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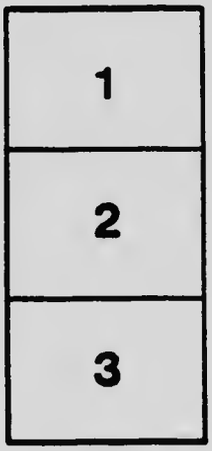

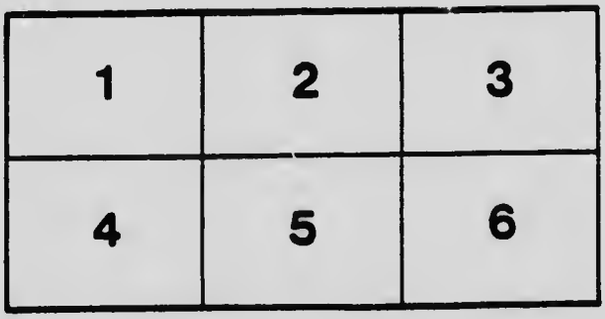

Cherry Fruit-Flies

BULLETIN 227] JANUARY, 1915

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Cherry Fruit-Flies

BY

L. CAESAR AND G. J. SPENCER

SUMMARY OF CONTENTS

There are two species of Cherry Fruit-flies in Ontario that have been causing much loss to cherry growers. They are not new insects, but their identity as pests was not known until the years 1910 and 1912 respectively.

These insects are distributed here and there over all the Niagara district, and probably in many of the other cherry districts of the province.

The injury is caused by the flies laying their eggs just beneath the skin, and the maggots or larvae that hatch from these feeding on the juice of the cherry and destroying the pulp by tearing it apart with small black hooks which act as jaws. The percentage of wormy cherries in infested orchards varies from 5 to 99 per cent. Many otherwise good orchards are sometimes so badly infested that the fruit cannot be picked. Wormy cherries are subject to Brown Rot and help to spread this disease to those that are not wormy. The sale of wormy cherries injures the market for good cherries by ... people afraid to buy them, because often it is almost impossible to tell w... cherry is wormy or not until it is opened. The total loss from the flies m... to several thousand dollars each year, but is much less some years than ... varieties like Early Richmond and early sweet cherries are almost exempt from attack, but all later sour and sweet cherries are infested, especially Montmorency and Morello. So far as known no other orchard fruit is subject to injury from the pest.

The adult insects are two-winged flies, about two-thirds the size of a House-fly. The wings are conspicuously marked by dark crossbands. Near the centre of the back is a little cream or yellow dot. The head and legs are yellow and the body black, or mostly black, except that one species has four white bands across the abdomen of the female, and three across that of the male. The other species has the abdomen entirely black. Consequently it is proposed to call the first species the White-banded Cherry Fruit-fly and the other the Black-bodied Cherry Fruit-fly.

The flies of the latter species appear on the trees about a week earlier in spring than those of the former. In Niagara they may usually be seen about the end of the first week in June, the other species about June 11th. The adults probably

live on an average about three weeks. No eggs are laid for ten or twelve days after they emerge. In the meantime they feed on whatever they can find on the surfaces of the leaves and on the juice of injured cherries when these become ripe. The mouth parts are like those of a House-fly, and may be said to consist of a moderately long sucking tube with broad lips at the tip to collect and hold the food till it is dissolved by saliva and sucked up.

Eggs are laid just under the skin of the cherries with a sting-like ovipositor. They hatch in about five days. The maggots are full grown in about fourteen days as a rule. They are usually glossy white or sometimes yellowish, about quarter inch long when mature, cylindrical and tapering sharply towards the anterior end. There is no head or legs; a pair of little black retractile hooks at the small end takes the place of jaws. On leaving the fruit the larvae work into the soil about an inch or go down cracks, if the surface is hard, and soon change to the puparia, inside of which the pupa is formed. Puparia look like little grains of wheat. In this form they remain dormant until the next June, when they change to flies and move about through the orchard.

The chief natural means of keeping the insects in check are the condition of the surface of the soil itself under the trees, ants and birds, including poultry. A hard surface interferes with the adult flies being able to emerge out of the soil; it also prevents the larvae from working their way in. Ants and birds devour the recently emerged adults on the ground, also the larva and pupae wherever they are visible.

Cultivation of orchards does not help to control the insects.

Spraying.—Many experiments in 1913 and 1914, both on large orchards and on caged trees show that the insects can be easily and cheaply controlled by poisoning the adults before they can lay their eggs. The best mixture to use is from 2 to 3 lbs. arsenate of lead (paste) to 40 gallons of water, sweetened with one gallon, or nearly one gallon, of cheap molasses (black strap). Arsenate of lead without the molasses will probably give almost as good results. Until the pest is nearly annihilated two applications should be given each year in badly infested orchards, the first about the 8th of June, or about a week before Early Richmonds begin to ripen, the second application ordinarily about June 20th, or about the time the Montmorencies are showing the first symptoms of the red blush. It is well to spray plum, apple and pear trees that happen to be among or very close to the cherry trees, as the flies rest and feed on their foliage also. Early varieties of cherries should not be given the second application, as they are then too near picking time. Two years' treatment should free an orchard of the pest, unless fresh infestation comes from outside sources.

In spraying, both the under and upper surface of the leaves should be given a light covering, so that the rains will not quickly wash off all the mixture. Cover all or nearly all the foliage, but do not make it drip.

The cost of spraying trees fourteen years of age twice should not be more than five cents per tree. This includes cost of mixture, labor and horse.

Useless cherry trees around the fence corners or road-side should be removed.

Neighbors should be urged to co-operate by spraying their own orchards. This prevents re-infestation from outside sources.

Close observations for two years in five orchards, along with some special tests, show that bees are not attracted to the poison, and that there is no danger of poisoning them if the directions given above are followed.

CHERRY FRUIT-FLIES.

(*Rhagoletis cingulata*, Loew, and *Rhagoletis fausta*, O.S.)

In the autumn of 1909, Mr. F. G. Stewart, of Homer, a village near St. Catharines, stated in a meeting of the fruit growers of the province in Toronto that some insect, evidently not the Plum Curculio, was causing serious damage to his cherries. The senior author was not present at the meeting, but was written to by Mr. A. B. Cutting, B.S.A., of the *Canadian Horticulturist* and asked what insect was doing the injury. In reply he stated that, while he suspected it was the "Cherry Fruit-fly" described by Prof. Slingerland in Bulletin 172 of Cornell University, he could not be sure; but, as he considered the matter an important one, would the next year endeavor to determine the identity of the insect. Accordingly on July 6th, 1910, the orchard was visited and over one hundred adult flies were found. These all proved to be the species described by Prof. Slingerland, *Rhagoletis cingulata*. Examination of the fruit and conversation with Mr. Stewart made clear that in this orchard at least much loss had been caused for years by the pest.

Owing to lack of time no further attention could be paid to the insect until the year 1912, when a number of other cherry orchards were visited to see whether the fly was present and doing damage in them also. On June 22, while inspecting an orchard situated about two miles from Mr. Stewart's, the senior author was astonished to find large numbers of another species of Cherry Fruit-fly causing similar injury on a large scale. Specimens of this new insect were sent to Dr. J. M. Aldrich, the well-known authority on two-winged flies (Diptera), and other specimens were taken to Mr. J. G. Illingworth, of Cornell University, by Mr. A. G. Bland, a student of the Agricultural College, who was present at the time the discovery was made. Both Dr. Aldrich and Mr. Illingworth wrote, stating that the new Cherry-fly was known as *Rhagoletis fausta*, and that it had been discovered a little earlier that year to be the cause of considerable injury to cherries in New York State, all the injury previous to this discovery having been supposed to be due to the first mentioned species.

Further examination of orchards showed that many cherries were infested by one or other of these pests, but in many cases, as the adults were not seen, it was impossible to ascertain which insect was to blame, or whether both were. As the cherry industry is a very important one in the Niagara district, it therefore seemed advisable to make a careful study of the life histories of both insects as soon as possible, with the object of discovering the most economical and practicable means of control.

In 1912 a few preliminary tests were made with sweetened poisons, various fragrant substances such as essence of pear, and tanglefoot, but no real study could be undertaken until 1913. In this year Mr. Stewart's two orchards at Homer were chosen for the experiments, as they were both very badly infested. The life history of one species and part of that of the other were worked out that year, and the method of control tested was found very satisfactory. In 1914 the work was repeated in two other orchards. One of these was infested by one species almost exclusively, the other by the other. The crop in both had been very badly injured the previous year.

To this second year's study the junior author, who had done the larger share of the work in 1913, was unable to devote more than about seventeen days, consequently the senior author obtained the assistance of Mr. J. C. Shipton, a fourth year student of Entomology at the O.A.C., Guelph. Mr. Shipton proved a valuable helper,

being energetic, persevering, thorough and possessed of no small amount of initiative and originality.

