

Connecticut Agricultural Experiment Station
New Haven

Control of the Apple Maggot¹

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THE apple maggot, *Rhagoletis pomonella* Walsh, infests many kinds of apples. Sweet and mildly acid varieties are preferred, though, when abundant, flies will lay eggs in almost any kind. Examples of heavily infested varieties are Early Harvest, Sweet Bough, Wealthy, Gravenstein, Spy and Delicious. Baldwin, Ben Davis, McIntosh, Stayman Winesap and Greening are moderately resistant

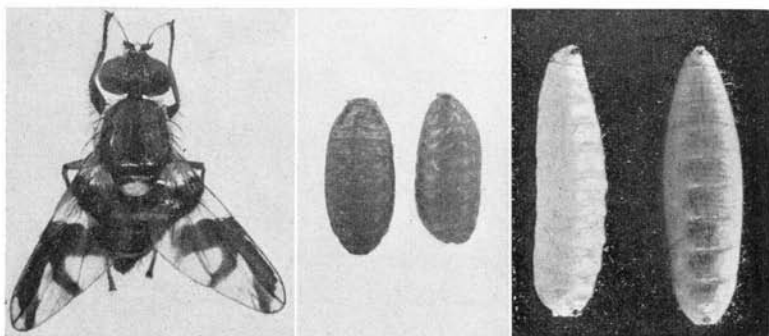


FIGURE 1. Apple maggot, puparia and adult fly (five times enlarged). Left, fly; middle, puparia; right, maggots.

in the average season but may be heavily infested in years of extreme abundance. Any variety not ordinarily infested may become so if interplanted with early or other varieties particularly subject to attack. The maggots tunnel through the fruit which usually drops to the ground and in general is worthless from a commercial standpoint. Figures 2 and 3 show infested apples. The fly, maggots, and puparia are shown in Figure 1.

¹Also known as the apple fruit fly, or railroad worm. This circular is a revision of Circular 101.

INDIVIDUAL LIFE HISTORY

The individual life history consumes a full year, or, in some cases, more than one year. Maggots developing in very early fruit, however, may produce flies the same season, but as a rule the latter perish before they are able to lay eggs. Generally, flies emerge from hibernation in June or July, feed for 10 days or so, mate and then begin to lay eggs in the fruit. Maggots develop during late summer and fall and, when they mature, leave the fallen fruit and enter the soil to transform. They remain in the soil as puparia until adults emerge the following season. A relatively small percentage carry over until the second summer, or, in more northerly localities, until the third to the sixth year.

The following table gives the length of various stages under optimum conditions as determined at our laboratory. Temperatures

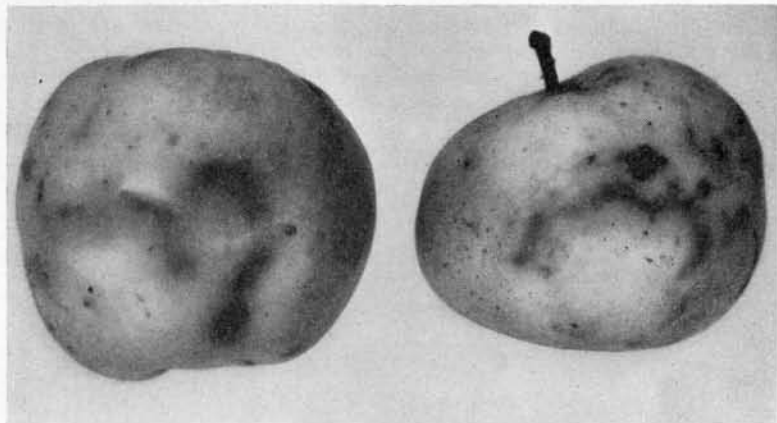


FIGURE 2. Infested apples showing typical depressions and "railroads."

ranged from 75° to 80° F. and humidity from 60 to 70 percent. Food supplied was honey and yeast; light, daylight from a north window.

Pre-oviposition period	7 to 10 days
Oviposition period (average)	71 days
Pre-mating	4 to 10 days
Mating (average)	52 days
Larval emergence from apples	
Time to first emergence ¹	21 days
Period of emergence	12 days
Fly emergence from soil ²	
Time to first emergence ¹ (average)	63 days
Period of emergence	107 days
Maximum life of flies	103 days
Average life	41 days

¹From the time the egg is laid in the apple.

²This period would be greatly lengthened in the case of those individuals passing the winter in the soil. In the field, other periods would also be shortened or lengthened depending on climatic conditions.

