 at a temperature range of from 20°C to 25°C these cutworms ate about twice as much as they did in the temperature range of 7°C to 10°C, and further that at the temperature range 34°C-39°C they ate about twice as much as at the range 20°C-25°C. The inference is clear, therefore, that the higher the temperature is within natural limits at that season of the year the more food these cutworms will consume. At this point, however, a change begins to occur in

TABLE II

FOOD EATEN NIGHTLY BY CUTWORMS FROM MAY 16 TO JUNE 12, 1926

Four Day Periods	Temperature Range 7°C to 39°C for all Lots		
Date 1926	Total No. of lots of 30 cut-worms	Total Food Eaten by these Cutworms	Average amount of Food Eaten by Each lot of 30 Cutworms
May 16-19 incl.	15	5.49 gms	.36 gms
May 20-23 incl.	19	13.81 gms	.72 gms
May 24-27 incl.	28	30.20 gms	1.07 gms
May 28-31 incl.	27	42.82 gms	1.58 gms
June 1-4 incl.	13	24.95 gms	1.91 gms
June 8	4	6.35 gms	1.58 gms
June 9-12 incl.	13	16.30 gms	1.25 gms

TABLE III

AVERAGE AMOUNT OF FOOD EATEN BY LOTS OF 30 CUTWORMS NIGHTLY DURING FOUR DAY PERIODS UNDER DIFFERENT TEMPERATURE RANGES

TEMPERATURE RANGES

Date 1926	7°C to 10°C incl. 44.6°F to 50°F incl.	20°C to 25°C incl. 68°F to 77°F incl.	34°C to 39°C incl. 93.2°F to 102.2°F incl.
May 16-19 incl.	.16 gms.	.31 gms	.63 gms
May 20-23 incl.	.37 gms	.73 gms	1.55 gms
May 24-27 incl.	.47 gms	.99 gms	1.81 gms
May 28-31 incl.	1.08 gms	1.91 gms	1.35 gms
June 1-4	1.48 gms	2.28 gms	1.97 gms
June 8	1.9 gms	2.25 gms	1.1 gms
June 9-12	1.43 gms	1.65 gms	.84 gms

the temperature preferences of the cutworms. The extremely high temperatures are no longer the most desirable ones for food taking. During the periods May 28-June 12 the most desirable feeding temperature range of those shown is 20°C-25°C. It is also noted that feeding goes on well at the lowest temperature range 7°C-10°C.

An attempt was also made while the above work was under way to determine the time required for poisons to kill cutworms. Paris green and calcium arsenate were the stomach poisons used. Both were used with bran and also with alfalfa leaves as carriers for the poisons. The poisoned baits were left with the cutworms over night and removed in the morning in each case. Following this, each lot of cutworms was given fresh alfalfa daily throughout the experiment. Table IV gives details and compares the relative usefulness of paris green and calcium arsenate as insecticides for the purpose of poisoning cutworms.

The paris green and calcium arsenate were used at the same rate in all the baits used. A study of this table reveals the fact that neither paris green nor calcium arsenate kills quickly. Although paris green kills slightly quicker than calcium arsenate the relative difference is not very great. Relatively few cutworms were dead before the end of the third day. For example the total number of cutworms killed by paris green by the end of the third day was only 21 out of a total of 89 killed. Nearly half of this total died on the fourth and fifth days after eating the paris green. The majority of the cutworms which died from the effects of eating calcium arsenate died on the fourth, fifth and sixth days. An observation of some considerable economic importance was made to the effect that once the cutworm took the poisoned bait it stopped feeding almost com-

[illegible]

TIME REQUIRED FOR THE DARK-SIDED CUTWORM TO SUCCUMB TO POISON

Date Poison Given	Number of Cutworms	Poison in bait	No. of cutworms Found Dead at Times Stated Belo										
			1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	9th day	10th day	
June 9	30	Paris Green	1	3	4	5	3	5	0	1	1	0	
June 9	30	Paris Green	0	0	2	4	7	1	0	3	0	0	
June 10	30	Paris Green	0	2	2	3	3	2	0	0	1	1	
June 10	30	Paris Green	0	0	2	3	2	1	1	1	1	0	
June 15	30	Paris Green	2	1	0	3	0	0	1	0	2	0	
June 15	30	Paris Green	0	1	1	2	5	4	2	0	0	0	
Totals	180	Paris Green	3	7	11	20	20	13	4	5	5	1	89
June 9	30	Calcium Arsenate	0	0	3	2	7	5	4	0	0	0	
June 9	30	Calcium Arsenate	0	0	2	1	1	4	2	0	1	0	
June 10	30	Calcium Arsenate	0	0	1	5	3	5	2	1	3	0	
June 10	30	Calcium Arsenate	0	0	3	4	3	1	1	2	0	3	
June 15	30	Calcium Arsenate	2	0	2	0	0	0	1	2	0	0	
June 15	30	Calcium Arsenate	0	2	0	2	4	1	0	0	1	1	
Totals	180	Calcium Arsenate	2	2	11	14	18	16	10	5	5	4	87
Check	30		0	1	0	0	0	0	1	0	0	0	