The result of the two years' study of these pests has, it is believed, given a fairly full and reliable knowledge of the life histories of both insects and proven beyond question that they can be controlled easily and with very little expense.

Proposed Popular Names for the Flies.

In Bulletin 325 of Cornell University the proposal was made that the names of these two flies should be respectively "The Common Cherry Fruit-fly" and "The

Fig. 1.—A female Black-bodied Cherry Fruit-fly, Rhagoletis fausta. Note the arrangement of the dark markings on the wings, and also the black abdomen without white crossbands.

Northern Cherry Fruit-fly." The authors of the present bulletin, while reluctant to suggest different names, believe that the above would have no significance to fruit growers, and therefore propose that for the first fly discovered (*Rhagoletis cingulata*), the name should be "The White-banded Cherry Fruit-fly," because of the white bands across its abdomen, and for the other (*Rhagoletis fausta*) "The Black-bodied Cherry Fruit-fly," because the black abdomen without any white crossbands is the most striking characteristic of this species.

Description of the Flies.

The White-banded Cherry Fruit-fly is scarcely two-thirds the size of a House-fly. The general color is black, but the abdomen, as mentioned above, is crossed by conspicuous white crossbands, females having four of these, males three. On

Fig. 2.—A female White-banded Cherry Fruit-fly Rhagoletis cingulata. Note the arrangement of dark markings on the wings, and the presence of white crossbands on the abdomen.

the hinder part of the back of the thorax is a little pale yellowish spot, and along each side from the base of the wing to the head is a yellowish stripe. The head is yellow with beautiful glistening gold-green eyes. The legs are also yellow, though in some specimens the upper parts are blackish. The wings are very conspicuous because of four dark-brown crossbands. These can be clearly seen in Fig. 2. It will be observed that at the tip of each wing is a little black spot not found in the

other species, or in any other closely related Fruit-fly. There are also two clear areas running all the way across the wing between the dark areas. This, too, is characteristic of this species.

The Black-bodied Cherry Fruit-fly (see Fig. 1) is a little larger than the other species, is black in color and, as stated above, has no white crossbands on the abdomen, this fact making it very easily distinguished from the White-banded species.

Fig. 3.—A female adult of the Apple Maggot or Railroad Worm, Rhagoletis pomonella. Note the arrangement of the dark markings on the wings and the presence of white crossbands on the abdomen.

It has a similar yellow spot on the back and yellow line along each side of the thorax. The head, eyes and legs resemble those of the other in color, with the exception that the stoutest section of the legs (femora) is usually black. The crossbands on the wings are darker, being black instead of dark brown, and are arranged very differently from those on the other species. There is only one clear area running all the way across the wing between the dark bands. This fact and the presence of a little clear, nearly circular dot in the broad portion of the dark area are characteristic of this species.

In both species the females are somewhat larger than the males. Of the white-banded flies a few males were seen that were so small as to entitle them to be called dwarfs.

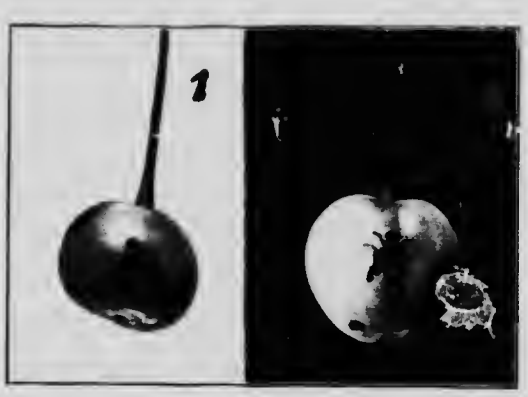

Fig. 4.—Cherry Fruit-flies on the fruit: (1) the Black-bodied Cherry Fruit-fly; (2) the White-banded Cherry Fruit-fly.

How Cherry Fruit-flies can be Distinguished from their Close Relative, the Apple Maggot or Railroad Worm.

The easiest way to distinguish the Cherry Fruit-flies from the Apple Maggot is by the arrangement of the dark markings on the wings. The peculiarity of these markings in the latter insect is that they are continuous, there being no clear trans-

verse area completely separating them as in the other two species. Furthermore, the Apple Maggot is a little larger than either of the others, and has for the most part white markings on the body where the others have yellowish. It has also, like the White-banded Cherry Fruit-fly, four white crossbands on the abdomen of the females and three on the males. (See Fig. 3.)

History of the Flies.

So far as known both species of flies appear to be native to North America. The White-banded Cherry Fruit-fly was described from the middle United States as early as 1862, and from New Jersey in 1873. It was apparently not known to be a serious pest until Prof. Slingerland, of Cornell University, N.Y., published a bulletin (No. 172) on it in 1899, and described the injury it was causing. Since that time it has been found in several States, but very little has been published concerning it. In Canada, so far as known, the first discovery of this species was made in 1910, as referred to above. It clearly had been present in Ontario for many years before this, but fruit growers, with very few exceptions, had always attributed the damage to the Plum Curculio. Whether this species occurs in any

Fig. 5.—Adult Fly of the Apple Maggot or Railroad Worm on the fruit, Cherry Fruit-flies above.

other province than Ontario is not certain. Dipterous larvae have been found in cherries on one or two occasions in Quebec, but the adults apparently were not reared or captured.

The Black-bodied Cherry Fruit-fly was first described in 1877 from specimens captured on Mount Washington in the State of New Hampshire. In 1904 the maggots of this species were found in cherries in British Columbia, an adult reared from these later.

In 1910 some adults were found by M. C. Van Duzee, at Kearney, a town in Ontario between Parry Sound and Ottawa. In 1912 the entomologists of Cornell University discovered its presence in New York State, and a little later in the same season, as mentioned above, it was found near St. Catharines, in Ontario. British Columbia and Ontario are the only two provinces in Canada from which it has been

reported, and in the former both the Provincial entomologist and the horticulturist state it is so rare that they have not themselves seen it or heard of any damage being done by it for years.

Distribution of the Flies in Ontario.

Owing to the great amount of work required in studying the life-histories and testing control measures, it was found impossible to visit all the cherry districts of the province and determine at first hand the distribution of each species. Most of the Niagara district was, however, inspected, and it was discovered that both species could be found all the way from Burlington to near Niagara-on-the-Lake or Queenston, a distance of fifty miles; in fact there is scarcely any doubt that both flies can be found in every section of the Niagara peninsula, though by no means in all the orchards. Outside of Niagara, infested cherries have been found at Waterdown, Oakville and Cobourg, and judging from a letter received from a lady in Berlin, some trees in that town are also infested. A grower in York County, and another in Elgin, think the insects are present also in their respective counties. There has, however, been no opportunity to obtain adults from any of these places and to determine whether only one or both species are present. With the single exception of Kearney, where, as previously mentioned, some specimens of the Black-bodied species were found in 1910, neither fly has been reported from any other part of the province than those mentioned. Further search would, however, likely reveal their presence in at least some of the towns and villages where colonies could easily become established by throwing out upon the ground purchased wormy fruit.

Comparative Abundance of the Two Species.

So far as could be judged from two seasons' observations, the White-banded Cherry Fruit-fly is in the average orchard considerably more abundant than the Black-bodied, and is responsible for a greater amount of damage to the fruit. There are, however, some exceptions; for instance, in one large orchard at St. Catharines more than 99 per cent. of the flies belonged to the Black-bodied species. On the other hand, in three badly infested orchards at Homer, only two miles away, about 99 per cent. belonged to the White-banded species. In a number of orchards both species seemed to be present in nearly equal numbers. In computing the comparative abundance it is necessary to keep in mind the fact, which will be referred to below in detail, that the Black-bodied species begins to emerge a week or so earlier than the other species, and disappears from the orchard about two weeks before it. Therefore in the very early portion of the Cherry Fruit-fly season almost all the adults seen are likely to be of the Black-bodied species, while during the last few weeks only the White-banded one will be seen, and in the intervening time both species.

Kinds of Fruit Attacked.

So far as could be discovered no other kind of fruit than cherries is attacked by either species of Fruit-fly. Plum, pear and peach trees in the midst of badly infested cherry orchards had not a single fruit affected. No injury was found on any of our native wild varieties of cherry, but only on the imported ones or on those that had grown up wild from the seeds or roots of these. Of the cultivated cherries the worst infested are the medium late and late ripening sour varieties, especially Montmorency and Morello. Late sweet varieties are also attacked, at least by the White-banded species. It was not definitely recorded or remembered

whether the other species was also found attacking them, though the writers are under the impression it did. Sour cherries that mature as soon as Early Richmond, and also all early sweet varieties, are almost exempt from attack, apparently because they are so far advanced by the time the flies are ready to lay eggs that in most cases they choose the other varieties in preference, green cherries or those just beginning to change color being regularly preferred by the flies for oviposition. Sometimes, however, a few eggs are laid in Early Richmond and possibly also in some other early varieties.

If, as is thought to be the case, the flies are native to North America, they must have originally had, and probably still have, some native wild fruit that they breed in. Such fruit or fruits must mature about the same time as cultivated cherries would in the same locality.