SEASONAL LIFE HISTORY UNDER FIELD CONDITIONS

Adult flies from maggots of the previous year begin to emerge in June and continue until August or September. The peak of adult emergence is usually reached during the last 10 days in July. The first eggs are laid within a week or 10 days after emergence from the soil and the peak of this activity is reached between two and three weeks later. This means that maximum oviposition should occur between August 5 and 10 for the average season when the peak emergence falls on July 20 (Figures 6 and 8). As already indicated, flies have been kept alive in cages under very favorable conditions for a maximum of 103 days. Under such conditions the average life is about 41 days, and it appears that favorable field conditions will allow nearly the same longevity. It is, therefore,

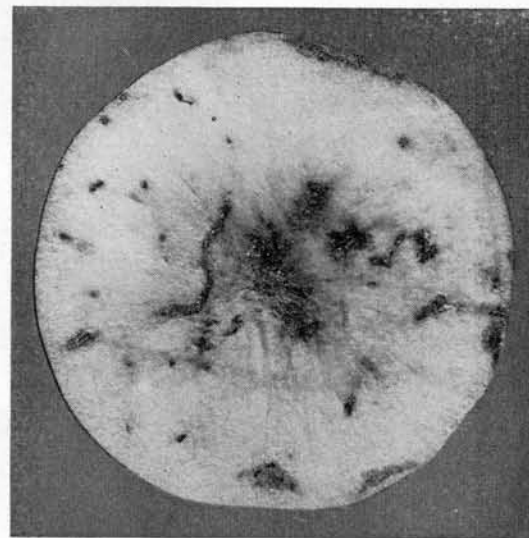


FIGURE 3. Cross section of an infested apple.

possible for flies to continue alive in the orchard until the fruit is harvested and to lay eggs over an extended period. In 1940, females were observed laying eggs on September 7 and individuals captured then appeared capable of laying after that date since their ovaries were distended with eggs.

HABITS AFFECTING CONTROL

Obviously there is considerable danger from ovipositing flies all during August and early September, so that wherever there is movement of flies from outside sources, such as uncared for trees or unsprayed orchards, sprays during July will not suffice. Additional treatments in August may be necessary. For a few days after emergence from the soil, the flies seem to avoid the fruit, but appear in

numbers when ready to deposit eggs. In cool, sunny weather they are easily seen on the sunny side of the trees, and exposed sides of the fruit. On dark, rainy days they hide under the foliage and are found with difficulty. Eggs are inserted mostly in fairly green fruit. Ripening apples are avoided, probably because the maggots will not have time to mature if the eggs are laid there.

Flight. It is frequently asked how far mature apple maggot flies will travel. The distance, as determined by various entomologists, is not often more than 300 yards. It has been shown that activity of flies within an orchard is more extensive than formerly realized, and there seems to be rather free movement from tree to tree and from one portion of the orchard to another. Cases are

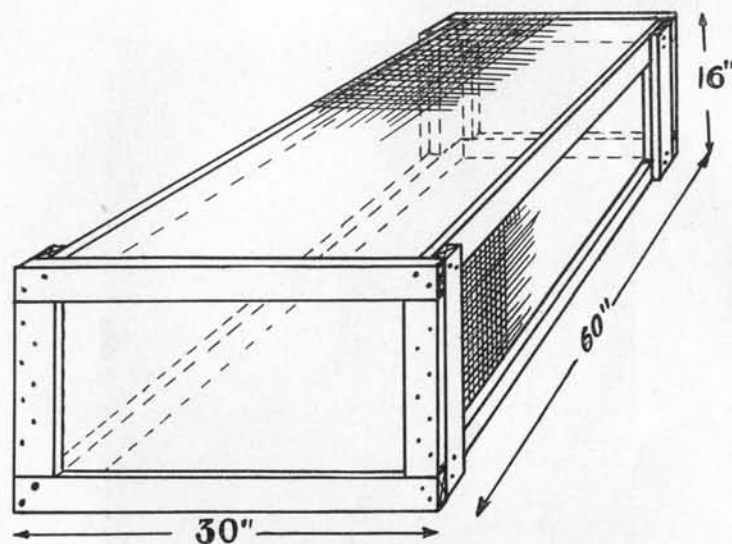


FIGURE 4. Simple ground cage for trapping flies and obtaining emergence dates in individual orchards. The cage is useful for determining spray dates and should be placed over spots where apples were piled the previous fall. Scatter the fruit and mark the spot with stakes soon after the maggots have left to enter the soil.

known in which marked flies have travelled as much as 700 yards in order to reach apple trees, and they might, with favorable winds, travel farther than that. It is believed, on the other hand, that the majority will not fly more than 300 yards to get food, and recommendations for tree removal near commercial orchards are based on this figure. Infested apples should be taken at least that distance away from bearing trees in order to prevent return of the flies the following year.