Note. The baits used on June 15 were not freshly made.

pletely. Very little alfalfa was consumed by the cutworms which had fed on the baits even the first night after the poison had been taken. For all practical purposes, therefore, even though the poisoned cutworms did not die at once they did not do any further damage before they finally died. It will be noted further that only about 49% of the cutworms which fed upon or had an opportunity to feed upon the poisoned baits died within ten days. Some cutworms died after that time while others recovered. It is presumed that those which recovered regained their appetites.

SUMMARY

1. In a normal year such as 1926 the maximum damage done by the Dark-sided Cutworm *Euxoa messoria* occurs about the first week of June.
2. This species continues to feed until near the end of June.
3. Until near the end of May the higher the temperature within natural limits the more the cutworms eat.
4. Beginning near the end of May and continuing into June the optimum feeding temperatures dropped to the range 20°C to 25°C. (68°F to 77°F).
5. Paris green kills slightly quicker than calcium arsenate.
6. The maximum deaths for paris green occurred on the fourth and fifth days while for calcium arsenate they occurred on the fifth and sixth days.
7. Cutworms which have eaten poisoned bait stop feeding although they do not die for several days.

oOo

do	30	23	do	3	2.65	.35	3	.95	1.7
do	30	38	do	3	2.45	.55	3	1.45	1.0
May 28-29	30	9.4	3 p.m. to 10 a.m.	3	2.75	.25	3	1.3	1.45
do	30	9.4	do	3	2.75	.25	3	1.3	1.45
do	30	22	do	3	2.8	.2	3	.7	2.1
do	30	22	do	3	2.8	.2	3	.5	2.3
do	30	24	do	3	2.6	.4	3	.5	2.1
do	30	24	do	3	2.6	.4	3	.1	2.5
do	30	39	do	3	2.45	.55	3	1.1	1.35
May 29-30	30	9.1	3 p.m. to 9 a.m.	3	2.85	.15	3	1.5	1.35
do	30	9.1	do	3	2.85	.15	3	1.8	1.05
do	30	20.5	do	3	2.8	.2	3	1.2	1.6
do	30	20.5	do	3	2.8	.2	3	.85	1.95
do	30	23	do	3	2.5	.5	3	.25	2.25
do	30	23	do	3	2.5	.5	3	1.0	1.5
do	30	37	do	3	2.25	.75	3	1.4	.85
May 30-31	30	9.1	10a.m. to 9 a.m.	3	2.85	.15	3	1.6	1.25
do	30	9.1	do	3	2.85	.15	3	1.85	1.0
do	30	22	do	3	2.9	.1	3	.6	2.3
do	30	22	do	3	2.9	.1	3	.55	2.35
do	30	24	do	3	2.7	.3	3	.6	2.1
do	30	39	do	3	2.4	.6	3	.2	2.2
May 31 - June 1	30	8.8	2 p.m. to 9 a.m.	3	2.95	.05	3	1.3	1.65
do	30	8.8	do	3	2.95	.05	3	1.4	1.55
do	30	22	do	3	2.8	.2	3	.5	2.3
do	30	22	do	3	2.8	.2	3	.8	2.0
do	30	39	do	3	2.5	.5	3	.6	1.9
do	30	45	do	3	2.7	.3	3	2.6	.1

At 45°C cutworms were all dead. Alfalfa in both check and tin occupied by cutworms was brown and smelled strongly as if cooked.

June 1-2	30	8.3	5 p.m. to 10 a.m.	3	2.8	.2	3	1.2	1.6
do	30	21	do	3	2.7	.3	3	.2	2.5
do	30	38	do	3	2.15	.85	3	.4	1.75
do	30	41	do	3	1.95	1.01	3	none eaten larvae all dead. Cooked.	
June 2-3	30	9	3:30 p. m. to 10 a. m.	3	2.9	.1	3	2.15	.75
do	30	27	do	3	2.9	.1	3	.4	2.5
do	30	38	do	3	2.6	.4	3	.1	2.5
do	30	46	do	3	cutworms all dead. Cooked. Alfalfa brown and smelling.				
June 3-4	30	9	4 p.m. to 9:30 a.m.	3	3	.0	3	1.0	2.0
do	30	25	do	3	3	.0	3	.75	2.25
do	30	37	do	3	2.5	.5	3	1.0	1.5
June 3-4	30	38	do	3	2.9	.1	3	.7	2.2
June 7-8	30	9	4:30 p.m. to 9:30 a.m.	3	2.55	.45	3	.65	1.9
do	30	22	do	3	2.65	.35	3	.4	2.25
do	30	37.5	do	3	2.1	.9	3	1.3	.8
do	30	38	do	3	2.05	.95	3	.75	1.3
June 8-9	30	7.3	4:30 p.m. to 10 a.m.	3	2.1	.9	3	1.3	.8
do	30	8.3	do	3	2.6	.4	3	1.2	1.4
do	30	22	do	3	2.6	.4	3	1.0	1.6
do	30	31	do	3	2.3	.7	3	.4	1.9
do	30	37	do	3	2.2	.8	3	1.3	.9
June 9-10	30	-.5	5 p.m. to 10 a.m.	3	2.8	.2	3	2.8	.0