Nature and Extent of the Injury.

The injury is caused by the little white maggots which hatch from eggs laid by the flies under the skin of the fruit. These maggots tear the pulp with their tiny hooks, which serve as jaws, and suck the juice thus set free, soon rendering the interior unsightly and the cherry unfit to eat. Frequently the side of the cherry just above where the maggot is feeding collapses and turns brown, but in many cases, especially of the Montmorency variety, it is difficult to tell whether the cherry is infested until the fruit is opened. Wormy cherries, in hot moist weather, are very subject to Brown Rot, and, as this disease will spread under favorable conditions from one cherry to any other touching it, considerable additional loss is caused in this way. Furthermore, the sale of cherries is injured by putting wormy fruit on the market, because any one who finds a large number of maggots in what he supposed was clean fruit is so disappointed and disgusted that he hesitates to risk buying again.

As stated above, many cherry orchards in the Niagara district are infested, and a few in some of the adjacent counties and in other parts of the province. It is not known what percentage of the cherries are injured outside of Niagara, but in that locality the loss is sometimes great. Orchards have been visited the last two years in Burlington, Grimsby, St. Catharines, and Port Dalhousie, in which some trees had over 90 per cent. of wormy fruit. Most of these orchards were small, but others were capable of producing a crop worth $1,000 and upwards at normal prices. The two orchards treated in 1911 contained each about one hundred and fifty moderate to large sized trees, and in the previous year both were so badly infested that scarcely a basket of fruit was picked in the one and only a very small proportion in the other. In 1911 in the same district a neighboring orchard of about fifty Montmorency trees had approximately 90 per cent. of wormy fruit.

These are, of course, exceptions, for in most orchards there are very few flies and in others none. Usually, however, in all except young and well isolated orchards some of the cherries are wormy.

The amount of injury varies from year to year, weather conditions evidently determining to a large extent the abundance or scarcity of the flies.

In summing up the extent of the loss the writers believe that more injury is caused to cherries by these two pests in Niagara than from the Plum Curculio and Aphids combined, and that the total must amount to several thousand dollars annually.

Life Histories.

The following brief summary of the life-history will simplify the fuller account given below. Each species of Fruit-fly passes through the same stages. There are first the winged flies appearing in June (see the previous figures). These lay their eggs in cherries just beneath the skin. The little white maggots or larvæ that hatch from these feed on the juice of the cherry until they are full grown (see Figs. 8-10), when they work their way out, enter the ground a short distance, contract their bodies into what is known as the puparia (see Fig. 15), inside of which—and therefore invisible—the pupæ are soon formed. In this dormant stage they pass the winter and early spring until June, when, as implied above, they change into winged flies.

Each of these stages will now be discussed in more detail.

Date of Earliest Emergence of the Flies.

Observations the last two years show that at St. Catharines the Black-bodied Cherry Fruit-fly begins to emerge sometime in the first or early in the second week of June. In 1913 no flies of this species were observed until June 11th, but as twenty-eight specimens were captured that day it seems clear that emergence had begun some days earlier, probably about June 7th or 8th. In 1914 the first fly was seen on June 4th, but observations on June 6th showed so many adults in a nearby orchard that it seemed likely that the earliest fly might have emerged on June 2nd or 3rd. In very warm sheltered gardens in towns they would be still earlier, varying always with the stage of the cherries in one district compared with another. At St. Catharines the Early Richmond cherries had not begun to show signs of coloring when the earliest flies emerged, but a few days later the red blush began to appear.

The White-banded species is a week or more later in appearing, the first flies at St. Catharines in 1913 being seen on June 11th and in 1914 on the same date. Only two were found on each occasion, so that these were probably almost the earliest individuals. At this date the Early Richmonds had just begun to show a little sign of coloring, but Montmorencies were still quite green and not more than half grown.

Date of Maximum Emergence.

In 1913 it was impossible from pressure of work to keep a record of the daily emergence of the Black-bodied species, but in 1914 such records were kept. Table I shows that at St. Catharines the greatest number of flies of this species for any single day emerged on June 10th, and the greatest number for any six consecutive days from June 8th to June 13th. In this period 251 flies out of a total of 301, or a little over 83 per cent., emerged. Hence it is quite clear that the great majority of the flies of this species came out in 1914 during the second week in June. It is very probable that this will hold true in most years in ordinary orchards in the Niagara district, while in colder districts the date will be later.

The maximum emergence of the White-banded species was considerably later. Orchard observations in 1913 indicated that the date was about June 21st or 22nd. Table II shows that in 1914 the maximum for any one day was on June 18th, and for any six consecutive days from June 16th to 21st. Between these last two dates out of a total of 237 flies, 166, or a little over 70 per cent., emerged. Hence it seems justifiable to infer that at St. Catharines the majority of the flies of this

species emerge during the third week in June, or a week or a little more, later than the other species.

Examination of puparia in the soil tended to corroborate the above conclusions. The puparia were easily obtained in both orchards by putting the earth into water in pails and floating them. The empty cases showed the percentage that had emerged by the dates of digging.

TABLE I.—SHOWING THE DATES OF EMERGENCE OF THE BLACK-BODIED CHERRY FRUIT-FLIES IN AN ORCHARD AT ST. CATHARINES, FROM CAGES PUT OUT ON THE GROUND ON JUNE 7TH, 1914.

Date of Emergence.	Number of Flies.	Date of Emergence.	Number of Flies.
June 8	16	June 20	3
" 9	42	" 21	2
" 10	94	" 22	5
" 11	34	" 23	2
" 12	49	" 24	2
" 13	16	" 25	3
" 14	3	" 26	0
" 15	6	" 27	0
" 16	15	" 28	0
" 17	3	" 29	0
" 18	4	" 30	2
" 19	0		

Total 301 (females 229, males 72).
No more flies emerged after June 30th in the cages.

TABLE II.—SHOWING THE DATES OF EMERGENCE OF THE WHITE-BANDED SPECIES IN AN ORCHARD AT ST. CATHARINES, FROM CAGES PUT ON THE GROUND ON JUNE 12TH.

Date of Emergence.	Number of Flies.	Date of Emergence.	Number of Flies.
June 13	5	June 24	3
" 14	6	" 25	6
" 15	12	" 26	2
" 16	18	" 27	3
" 17	20	" 28	1
" 18	55	" 29	0
" 19	37	" 30	0
" 20	20	July 1	1
" 21	16	" 2	0
" 22	13	" 3	1
" 23	18		

Total 237 (170 females, 67 males).
No more flies emerged in the cages after July 3rd.

PERCENTAGE OF FEMALES VERSUS MALES.

It will be observed that in Table I. out of the 301 flies of the Black-bodied species 229 were females and 72 males, so that the females were three times as abundant as the males. In 1914 the females on the trees were seen to be the more abundant throughout the season, but in 1913 the males were at first in the majority; for instance, out of 24 flies captured on June 11th 20 were males. Later on in the season the females became the more numerous, and remained so to the end.

Of the 237 flies of the White-banded in Table II 170 were females and 67 males. Thus the females of this species were about two-and-a-half times as

numerous as the males. This was true throughout all the earlier part of the season, but towards the end both in 1913 and 1914 the males became much the more numerous, there being approximately five males to each female the last two weeks. In the cages more females than males emerged right up to the end, so it would appear as if the males of this species lived longer than the females. Further experiments would be necessary to determine this with certainty.

How Long the Flies Live.

At St. Catharines in 1914, 51 freshly emerged flies of the Black-bodied species were placed in a cage enclosing a small tree with plenty of fruit on it. A little water was thrown over this cage once every dry day so that the flies would not die of thirst. One month later all the flies were dead, the last one having lived thirty days. In another cage containing five freshly emerged flies of the same species two males lived for thirty days. We thus see that the adults of this species may live for a month; a very few probably live longer. The average length of life in the orchard is probably less. This is inferred from the following: The cages on the ground (see Table I) showed that the majority of the flies emerged between June 8th and 13th, 83 per cent. being out by the latter date. Observations in unsprayed orchards showed that, while a few of this species could be found in 1914 as late as July 17th, the great majority had disappeared more than a week earlier.

Fig. 6.—Diagram of head of Cherry Fruit-fly to illustrate mouth parts. Note the large lip-like tip.

The same condition of affairs existed in 1913, the last fly of this species being found on July 15th, very few being seen after July 7th. It seems reasonable, therefore, to conclude that the average length of life is a little less than one month. It is probably nearer to three weeks.

The White-banded Cherry Fruit-fly apparently lives about the same average length of time as the other species, though the males may live longer. In 1913 at least one fly lived a month in a large cage enclosing a tree. In 1914, in each of three similar large cages, a few, but only a very few, flies lived a month. These cages also had a little water thrown over them daily, except when it rained. In the cages on the ground the majority of the flies were seen to have emerged by June 21st, but by July 21st there was scarcely a fly of this species to be seen except a few males. In fact, after July 15th, the flies were very scarce in the check orchards. This is three days less than a month from the date of maximum emergence, June 18th. It is natural, therefore, to conclude that the average length of life is less than one month, and probably not more than about three weeks. One may occasionally find a few individuals of this species, usually males as previously stated, later than the above date; for instance two were found in 1912 on July 29th at Grimsby; in 1913 on August 6th at St. Catharines; and in 1914 at the latter place on July 26th, but as the last fly emerged in our cages on July 3rd in 1914 it would not be surprising if even these individuals were not more than a month old.

Feeding Habits of the Flies.

In the early part of the season, before they have begun to lay eggs, the flies spend most of the time on the leaves, and are most abundant on the sunny side of the tree, where they delight in the warmth. They are, as a rule, much tamer than a house-fly, and can, with the aid of a magnifying glass, be seen to have their mouth parts extended much of the time searching for food. If they find any kind of foreign substance on a leaf they seem to test whether it can be eaten. They are specially fond of sweet things, but do not seem to have any special sense of smell to direct them to these. The surface of the leaf itself is not injured by the flies, because the mouth parts are made only for sucking and resemble closely those of a house-fly. They may be said to consist of a moderately long sucking tube with a broad expanded tip (see Fig. 6). This tip acts as lips and enables them to suck in substances readily and to loosen any little solid particles and hold them in position until they can be dissolved by saliva and then drawn up through the sucking tube into the stomach. As the season advances and the cherries become ripe the flies feed largely on these, sucking the juice that escapes through injuries.

These feeding habits of the flies have revealed, as will be shown later, a very simple method of killing them before they can do any injury.

Length of Time Between the Emergence of Females and Laying of Eggs.

It is important to know, at least approximately, how long a fly lives before she begins to oviposit, because this will help in determining how soon the orchards must be sprayed to kill them before any eggs can be laid in the cherries. The data obtained on this point is not so complete as desirable; nevertheless considerable attention was given to the matter, and the writers feel fairly confident that for both species ten days is about the minimum time and somewhere between twelve and fourteen the average. This conclusion was arrived at as follows: In the first place ovaries of flies were examined from time to time in unsprayed orchards, and it was seen that the eggs were not matured in them until about two weeks from the time the earliest flies were believed to have emerged. (A fly that is ready to lay eggs can usually be recognized by its having the abdomen larger than one with immature ovaries). In the second place six freshly emerged female and six male flies of the White-banded species were put in a cheese cloth cage enclosing an unsprayed tree with much fruit on it. The cage was put on early, so that no earlier flies could get access to the fruit. In this cage the first larva had matured and left the fruit in twenty-six days, and nine more in twenty-nine days from the date of putting in the flies. In Table III it will be seen that the shortest time in our tests from the depositing of an egg until the larva left the fruit was sixteen days. Hence it was natural to infer that the first egg was laid in about ten days from the time of emergence of the flies and the next nine in thirteen days or possibly less. In the third place a female of the Black-bodied species was seen ovipositing in an exposed orchard on June 11th, 1914 (the egg was obtained), but, as mentioned above, this species had evidently not begun to emerge earlier than June 2nd or 3rd, and so the female could scarcely be more than ten days old. Moreover, several females of the White-banded species were seen ovipositing on a tree in a garden in the city on June 17th, 1914. It is believed that this species in the ordinary orchards could not have emerged earlier than June 10th, but in a sheltered city garden the date might be a few days earlier, and so possibly even on the 6th. This, then, would mean eleven days from the time of emergence until ovipositing began.

Number of Eggs Laid by a Fly.

It is very difficult to get any true estimate of the number of eggs laid by a fly of either species, because in neither small nor large cages do the flies appear to act quite normally in this respect. An examination of the ovaries of flies that were ready to oviposit showed that some contained as high as two hundred and forty eggs, either fully formed or clearly distinguishable. In addition to this there was the possibility of the formation of more as the earlier ones were deposited. This would imply that a fly could lay several hundred eggs. In order to test the number actually laid, three cages, each enclosing a tree with an abundance of fruit on it were made. In one one female and two males were placed, in another two females and three males, and in a third six females and nine males. In only the second of these cages was any useful data obtained. Here one fly laid forty-four eggs that hatched. The other fly in this cage died too early to oviposit. In the other cages some eggs were laid, but apparently no fly laid as many as the one in the second cage, namely, 44. It is scarcely logical to suppose that the average is not larger than this.

Fig. 7.—Abdomen of Cherry Fruit-fly enlarged about five times to show the sharp, protruded, sting-like ovipostor which pierces through the skin of the fruit when laying eggs.

Stage of the Cherries when Eggs are Laid. Method of Oviposition and Number of Eggs in a Cherry.

The flies will lay eggs in cherries that have colored up, and are, therefore, nearly full grown, but they regularly prefer those that are green or are turning yellow and have not yet reddened. The eggs in every case are inserted a very short distance under the skin by the sharp sting-like ovipositor (see Fig. 7). When a fly is ready to lay she moves restlessly and quickly about on the surface of the cherry as if seeking a suitable place; frequently, as if not satisfied, she passes to a nearby cherry, where she repeats these movements. Sometims five or six cherries are thus visited. Having at last selected a place to her liking she rises on her legs and arches her abdomen so that the ovipositor touches the cherry either perpendicularly or at an angle of about 120 degrees from her body. She then forces it in by successive pushes rather than by backward and forward movements. (See Fig. 7.) Almost as soon as the ovipositor is inserted the full length the egg is slowly passed down and deposited. The whole operation usually requires less than thirty seconds, though sometimes it is much slower. A single fly may lay six or more eggs in an hour. The egg itself cannot be seen from the surface, though by cutting across the skin with a sharp knife it can easily be made out. It is very small, glistening white, nearly elliptical and a little more than three times as long as wide. As many as five eggs have been found in a single cherry, two or three being a common occurrence, but in most cases, unless the number of flies is remarkably large, there is

only one. In many instances punctures are made, but no eggs laid; one cherry from a very badly infested tree at Burlington had forty-two such punctures, but only five eggs.

A short time after the egg is laid the puncture can be easily seen as a tiny brownish dot on the surface if the egg is laid vertically, or as a little elongated brown streak about four or five times as long as broad if the egg is laid obliquely. Occasionally a little dimple gradually forms in the cherry at the place where the egg is laid. This is due to the tissues injured by the ovipositor not growing while those immediately around them continue to do so.

Length of Time Required for the Eggs to Hatch.

Numerous cherries were tagged as soon as the eggs were laid and then dissected at various intervals to discover when hatching took place. In this way more than a dozen records of the incubation period were obtained in 1913 and fourteen in 1914. The dates of the latter are given in the table below to show that in the cool weather in June the time was longer than in July, which was a very much warmer month.

Table III.—Showing the Length of Time Required for Incubation of Eggs in 1914.

Egg deposited.	Egg hatched.	Number of days.
June 17	June 24	7
" 18	" 26	8
" 19	" 27	8
" 22	" 28	6
" 24	" 29	5
" 25	" 29	4
" 25	" 30	5
" 30	July 4	4
" 30	" 4	4
July 2	" 6	4
" 2	" 6	4
" 2	" 7	5
" 7	" 12	5
" 8	" 13	5

The totals of the two years showed that the average time was about five days. Most of the eggs were of the White-banded species, but some were of the other species, so that apparently the time required for incubation in both cases is about the same.

Fig. 8.—Full-grown larvae or maggots of Cherry Fruit-fly, natural size. Note the absence of a distinct head and the tapering of the body at the anterior end.

Fig. 9.—Diagram of a much enlarged larva showing the two little black hooks at the small end, which serve as jaws and tear the pulp.

Description of the Larva or Maggot and its Habits.

The larva that hatches from the egg is a very small, glossy white maggot. When full grown it is about quarter of an inch in length, cylindrical in form, tapering quickly at one end and blunt at the other. There are no legs and no visible head, but at the pointed end are two little black hooks that can be protruded and

Fig. 10.—Full-grown larvae of Cherry Fruit-flies in the fruit.

retracted at will and serve as jaws to tear the pulp and free the juice on which the maggots feed (see Figs. 8 and 9.) Most of the maggots of both species are white, but a considerable number are cream colored or even yellow. It has been claimed that those of the Black-bodied Cherry Fruit-fly are yellow, but this was not true at St. Catharines, where it was found impossible to distinguish the larvae of the two species except by a microscopical study of the mouth hooks and what is

Fig. 11.—Nearly full-grown larva of the Plum Curculio in a peach. Note that it is larger than the larva of the Cherry Fruit-fly and is curved. Its brown head cannot be seen in this photograph. (After Quaintance.)

technically called the cephalopharyngeal skeleton. It would appear that the color depended chiefly upon the condition of the cherry when the larva was feeding and on the variety of cherry.