At -.5°C the alfalfa was frozen.

do	30	5	do	3	2.7	.3	3	2.0	.7
do	30	9	do	3	2.7	.3	3	1.7	1.0
do	30	24.5	do	3	2.7	.3	3	.85	1.85
do	30	30.5	do	3	2.7	.3	3	1.3	1.4
do	30	37.5	do	3	2.5	.5	3	1.6	.9
June 10-11	30	-3	3:30 p.m. to 9 a.m.	3	2.9	.1	3	2.9	.0

Alfalfa plants frozen. No activity on part of cutworms.

do	30	5	do	3	2.6	.4	3	1.9	.7
do	30	9	do	3	2.9	.1	3	1.1	1.8
do	30	25	do	3	2.7	.3	3	1.2	1.5
do	30	29	do	3	2.7	.3	3	.95	1.75
do	30	38	do	3	2.1	.9	3	1.2	.9
June 11-12	30	9	5 p.m.to 12 a.m.	3	2.85	.15	3	.9	1.95
do	30	30	do	3	2.6	.4	3	1.2	1.4
do	30	35	do	3	2.3	.7	3	1.3	1.0
do	30	38	do	3	2.1	.9	3	1.6	.5

Details of work Done in Determining Optimum Feeding Temperatures for the Dark-sided Cutworm (Euxoa messoria Harris).

Note. Food was alfalfa leaves and tender stems

Date	No. Cutworms used	Constant Temp °C.	Time under constant Temp.	Wt. of check when placed in oven grams	Wt. of check when removed from oven grams	Loss in wt. of check grams	Amt. food given cutworms grams	Amt. food removed grams	Amt. food consumed grams
May 15-16	30	10	7:30 p.m. to 2:10 p.m.	2.0	1.85	.15	2.0	1.6	.25
do	30	35	do	2	1.5	.5	2.	1	.5
do	30	23	do	2	1.7	.3	2.	1.5	.2
May 16-17	30	24.5	2:45 p.m. to 9:00 a.m.	2	1.75	.25	2	1.6	.15
do	30	39	do	2	1.45	.55	2	.8	.65
do	30	10	do	2	1.9	.1	2	1.85	.05
May 17-18	30	22.5	5:30 p.m. to 9:30 a.m.	2	1.8	.2	2	1.5	.3
do	30	38	do	2	1.6	.4	2	1.1	.5
do	30	10	do	2	1.85	.15	2	1.7	.15
May 18-19	30	7.7	5 p.m. to 9 a.m.	2	1.8	.2	2	1.55	.25
do	30	7.7	do	2	1.8	.2	2	1.7	.1
do	30	35	do	2	1.55	.45	2	.8	.75
do	30	35	do	2	1.55	.45	2	.8	.75
do	30	20.5	do	2	1.8	.2	2	1.35	.45
do	30	20.5	do	2	1.8	.2	2	1.35	.45
May 19-20	30	20	do	2	1.85	.15	2	.95	.9
do	30	36	do	2	1.75	.25	2	.9	.85
do	30	16	do	2	1.95	.05	2	1.55	.4
do	30	7.2	do	2	1.95	.05	2	1.55	.4
May 20-21	30	6.6	do	2	1.7	.3	2	1.45	.25
do	30	6.6	do	2	1.7	.3	2	1.35	.35
do	30	32	do	2	1.25	.75	2	.6	.65
do	30	32	do	2	1.25	.75	2	.85	.4
do	30	19.5	do	2	1.6	.4	2	1.1	.5
do	30	19.5	do	2	1.6	.4	2	1.1	.5
May 21-22	30	6.6	do	2	2	0	2	1.6	.4
do	30	6.6	do	2	2	0	2	1.7	.3
do	30	19.5	do	2	2	0	2	1.45	.55
do	30	19.5	do	2	2	0	2	1.35	.65
do	30	20	do	2	2	0	2	1.15	.85
do	30	32	do	2	2	0	2	1.0	1.0
May 21-22	30	32	do	2	2	0	2	1.1	.9
May 22-23	30	7.2	12 noon to 2 p.m.	2	2	0	2	1.5	.5
do	30	7.2	do	2	2	0	2	1.6	.4
do	30	19.5	do	2	2	0	2	1.3	.7
do	30	19.5	do	2	2	0	2	1.1	.7 9
do	30	21.5	do	2	1.8	.2	2	.6	1.2
do	30	34	do	2	1.9	.1	2	.0	1.9
do	30	34	do	2	1.9	.1	2	.05	1.85
May 23-24	30	7.7	2 p.m. to 3:30 p.m.	3	2.95	.05	3	2.7	.25
do	30	7.7	do	3	2.95	.05	3	2.7	.25
do	30	20	do	3	3	.0	3	2.1	.9
do	30	20	do	3	3	.0	3	2.15	.85
do	30	22	do	3	2.75	.25	3	1.5	1.25
do	30	33.5	do	3	3	.0	3	1.25	1.75
do	30	33.5	do	3	3	.0	3	1.1	1.9
May 24-25	30	8.3	4 p.m. to 2.30 p.m.	3	3	0	3	2.5	.5
do	30	8.3	do	3	3	0	3	2.5	.5
do	30	21	do	3	3	0	3	2.35	.65
do	30	21	do	3	3	0	3	2.25	.75
do	30	23	do	3	2.9	.1	3	2.15	.75
do	30	35	do	3	2.8	.2	3	1.25	1.55
do	30	35	do	3	2.8	.2	3	1.1	1.7
May 25-26	30	7.7	5 p.m to 9 a.m.	3	2.5	.5	3	1.95	.55
do	30	7.7	do	3	2.5	.5	3	1.95	.55
do	30	20.5	do	3	2.45	.55	3	1.4	1.05
do	30	20.5	do	3	2.45	.55	3	1.55	.9
do	30	23	do	3	2.2	.8	3	1.0	1.2
do	30	34	do	3	1.9	1.1	3	.5	1.4
do	30	34	do	3	1.9	1.1	3	.7	1.2
May 26-27	30	8.8	do	3	2.9	.1	3	2.4	.5
do	30	8.8	do	3	2.9	.1	3	2.2	.7
do	30	21.5	do	3	2.8	.2	3	1.55	1.25
do	30	21.5	do	3	2.8	.2	3	1.3	1.5
do	30	23	do	3	2.7	.3	3	1.85	.85
do	30	35	do	3	2.6	.4	3	1.1	1.5
do	30	35	do	3	2.6	.4	3	1.1	1.5
May 27-28	30	8.3	3p.m. to 9 a.m.	3	2.8	.2	3	2.1	.7
do	30	8.3	do	3	2.8	.2	3	2.4	.4
do	30	21	do	3	2.8	.2	3	1.85	.95
do	30	21	do	3	2.8	.2	3	1.0	1.8
[illegible]	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3	[illegible]	1.45