As soon as the maggot hatches from the egg it makes its way to the pit, leaving a little brown thread-like streak behind it in the flesh. The pit itself is not attacked, but the pulp is destroyed by the tearing action of the little mouth hooks mentioned above, and by the extraction and consumption of the juice. Usually the maggot feeds only one one side of the pit and not all around it, and in consequence the skin of the cherry on this side collapses after a time, thus indicating the presence of the insect within.

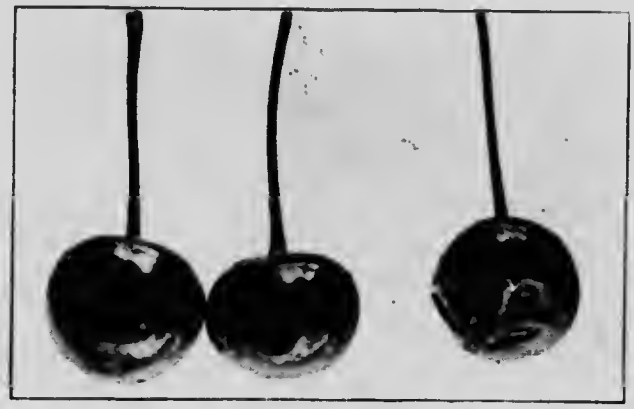

FIG. 12.—Ripe wormy cherries, showing the sunken areas above where the Cherry Fruit-fly maggots are working.

FIG. 13.—Unripe or nearly ripe cherries, showing the hard, dark, distinct sunken areas caused by the feeding of the larvae of the Plum Curculio. These can easily be distinguished from those caused by Cherry Fruit-fly larvae.

When the maggots are about one-half to two-thirds grown, many, but not all, of them make one and sometimes two or more little holes through the skin. There is very little doubt that these holes are for breathing or ventilating purposes. Other holes are sometimes made in ripe infested cherries by wasps, beetles or other insects

that feed on the juice. A small sap-feeding beetle known as *Ips quadriguttatus* (*fasciatus*) very commonly works its way inside such cherries, either through a fresh hole or by enlarging the one made by the maggot.

NUMBER OF MAGGOTS IN A CHERRY.—There is usually only one maggot in a cherry, but sometimes there are more; for instance, from one badly infested tree at Burlington forty-two wormy cherries were examined. Of these twenty-one had

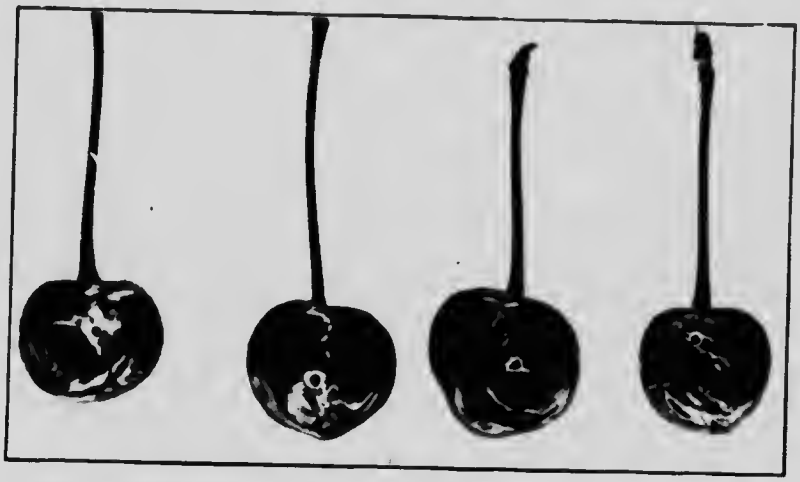

FIG. 14.—Breathing holes in ripe cherries made by the larvae of the Cherry Fruit-fly. The margins of the holes have been whitened, to show them more clearly.

each one worm, sixteen had two, four had three, and one had four. At St. Catharines, too, a considerable number of cherries each containing two worms were found, and occasionally one with more than that number.

LENGTH OF TIME SPENT BY THE MAGGOTS IN THE FRUIT.—The length of time spent by the larva or maggot in the fruit varies with the rate of ripening of the fruit and with the temperature. In green cherries and in cool weather the period is longest. In 1913 the minimum time was found to be about 12 days and the maximum about twenty-two. In 1914, as the following table shows, the minimum was about eleven days and the maximum about nineteen, with an average of about fourteen days.

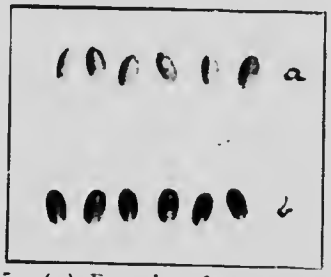

FIG. 15.—(a) Puparia of the Black-bodied Cherry Fruit-fly, about natural size. (*b*) Puparia of the White-banded Cherry Fruit-fly, about natural size. Note the much lighter color of the upper.

TABLE IV.—SHOWING THE LENGTH OF TIME FROM THE LAYING OF THE EGG UNTIL THE LARVA LEAVES THE FRUIT, AND ALSO THE APPROXIMATE LENGTH OF TIME SPENT BY THE LARVA IN THE FRUIT, THE LATTER BEING OBTAINED BY SUBTRACTING FIVE DAYS, OR THE AVERAGE EGG INCUBATION PERIOD, FROM THE ABOVE TOTAL IN EACH CASE.

Egg laid.	Larva left fruit.	Total No. of days.	No. of days as larva in fruit.
July 8.....	July 25.....	17	17 less 5 12
" 8.....	" 27.....	19	19 " 5 14
" 9.....	" 28.....	19	19 " 5 14
" 9.....	" 30.....	21	21 " 5 16
" 10.....	" 27.....	17	17 " 5 12
" 10.....	" 28.....	18	18 " 5 13
" 11.....	" 27.....	16	16 " 5 11
" 12.....	" 30.....	18	18 " 5 13
" 12.....	Aug. 5.....	24	24 " 5 19

Average time from egg is laid until the larva leaves fruit 18 7-9, or approximately 19 days.
Average time as larva in fruit 13 7-9, or approximately 14 days.

Note.—The weather was warm during all this period and the cherries ripened rapidly, hence the average of 14 days is possibly shorter than in some seasons. There is also the fact that in very warm weather eggs often hatch in 4 days instead of 5; this would increase the average to 15 days.

PUPAL STAGE.

As soon as the larvae leave the fruit and drop to the ground they try to work their way into it, preparatory to transforming to the pupal stage, in which they pass the winter. If the ground is soft they work their way down in a very few minutes, but, if it is baked by the rain and heat, or is hard from not having been cultivated, they cannot burrow in through it and have to seek for cracks, or openings of any kind. If they fail to find these and have left the cherry in the heat of the day, they soon die from the heat or are destroyed by predaceous insects, birds or other animals. In the soft ground they go from one to two inches below the surface, but where they enter cracks in hard ground they go much deeper, apparently to receive more moisture and protection from the drying atmosphere and heat. In thick weeds and grass they sometimes remain almost on the surface among the roots and hidden by these from the sun. After going as far as it finds necessary or convenient in the soil or in the various places mentioned, the larva contracts its body so that both ends are uniformly rounded, the whole now roughly resembling a grain of wheat. This new form, called the puparium (plural puparia) is usually brought about in a day or less, but sometimes the larva does not transform into it for several days and apparently a few individuals pass the winter in the larval stage. Inside the puparium the true pupa is formed, but cannot, of course, be seen without dissecting away the outer covering or puparium.

Once the puparium has been formed the insect never moves, but remains quite dormant until the next June, when it changes into an adult fly, leaves the soil, and moves about on the trees. It is very probable that, like the Apple Maggot or Railroad Worm, a small percentage remain two years in the pupal stage before transforming to adults. The writers have not had a chance to test this, but believe that as a number of apparently healthy pupae did not emerge during the cherry season, some of those which were still alive at the end of the season would probably remain over to the next year.

Distinction Between the Puparia.

As found in the soil in spring the puparia of the Black-bodied species are cream or straw colored, while those of th White-banded species are brown. This difference can be seen by looking at F g. 15, though the photograph does not show it nearly so well as an examination of the puparia themselves. In size and shape both kinds are almost identical.

Natural Means of Control.

Fruit growers whose orchards have for many years been infested with Cherry Fruit-flies agree in reporting that the injury is much greater some years than others. There is very little doubt that this difference is due chiefly to a difference in weather conditions in the various years. Some seasons afford ideal weather for the flies to thrive and lay numerous eggs and for the larvae on becoming mature to enter the soil easily, pupate and remain healthy in this state until the next year. It is impossible to state definitely what these ideal conditions for the flies are. Our observations and experiments, however, lead us to believe that the condition of the soil, which is partly due to the weather and partly to cultivation or non-cultivation, at two periods in the year is of very great importance in determining the abundance or scarcity of the flies. These two periods are first in June and early July, when the adult flies are making their way up through the ground from their pupal cases, and second, in July and August, when the larvae are full grown and trying to enter the soil to pupate. In these periods, if the soil is loose and soft from recent cultivation or from moisture, the flies will easily be able to emerge and the larvae to enter it; but, if the surface is hard from lack of cultivation or from hea y, beating rains, followed by hot sunny weather that baked the top and left a crust, the flies will not be able to work their way through this hard surface, and must perish unless they escape through cracks or other openings. Moreover, the larvae cannot with their delicate little mouth hooks force a way down through such soil, and unless they find crevices or holes down which to go, or stones or chips or other protection under which to hide, they must perish either from the dying heat or from the attacks of ants, ground beetles, birds or other foes.

In order to study what the mature larvae did under various soil c nditions twenty-five lots of twenty-five larvae in each were at different times placed upon the surface of the soil. The following observations were made: First, in loose, freshly cultivated soil all the larvae went below the surface in a few minutes, the last being gone in eighteen minutes. Second, in well-watered lawns where the grass was kept mown and where the soil was moist, they disappeared almost as quickly. The same thing also happened in long grass and among weeds like burdock, plantain, etc., the earth being unbeaten and moderately easy to penetrate. Third, in an unwatered lawn where the earth had been tramped and had no cracks none could enter, and all perished from heat or were carried off by ants. Fourth, in cultivated land where the surface had been beaten by rain and was hard and cracked, the majority went down the cracks but a considerable number were carried off by ants or were killed by the scorching sun before they could find the cracks. Much the same thing occurred when they were placed on land that had been well cultivated but had become covered by a hard crust as the result of a recent heavy rain followed by very hot sunny days.

The above facts make it seem clear that the condition of the surface of the soil is a very important factor in determining whether these insects will be abundant

in an orchard. They would also lead to the conclusion that the flies should be most destructive and injurious in orchards where the soil is kept well cultivated and the surface loose, or else in such places as town or village lawns where the ground is frequently watered or in back yards where we usually find either excellent cultivation, or the very opposite with its attendant crop of weeds, loose boards, chips and other refuse, all of which allow the larvae a chance either to enter the soil or find good hiding quarters. Observations tend to show that this is the case.

It should, perhaps, be mentioned that the pupae in the soil, unlike the pupae of many other insects, are not injured by being disturbed. It is clear, therefore, that frequent and thorough cultivation, though valuable for the trees and fruit, is useless as a means of controlling the Fruit-flies.

A second natural means of control is by poultry, birds, spiders and ants. Chickens in an orchard readily devour the freshly emerged larvae before they enter the ground, and also scratch the surface and eat any pupae they can find. Sparrows and other birds also eat pupae or larvae whenever they find them. Spiders catch adults in their webs on the trees and destroy a small percentage in this way. Ants, however, are ravenous enemies. They destroy the newly emerged flies as soon as they come up out of the soil while they are still helpless and unable to fly. They also attack the larvae when they come out of the cherries and are endeavoring to enter the ground. In the tests mentioned above with the larvae, the ants in some cases destroyed 50 per cent. or more of them before they got into the soil. Every kind of ant, small or large, that happened to see either a helpless adult or a larva seemed, with almost equal eagerness, to rush upon it and hasten away with its prey.

Several attempts were made to find whether any parasites attacked the larvae or pupae. A small reddish four-winged fly, about a quarter of an inch long (a Braconid of the genus Opius) was reared from a number of pupae placed in sterile sand in a cage. Other specimens of this insect were also found in cages placed over the soil in the orchard to capture the adult Fruit-flies as they emerged. This is probably a genuine parasite unless it emerged from some puparium which very closely resembled those of the Fruit-flies, and so was put in the first mentioned cage by mistake.

A black (Ichneumon) four-winged fly of the genus Scambus was seen ovipositing in a wormy cherry, but seemed too large to be a parasite, as it was as large or a little larger than the Cherry Fruit-flies themselves. A number of the same species of Ichneumon flies were seen from time to time in the cherry orchard, but neither this nor the Braconid were in sufficient numbers to indicate that, if they were parasites, they played any important part in the control of the Cherry Fruit-flies.

As only very rarely a maggot in a cherry was found to be injured by disease of any kind, it appears that the larvae are seldom attacked by fungi or bacteria. The pupae in the soil may, however, be more subject to disease, especially in wet seasons and in soil that is not well drained. We have not sufficient proof to know to what extent this is true, although there is considerable reason for suspecting that not a few pupae are sometimes destroyed in this way.

SPRAYING, A THOROUGHLY SATISFACTORY ARTIFICIAL MEANS OF CONTROL

From the fact that the eggs are laid under the skin and that the larvae which hatch from them remain inside the cherry until they are full grown, it is quite evident that no spray mixture could reach either eggs or larvae and, therefore, the adult stage is the only one against which sprays can be used. Fortunately the feed-

ing habits of the adults and the long period that elapses from the time they emerge until they begin to lay eggs make it easy to poison them before they can oviposit.

As stated above, the flies are about ten days old before they begin to lay eggs, and in this interval they spend much time searching for food, chiefly on the leaves, moving about from leaf to leaf in so doing.

Advantage can be taken of these feeding habits, and the foliage sprayed with a poison to which molasses may be added to render it more attractive. The flies readily feed on this and are killed. The experiments by which this was proven in 1913 and reproven in 1914 will be described near the end of this bulletin. A careful perusal will convince the reader that spraying with a sweetened poison is a cheap, simple, economical and effective remedy.

The Best Mixture to Use.—The experiments showed that arsenate of lead alone would kill the flies, but, as they are fond of sweet substances, it is wise to add some molasses at least the first year when treating any severely infested orchard. Hence the mixture recommended is: *2 to 3 lbs. arsenate of lead (paste) to 40 gallons of water sweetened by the addition of one gallon, or nearly one gallon, of cheap molasses (black strap)*. The molasses should not be added to the water until the day that the mixture is to be applied, because it will soon ferment in hot weather and cause the arsenate of lead to be precipitated in a lumpy condition.

When and How Often to Spray.—The first application should be made as soon as the flies begin to appear. In the Niagara district this will be about the end of the first week in June; in colder districts it will be a few days later. A good way to determine the right time is to wait until the Early Richmond cherries are almost ready to show the first sign of a red blush, and then at once apply the mixture. The second application should ordinarily be about ten or twelve days after the first, or just before the blush begins to appear on any of the Montmorency cherries. This in the Niagara district will usually be about June 20th. If there is no rain after the first application, the second may be postponed a few days longer, but should never be put on any trees after the cherries are beginning to ripen because of the danger of its remaining until picking time. If heavy rains come soon after the first application and wash it nearly all off, the second application should be made a few days earlier than it would otherwise.

In the first application all kinds of cherries should be sprayed except any that are so early that they will soon be ripe. Apples, pears, plums or other fruit trees, among or close to cherry trees, should also be sprayed because, until the time of egg laying, the flies will feed and rest on the leaves of these trees just as readily and often even more readily than on cherry leaves, and so by spraying these there is less chance of any fly not getting the mixture in time to prevent oviposition.

At the second application none of the early varieties should be sprayed, but only the later sour and sweet varieties that are either still green or just beginning to show signs of ripening. It will do no harm to give a light application this time also to the nearby apple, pear or plum trees.

If the spraying is done in this way there is no danger of any persons being poisoned by using the fruit, in fact no sign of the poison will be seen on the fruit at picking time.

A barrel pump with one line of hose about thirty feet in length and an eight-foot bamboo rod with two large disc nozzles on a V makes a good outfit. A pressure of one hundred pounds is sufficient, except where one is trying to reach the top of a high tree. Small or medium sized holes in the nozzles are just as good as large ones and save the mixture. The spray should be applied to both sides of

the leaves, so that it will not be washed off so completely by rain. During rain the flies both hide and feed on the underside of the leaves and thus, if the mixture is there, they stand a better chance of being poisoned. The trees should be given just a moderately thorough application, so that nearly every leaf will be lightly covered with the mixture. If this is done every fly should get some poison, because they move about from leaf to leaf and from tree to tree.

Cost of Spraying.—It was found that it required four barrels of the mixture and the services of two men and one horse to spray twice in the above manner, one hundred vigorous Montmorency trees about fourteen years of age. The cost, therefore, would be as follows:—

12 lbs. arsenate of lead at 10c	$1 20
4 gals. molasses (black strap) at 40c	1 60
2 men for 5 hours at 15c. per hour each	1 50
1 horse for 5 hrs. at 15c. per hour	75
Total	$5 05

This shows that the total cost per tree for large or medium sized trees is slightly over five cents, which is remarkably cheap. It would be a little more expensive, of course, where apples and other fruit trees were mixed in among cherries and were also sprayed.

Effect of Adding a Fungicide to the Mixture.

From the result of a test it seems doubtful whether so good an effect would be obtained from the spraying if lime-sulphur or Bordeaux mixture were added. It would apparently be better to rely solely on the sweetened poison the first year at least and possibly the second year if the orchard were badly infested. After that the fungicide could be used with the arsenate of lead without any molasses. So far as can be seen from orchards thus sprayed year after year the fruit is kept free from worms.