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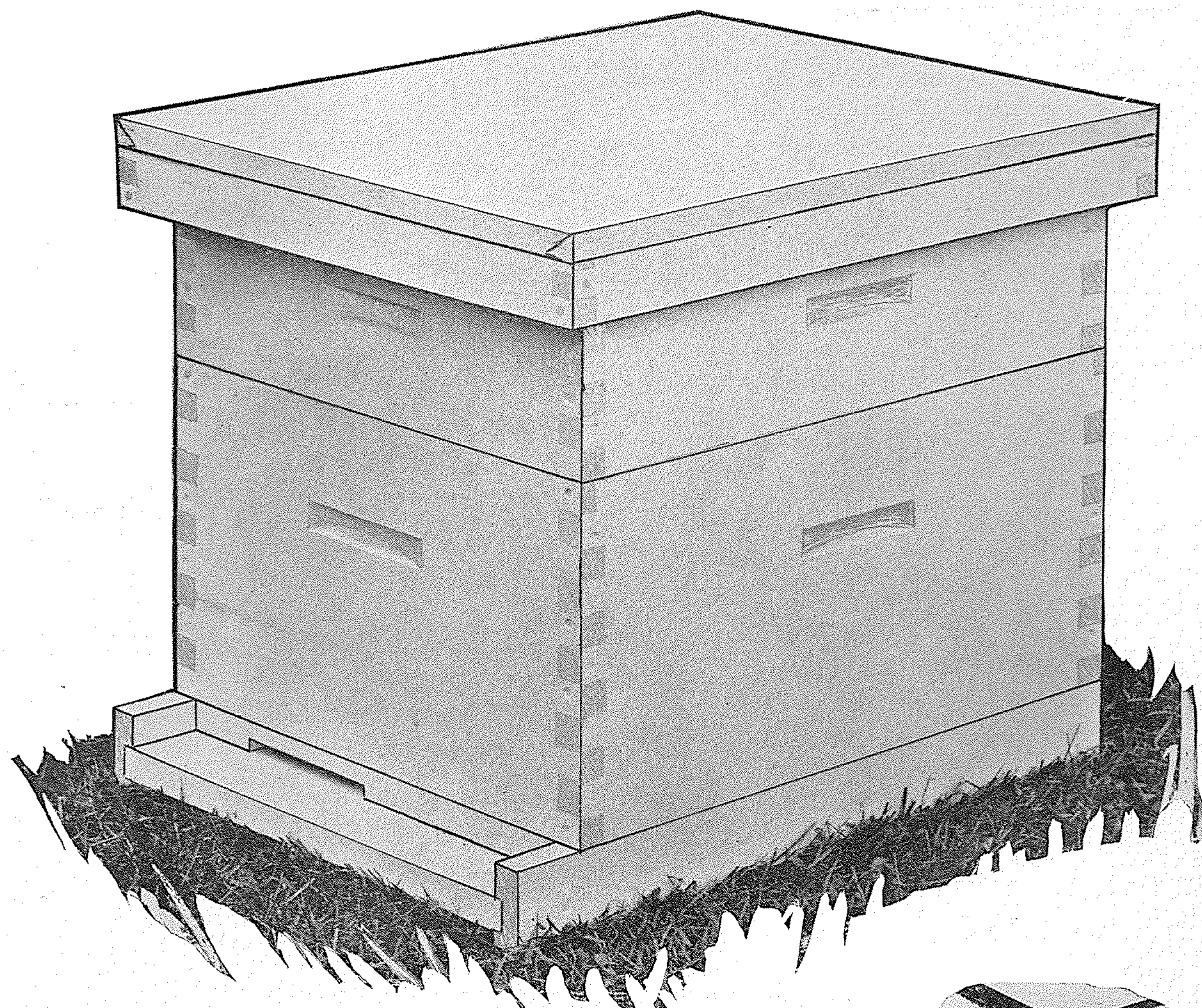
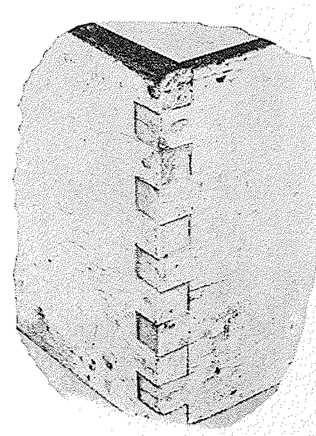
NOTES ON TECHNIC