As for Brown Rot, it was observed that the mere fact of keeping the cherries free from worms by the use of the sweetened poison helped greatly in lessening the amount of this disease in the orchard.

Some Other Points of Value in Getting the Best Results.

1. No check trees should be left to test the difference between sprayed and unsprayed trees. The flies move around from tree to tree more than a person would think when watching them, so that checks in the same orchard are not satisfactory and interfere with the results on the sprayed trees. The experiments described below will show this.

2. All useless cherry trees, whether in the orchard or anywhere on the farm, should be cut down and burned, that they may not serve as centres of infestation if left unsprayed.

3. Neighbors should be encouraged to co-operate so that as far as possible all the flies in the locality may be destroyed.

4. One application, as shown in the experiments, is not sufficient in an ordinary year to control these insects in a badly infested orchard, though it helps greatly.

5. With the work done thoroughly at the times advocated above the flies should be annihilated, or almost annihilated, in two years if the orchard is isolated or the neighboring orchards equally well treated. Spraying may then either be omitted

for some years until re-infestation begins to take place, or one application may be given about the time the Early Richmonds are beginning to show the first signs of red.

6. It is useless to look for good results if the spraying is put off until the eggs are being laid. Hence *promptness is absolutely essential,* especially for the first application.

Is there any Danger to Bees from the Sweetened Poison?

Many beekeepers will feel alarmed by the advocacy of sweetened poisons as remedies for Cherry Fruit-flies or any other insects. Such fears are natural and the writers themselves were anxious at first lest the bees might be attracted to the mixture and killed. It was, therefore, no small relief to find that, so far as could be seen, no bees of any kind visited any of the four orchards sprayed twice in 1913 and in 1914. The same thing was true so far as Mr. W. A. Ross, of the Dominion Entomological Division, and the senior author, could observe in an apple orchard of twenty-two acres sprayed by them with the same mixture for the Apple Maggot or Railroad Worm. Moreover, in order to test whether the molasses with the poison attracted bees, a mixture containing bran, Paris green, lemons, molasses and water was placed in a line about twenty feet in front of the hives. This mixture is the so-called "Kansas Grasshopper Remedy." Only two bees were seen to alight at it, and these almost immediately flew away again without feeding. It was then placed in a box within a yard of the hive, but the bees paid no attention to it. It, therefore, seems to be proven that at least at the times of the year when such remedies are likely to be used there is no danger to the bees from them. It has been found, however, in some other countries that if sugar is substituted for molasses the bees are attracted, hence only cheap molasses (black strap) should be used.

Experiments in Spraying Orchards in 1913.

Orchard No. 1.—This orchard was at Homer village, and belonged to Mr. F. G. Stewart. The soil was well adapted for growing cherries and the cultivation excellent, so that the trees were all in a healthy, flourishing condition. The whole orchard, with the exception of about twenty trees, was in a compact block. The total number of trees was one hundred and eighty-five. Of these, six trees to the west about sixty feet from the main body, with a road and two small spruce hedges between, were kept as one check, and nineteen smaller trees about five years old in the north-east corner were reserved as another. The remaining one hundred and fifty-eight trees, more than three-fourths of which were large Montmorency trees, were sprayed twice. As the species infesting this orchard was the White-banded Cherry Fruit-fly, and as this species did not begin to appear until June 11th, the first application was made on June 13th and the second on June 23rd. The mixture in both cases was 3 lbs. arsenate of lead to 40 gallons of water sweetened by almost one gallon of black strap molasses, except that the molasses was omitted on fifty trees in the second application. A knapsack spray machine was used to make the first application and a barrel outfit for the second. The work was fairly well done in each case, most of the leaves being covered.

The previous year many of the Montmorency trees were so badly infested that the fruit was not worth picking and was allowed to rot on the trees, thus affording an excellent opportunity for a worse infestation in 1913. That there were numerous flies this season and that the amount of injury would have been great in conse-

quence was shown by the fact that from six trees one hundred and seventy-five adults were captured by the writers in about two hours. Numerous flies were seen all through the orchard, especially about June 21st—the probable date of maximum emergence. Moreover in a small cage 4 ft. long by 1¾ ft. wide, placed on the ground to see how many flies would emerge in that area, a total of thirty-eight was obtained, which would indicate that there must have been several hundred flies to a tree in at least some parts of the orchard.

Result of Spraying.—It was observed that in about a week after the second application scarcely any flies could be seen in the orchard, and none were observed copulating or ovipositing at any time. When the cherries were being picked the pickers were asked to observe whether any of the fruit was wormy, but not a single

Fig. 16.—Orchard No 1, showing the excellent condition of the trees and of the cultivation.

wormy cherry was found, not even by the writers who frequently examined tree after tree.

Checks.—It was a great surprise to find that the checks were just as clean as the rest of the orchard, but as numerous flies had been seen on them just before and at the time of the second application there is no doubt that they were killed by flying to sprayed trees and eating the poison there. That the freedom of these check trees from worms was not due to disease was shown by the fact that in a caged unsprayed tree into which flies had been placed one individual lived for thirty days and 93 per cent. of the cherries were wormy. The results, therefore, in this orchard surpassed the highest hopes of all concerned.

Orchard No. 2.—This orchard also belonged to Mr. Stewart, and was situated about one hundred yards to the north-west of the other, with barns, house and high hedges between, so that very few flies would be likely to find their way from the one to the other. The orchard consisted of one hundred and ten trees, nineteen of

which were early sweet varieties; several others were Early Richmonds and most of the remainder Montmorency. The orchard was not a compact block, but had pears, plums, and peaches interspersed throughout it. Forty-eight cherry trees on the west end were left as a check, and the remainder, with the exception of the early sweet cherries, was given two applications of the same sweetened mixture as used in orchard No. 1. The applications were made a day later in each case. Unfortunately it did not occur to either of the writers at the time to spray the plums, pears or peaches as an aid in control. The same species of fly, namely, the White-banded, was with very few exceptions the only one that occurred in the orchard. Many trees had been badly infested the previous year. The orchard was cultivated and cared for in the same way as No. 1, and was healthy.

RESULTS.—The sprayed trees at picking had from 1 to 13 per cent. of wormy fruit, the unsprayed from 9 to 40 per cent. The average on the sprayed trees was approximately 4 per cent. and on the unsprayed 20 per cent. As a rule the trees farthest from the sprayed half were worst infested. These results showed that the spraying had done much good, but there seemed no doubt that the flies moved about to a considerable extent and that a check in the same orchard with sprayed trees was not satisfactory.

CAGE EXPERIMENTS WITH AND WITHOUT SPRAYS IN 1913.

Three cheesecloth cages, each enclosing a tree with considerable fruit on it, were constructed. The cages were approximately 6 ft. long, 6 ft. wide, and high enough to enclose the foliage completely (see Fig. 17). Tanglefoot was placed on the trunk and the base of the wooden supports to keep down ants.

Cage No. 1.—On June 21st, one hundred and fifteen flies were placed in this cage, about one-third of them being the Black-bodied species and the remainder the White-banded. The foliage on the tree was not poisoned, and a little water was thrown over the top of the cage on dry days to supply the flies with sufficient moisture.

RESULTS.—One month later the cage was taken down and every cherry examined. Out of 1,276 cherries, 93.6 per cent. were wormy. Many of the flies in this cage died before laying eggs, probably in some cases because a considerable number had been taken from the check trees in orchard No. 1 and had visited the sprayed trees without anyone suspecting that this would happen.

Cage No. 2.—This cage contained a tree that had been sprayed with the same sweetened mixture as used in orchards Nos. 1 and 2. In it were placed one hundred and fifteen flies of the Black-bodied species on June 22nd. As in Cage No. 1, the flies were watered every day. The cage was examined daily and dead flies removed.

RESULTS.—In a week almost every fly was dead, the majority having perished in three days. When the cherries were nearly ripe a wind storm wrecked this cage. The cherries were then examined and it was found that out of three hundred and eighty-nine only two were wormy. This is remarkable because some of the Black-bodied flies must have been ready to lay eggs when put in the cage, and as they were taken from an unsprayed orchard a mile or more away, it was clear they had not been poisoned beforehand. It would appear as if the feeding on the poisoned mixture checked egg laying at once, or almost at once.

Cage No. 3.—This cage contained a tree sprayed with arsenate of lead alone. In it on June 25th were placed one hundred and seventy-five flies of the White-banded species, all taken from check trees in orchard No. 1. Some, therefore, had probably visited poisoned trees nearby, and would have died early in any case. This cage, too, was watered every day or necessary.

RESULTS.—In eight days all the flies were dead, most of them having died within three days. On July 28th the cage was removed and the cherries examined. Out of a total of seven hundred and twenty none were wormy. This indicates that the flies would feed on arsenate of lead even without molasses.