DUCO, AS A MATERIAL FOR RINGING COVER GLASSES ON MICROSCOPIC SLIDES. The attention of those who prepare microscopic slides is drawn to *Duco* as a material for ringing the cover glasses on the finished slides. In a search for a desirable material for this purpose *Duco* was tried with rather satisfactory results. *Duco* is manufactured by Dupont Chemical Works, Parlin, New Jersey, U.S.A. and by Flint Paint and Varnish Limited, Toronto, Canada. One of its principal uses is as a finishing material for automobile bodies. Its desirable characteristics as a ringing material on microscopic slides are as follows:

1. It is easily obtained, being on sale in almost every town and city.
2. It is reasonable in price.
3. It comes in a variety of colors. Two colored effects may be obtained on slides if so desired.
4. It dries quickly. The whole process of placing the ring on the slide can be completed in a few minutes.
5. The finish is hard and glossy.
6. Duco may be applied directly to clean glass without previous preparation.
7. It is evidently durable.

—A. V. Mitchener, Manitoba Agr. Col.,
Winnipeg, Canada.





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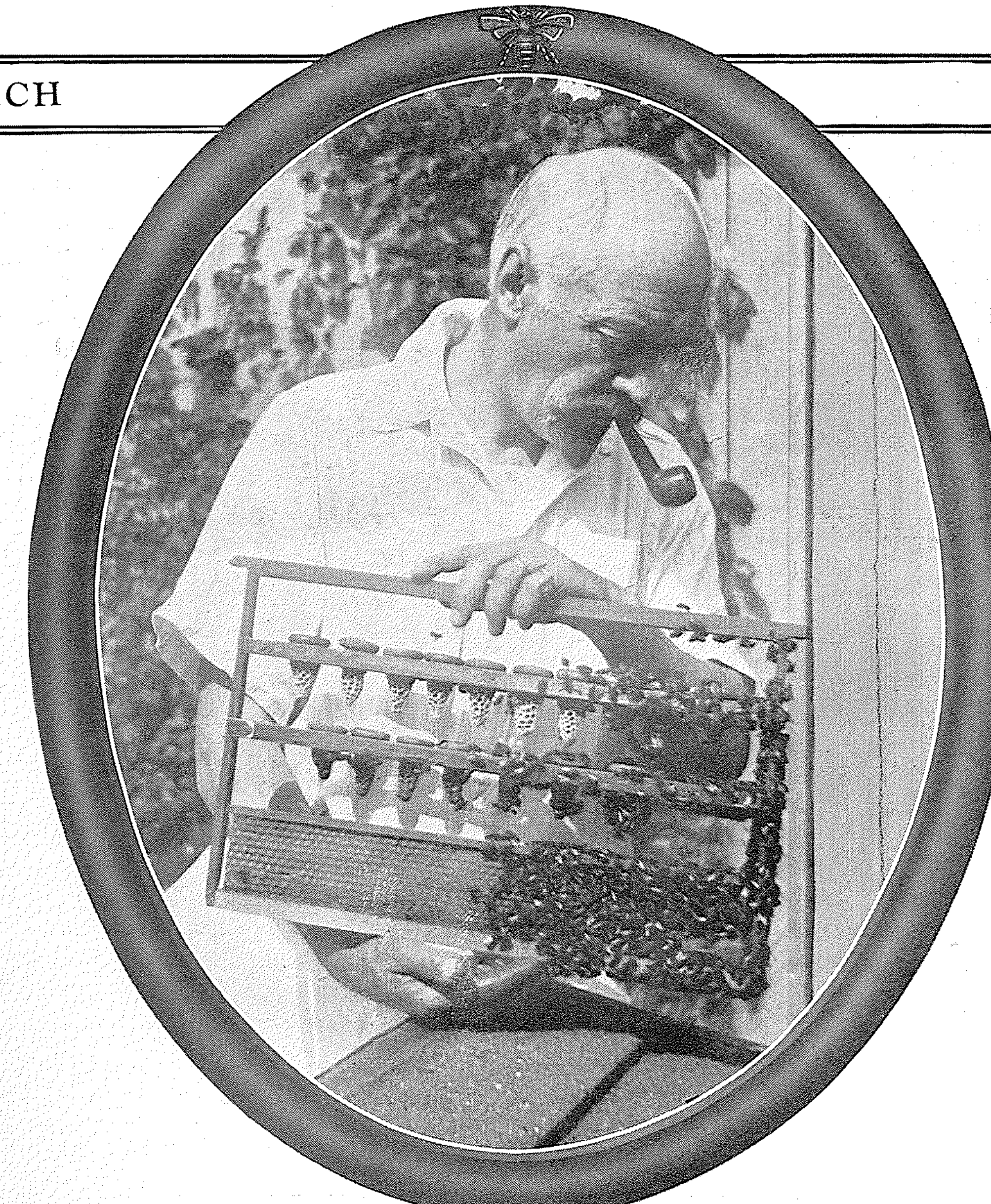

Influence of Temperature on the Honeyflow

By A. V. Mitchener

THE province of Manitoba, Canada, lies north of 49° L. North Dakota is situated immediately to the south. Manitoba is 280 miles from east to west along the southern boundary and 770 miles from north to south. Beekeeping as yet is carried on only in the southern part of the province, which is devoted to agriculture. In summer the temperature occasionally goes above 90° F. and the days of sunshine are many and long. The nights are comparatively cool. In general the climate is invigorating and delightful.

In the summer of 1922 an average colony of bees was placed on a set of scales in the Manitoba Agricultural College apiary and a daily record of its weight kept throughout the summer. The gains made by the colony fluctuated from day to day to such a conspicuous extent that weather records were obtained from the Physics Department at the college and an attempt was made to see what relation existed between the honeyflow and daily hours of sunshine, combined with minimum and maximum daily temperatures. A relationship was at once apparent. Since 1922 one or two colonies of bees have been kept on scales in the college apiary each year.

In 1924 an attempt was made to collect data on the period of the year when surplus honey accumulated in the apiaries of the province. Representative beekeepers were selected from fifteen scattered points over the whole beekeeping area of Manitoba. Each of these beekeepers agreed to keep a colony of bees on scales from the first of May to the end of September and to record its weight daily throughout these five months. I wish to express my appreciation to these beekeepers who have made possible such information as we have, of the honeyflows of the province in general. Not only did they keep these records for 1924, but many of them have kept similar records for 1925 and 1926. In each of the three years mentioned, fifteen beekeepers submitted their records for the five months of the summer. Figure 1 shows the result of the compilation of these records for the three years. The average daily gain per hive is shown for five-day periods throughout the summer. As an example for the five-day period July 29 to August 2, inclusive, 1924, the average daily gain for the fifteen colonies recorded was 3.2 pounds of honey. The fifteen colonies for the five-day period, therefore, stored a total of 15x5x3.2—240 pounds of honey. The season during which the bees are active in Manitoba usually extends from about the third week in April, when the bees are removed from the cellars, to early November, when the colonies are again placed in winter quarters. Brood rearing commences as soon as the bees are brought out of the cellar. From the records shown in Fig. 1, it will be noted that the bees begin to make gains during the latter part of May. The season of 1924 was about two weeks late. Normally about the middle of June the colonies scarcely hold their own in weight. About the end of June the honeyflow begins in earnest. Between the middle of April and this time the bees build up strong colonies of young workers. This is not only true of overwintered colonies but is also true of imported packages which have been brought in and placed in hives by the first of May. One important point to note is that our surplus honey is stored from one prolonged flow. Instead of having two or more seasonal flows of short duration, all our surplus-producing flowers come into bloom during this one period. The honey season in this area is concentrated within the limits of a little over two months. Sometimes, however, colonies make gains until the middle of September. What a few weeks between honeyflows means to the yearly crop is indicated by the records of one very strong colony in the M. A. C. apiary during the month of September, 1926. This month was unseasonably cold and cloudy, and during this period this particular colony lost weight to the extent of twenty-five pounds. Brood rearing causes the consumption of a great deal of honey.