SMALL CAGES.—Several attempts were made to get definite data from enclosing flies in small inverted fish-bowls, and placing a bottle of water in each containing fresh cherry twigs with leaves and fruit for the flies to feed upon and oviposit in. In some cages the fruit was poisoned, in others not. These cages were found very unsatisfactory and the data obtained very contradictory.

EXPERIMENTS IN SPRAYING ORCHARDS IN 1914.

Orchard No. 3.—This orchard belonged to Mr. R. Thompson, of St. Catharines. The soil was a sandy loam in a good state of cultivation. The previous year the cherries had been so badly infested that only a few baskets had been picked, hence

FIG. 17.—Large cage enclosing a tree; type of cage used for many of the experiments.

great numbers of maggots had entered the ground that year and pupated. In June, 1914, it was found by digging that there were still numerous live pupae in the soil. Moreover, observations in the orchard after June 6th showed that numerous flies emerged; cage tests also showed the same thing, so that there is no doubt the fruit would again have been ruined if it had not been sprayed. The main orchard consisted of one solid block of one hundred and twenty sour cherries of an unknown variety, that ripened at the same time as the Montmorency. About one hundred yards away were twenty Montmorency trees. All the trees except about six were fourteen years or more old. The species of fly infesting the orchard was almost entirely the Black-bodied one, only two or three individuals of the other species being seen. The first application was given on June 8th and the second on June

23rd. The mixture used on the large block of trees was 3 lbs. arsenate of lead to 40 gallons water sweetened with nearly one gallon of black strap molasses. On the twenty Montmorency trees the molasses was omitted. In applying the mixture a double-acting Gould spray pump was used and the work was well and rapidly done.

Results.—At picking time neither the pickers nor Mr. Shipton nor the senior author could find any wormy fruit, no matter where they picked it. The same was true of the plot where arsenate of lead alone was used. When, however, cherries were being stoned Mrs. Thompson found an occasional worm, but not more apparently than 1 in 1,000 cherries.

Mr. Thompson remarked on the unusual way in which the cherries remained on the trees for weeks without rotting, this indicating that the spraying had helped against the Brown Rot disease.

It is evident, therefore, that in this orchard spraying for the Fruit-flies gave most gratifying results.

Check.—In consequence of the previous year's experience no checks were intentionally left nearby, but a number of orchards in the neighborhood were selected for the purpose. These will be referred to later. It was discovered, however, when the cherries were ripe that there was a little clump of cherries in a ravine about two hundred yards from the main block. These, therefore, served as a check on orchard No. 3. Examination showed that approximately 75 per cent. of these were wormy.

Orchard No. 4.—This orchard of about one hundred and eighty moderately large trees, mostly Montmorency, belonged to Mr. Stevens of Homer village, and was situated not more than a quarter of a mile from orchard No 1 which had been sprayed in 1913. In that season so large a percentage of the fruit had been attacked that it and orchard No. 3 were considered the worst infested orchards seen anywhere in 1913, and were therefore chosen for the tests of 1914. The species infesting the orchard was almost exclusively the Whitebanded Cherry Fruit-fly, and, as it did not begin to emerge until June 11th, the first application was not made until June 12th. The ordinary sweetened mixture was used, except that on twenty trees to the west of the orchard the molasses was omitted. The second application was given on June 20th, and this time no molasses was used on any of the trees, but only the arsenate of lead and water. The spraying was well done with a barrel outfit. Cages spread over the ground to capture the adults as they emerged showed that in most of the orchard there were several hundred flies to each tree, so that the test was a good one.

Results.—No worms were found in any of the Montmorency trees, so that the owner was delighted. Late in the season it was discovered that one Morello tree and another, probably a Late Duke, had a few wormy fruit. From these trees six thousand cherries were carefully examined and twenty-three found wormy. This was a little over ⅓ of 1 per cent. Mr. Shipton, who had watched the orchard very carefully, thought that the flies that caused these wormy fruits must have come in from a clump of badly infested trees scarcely two hundred yards to the east, because the poison appeared to have killed every fly in the orchard in about a week or a little more after the last application.

This experiment, therefore, also gave almost perfect results, and likewise showed the value of arsenate of lead alone in controlling the flies.

Orchard No. 5.—This was an orchard of about forty moderate sized Montmorency trees. It was not inspected the previous season, but was reported to have been badly infested. It was sprayed with the usual sweetened mixture

on June 12th, the same day as orchard No. 4, because it was infested chiefly with the same species of fly. No later application was given.

RESULTS.—The one spraying did not control the pest as nearly 25 per cent. of the cherries, when picked, were wormy. The owner, however, said that the spraying had done a great deal of good. It was observed, moreover that the maggots were for the most part small, as if the earlier flies had been killed and the eggs had been laid by those that emerged later after the poison had been washed off by heavy rains. Several other cases were reported of fruit-growers who tried to control flies in badly infested orchards with one application and failed. It is evident, therefore, that two applications are essential unless no rain falls to wash the first off.

Check Orchards in 1914.—As already mentioned it was thought wise to use as checks, orchards that had been severely or moderately infested the previous year and that could in no way be affected by the mixture in the sprayed orchards. Two such orchards not far from St. Catharines were chosen, one with about fifty Montmorency trees twelve years or more of age, and the other with about seventy larger trees of the same variety. Both species of flies were present in these orchards though the White-banded was the more abundant. Females were frequently observed ovipositing, and at picking time careful observations showed that over 85 per cent. of the cherries in the former were wormy and an average of about 50 per cent. in the other. A few trees in the latter had almost every cherry infested. There was no reason except the spraying why there should have been more or even as many wormy cherries in these orchards as in Nos. 3 and 4 because as stated, 3 and 4 had been selected the previous year as the worst infested orchards seen in Niagara. There can, therefore, be not the least doubt that it was the spraying that made the difference.

CAGE EXPERIMENTS WITH SPRAYS IN 1914.

Cage No. 4.— This cage contained a tree, one-half of the foliage of which was sprayed with arsenate of lead at the rate of three pounds to forty gallons water, without any molasses. The other half was left unsprayed. On June 22nd forty-six freshly emerged flies were placed in the cage and supplied with water on dry days by throwing a little over the top of the cage.

RESULTS.—In eight days all the flies but one were dead. This one died soon after. This showed that even where they had a chance to avoid the poison the flies ate it and were destroyed.

Cage No. 5.—The tree in this cage had half the foliage sprayed with lime-sulphur (strength 1.010 sp. gr.) and the regular amount of arsenate of lead without molasses. The remainder of the leaves was unsprayed. On June 17th thirty-eight freshly emerged flies were placed in the cage and forty-six more on June 22nd.

RESULTS.—Many of the flies died in the first twelve days but a few continued to live for a month, though no eggs were laid. This would indicate that though the flies may have begun to feed on the lime-sulphur and arsenate of lead, some of them stopped doing so before they had taken enough to kill them. It is difficult to explain why the mixture should have prevented egg-laying for in all other large cages in which flies lived so long a considerable number of eggs were laid. This experiment makes it doubtful whether it is wise to add a fungicide to the poison the first year of treating a severely infested orchard.

Tests with Large Sheets Spread Beneath the Trees and Fastened to the Outer Branches to see How Soon the Poison Killed the Flies, and How Many would be Found Under a Tree.

Three of these sheets were used, two in 1913 and one in 1914. They were not entirely satisfactory, because it was observed that poisoned flies which dropped on them frequently crawled to the edge and dropped off. The wind also would toss them off at times. The following table gives an illustration of what happens. The orchard where this sheet was suspended was sprayed on June 8 and the sheet put beneath on June 10th, 1914.

Fig. 18.—Large sheet, five yards square, suspended beneath a tree to catch the poisoned flies as they dropped.

Sheet Record in Orchard No. 3.

Date.	No. of dead flies found and removed.	Observations.
June 11	3	
" 12	3	
" 13	5	
" 14	7	
" 15	5	
" 16	12	
" 17	6	
" 18	6	
" 19	0	Very high wind which would toss flies out.
" 20	2	
" 21	0	
" 22	2	
" 23	4	The orchard was resprayed this date.
" 24	2	
" 25	2	
" 26	1	
" 27	2	
" 28	0	
" 29	4	
" 30	0	Very high wind which would toss flies out.
July 1	1	
" 2	2	
" 3	1	This was the last fly: the sheet was taken down on July 12th.
Total	70	

Note.—This table should be compared with Table 1, which gives the dates of emergence for this same orchard (No. 3) from June 8th onwards. By a comparison of the two tables it can be seen that the poison killed the flies very soon after emergence.

ACKNOWLEDGMENTS.

The writers make no claim to having themselves discovered the above method of controlling the Cherry Fruit-flies. They were aware before beginning the investigation that the sweetened poison mixture had been used several years before in South Africa, Italy, and some other countries as a means of holding in check closely allied Fruit-flies with similar mouth parts and feeding habits. Moreover, Mr. J. F. Illingworth's excellent results with the mixture against Cherry Fruit-flies in New York State, as described in Bulletin 325 of Cornell University was also a stimulus to them in their work.