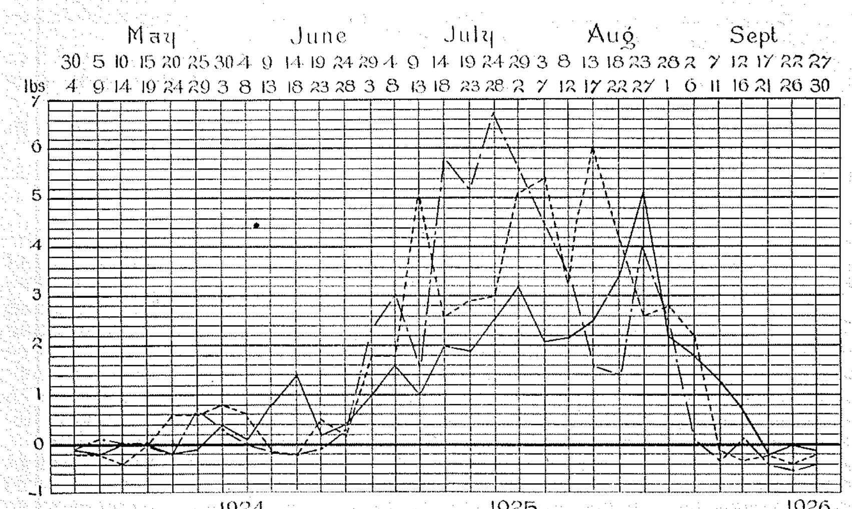

Fig. 1. Honeyflow in Manitoba for five-day periods for the years 1924, 1925, and 1926. The total surplus honey for each year is from one continuous flow

Following out of our study of the relation between honeyflows and sunshine and temperature, as shown by our records in the college apiary, we undertook a more extensive study of this subject in 1926. All those beekeepers who were recording the daily weight of a colony were also requested to record the daily maximum and minimum temperatures and also the estimated number of hours of sunshine each day. For the months of July and August, whose records are shown in Fig. 2, the average production of eleven colonies kept on scales was taken. During July nine beekeepers kept the maximum temperature, eight kept the minimum temperature, and seven estimated the daily hours of sunshine. During August six beekeepers recorded the maximum temperature, six the minimum temperature, and nine estimated the daily hours of sunshine. These respective records are averaged to secure the data shown in Fig. 2. As can be seen from consulting Fig. 1, July and August are our best months, and for this reason these two months were selected for study.

The chart, figure 2, shows the average daily production for the eleven colonies from as many widely separated points in Manitoba. The record in pounds may be read from the left side of the chart. As an example, on July 5 the average daily production per colony was 5.2 pounds. The daily maximum and minimum temperatures may be read from the right side of the chart. The extremes are indicated at the ends of the heavy vertical lines under

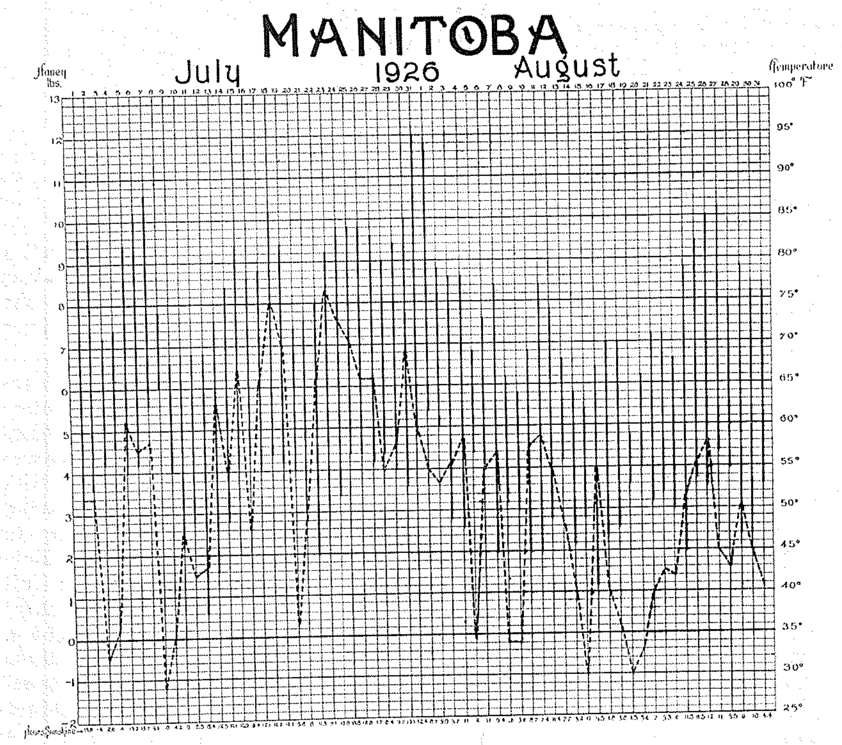

Fig. 2. Data compiled from widely separated apiaries in Manitoba to show what happens in an average colony under average conditions of sunshine and temperature

each date. The maximum is for the day indicated and usually occurred shortly after noon. The minimum is that of the night previous. As an example, on July 30 the maximum temperature was 85° F., while the minimum of the night previous was 53° F. There was a spread of 32° F. between the night temperature and that of the day following, namely, July 30. The hours of sunshine are shown in figures for each day at the bottom of the line indicating the particular day. For example, on August 3 there were 9.7 hours of sunshine.

Let us now examine the effect of hours of sunshine and the spread of temperature between the minimum of the night and the maximum of the day, upon the average daily yields. In the first place we should note that the honeyflow varies from day to day. The daily hours of sunshine also vary, and, further, the maximum and minimum temperatures vary considerably, which is another way of saying that the spread is not at all constant. It is reasonable to suppose that the flora is fairly constant over a short period of time. Figure 2 represents the average colony under average condition of sunshine and temperature. As an example, begin with July 3. The spread is 15° F. and the total sunshine for the day is 2.6 hours. The colony actually lost five-tenths pound weight. On July 4 the spread was 14° F., while there were four hours of sunshine and the colony gained two-tenths of a pound. On July 5 the spread is 27° F. and there were 13.2 hours of sunshine. The colony gained 5.2 pounds that day. On July 6 the spread is 30° F. and there were 13.7 hours of sunshine. The colony gained 4.5 pounds. On July 7 the spread was 25° F., sunshine 9.6 hours, and gain 4.7 pounds. On July 8 the spread was only 9° F., with no hours of sunshine, and the colony lost weight to the extent of 1.2 pounds. Examine the period of July 9 to July 20, or in fact any consecutive number of days.

A study of the data seems to prove that, other things being practically the same, the more hours of sunshine there are daily, the more nectar the bees bring into the hive. Evidence is also produced to show that the greater the spread between the night and the day temperature, the greater the increase in the weight of the hive. Further, it seems that the higher the spread is, namely, the hotter it is during the day, the greater the gains made by the colony. Maximum daily temperature is somewhat dependent upon sunshine. If the sun shines for a short period only, during the day, the maximum temperature will probably not be extremely high. If, on the other hand, the sun is out all day a high maximum may be expected.

August, 1926, was abnormally cool in Manitoba. By consulting Fig. 1, it can be seen that in 1924 and 1925 the peak yield occurred in August. This was not true in 1926.

A stimulating period of nectar secretion from willow and dandelion, of sufficient duration to ensure strong colonies at the beginning of the main flow, an ample supply of plants producing surplus nectar, many hours of sunshine daily, and a big spread between the night and day temperatures seem to be some of the essentials to big yields of honey. The average production per colony in Manitoba for the past five years is, according to the estimates of the provincial apiarist, 127 pounds. The conditions which prevail in Manitoba are very similar to those found in the northern states and other western provinces in Canada. The area of honey production in America seems to be moving north. Who knows but what in a few decades hence we shall find ourselves on the southern fringe of the principal honey-producing area of this continent? Manitoba.

British Columbia Honey Production, 1925

The British Columbia Provincial Apiarist reports that little progress was made in the bee-raising industry during 1925, according to a report from Consul H. S. Tewell, Vancouver, B. C. The production of honey amounted to 638,319 pounds, as against 679,289 pounds in 1924, the decrease being caused chiefly by protracted drought and forest fire smoke. The number of beekeepers, however, increased from 2,408 in 1924 to 2,426 in 1925, and the number of hives from 14,604 to 15,505. In addition to local production, the markets of British Columbia consumed 125,000 pounds of honey imported from other provinces during 1925.

Honey Bunk

Friend health fan advises omitting sugar from diet of children and replacing it with honey. M. C. A.

A.—Honey is all right if the kids like it, though I believe sugar is quite as wholesome and desirable.—(Questions and Answers in St. Paul Pioneer Press.)

Just as well say that gruel is as good as pure milk for little children. Sugar is a boiled and chemically purified product, while honey is the pure product of nature just as is milk. None of the preparations of man can be compared to the natural products of nature. Too much "bunk" in newspaper advice.—Editor.