EMERGENCE OF FLIES AS RELATED TO TIMING OF SPRAYS

It has been reported that flies emerge sooner from light, sandy soils than from heavy loams, and, of course, sooner from earlier

varieties of apples than from late. This is because the lighter soils heat up faster, and maggots from eggs laid in earlier varieties are further developed when they go into hibernation. Since sprays should be timed according to emergence, it is important to know the time of emergence in individual orchards. This may be estimated by placing simple cages over spots where infested apples were piled the previous year. When the piles are removed during the fall, stakes may be set to mark the location for the cages. The Station has had success with cages such as those illustrated in Figure 4. Figure 5 shows emergence from early and late varieties in Wallingford. Figure 7 shows emergence mainly from Astrachans and Gravensteins at Mount Carmel.

CONDITIONS AFFECTING INCREASES IN MAGGOT INFESTATIONS

Heavy fruit drops during August and September of the preceding year promote increase if the fruit remains on the ground. The

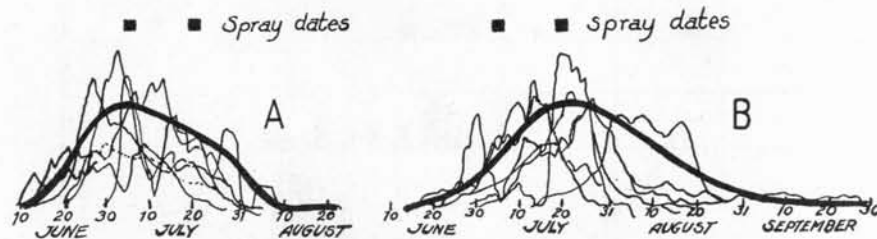


FIGURE 5. Chart of emergence of apple maggot flies at Wallingford, Connecticut, from data by Porter. A. Emergence from early or summer apples. B. Emergence from fall or winter varieties.

hurricane of September, 1938, may have started the insect on its present upward swing since many infested fruits stayed where they fell after the storm. As already stated, the flies are most active on bright, sunny days and least active on cool, rainy ones. Long periods of sunny weather without much rain would probably be favorable. Any climatic or other factor which prevents development of fruit on uncared for trees would be considered unfavorable for the insect. It is believed that trouble from the maggot is less than normal during those years when fruit on wild apple trees is reduced by canker worm or tent caterpillar defoliation.

PARASITES AND PREDATORS

The parasite most commonly reported from the apple maggot is *Opius melleus* Gahan, a hymenopterous wasp-like insect that lays its eggs in the developing maggot while the latter is still within the fruit. This insect is known to parasitize nearly 30 percent of the larvae of the blueberry maggot but rarely reaches that percentage in the apple maggot. Normally it does not parasitize more than 5 percent and our records so far show nothing over 15 percent. A para-

site of the eggs has also been recorded (*Anaphoidea conotracheli* Gir.). This species, said to parasitize 20 to 30 percent of apple maggot eggs, also attacks the plum curculio. Spiders, ants and possibly other predators kill adult flies or newly emerged larvae. Evidently these enemies and parasites have not been able to hold down the rising abundance of the apple maggot since 1938. We know that *Opius melleus*, for example, has been almost non-existent in

Apple Maggot Egg Deposition Insectary Cages, Mt.Carmel 1937.

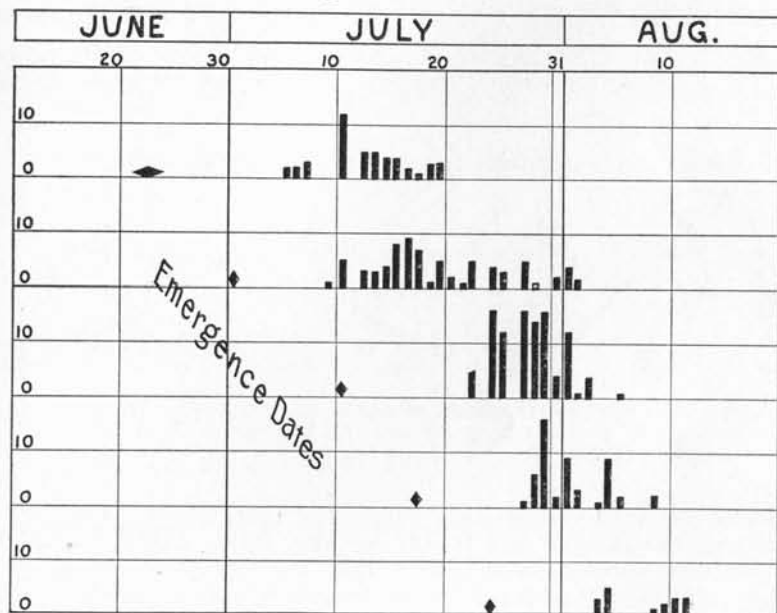


FIGURE 6. Chart showing emergence dates and egg deposition of the apple maggot.

the vicinity of Mount Carmel but we have little information concerning the egg parasite.

DISCUSSION OF CONTROL MEASURES

Maggot flies obtain food and moisture from the surface of the fruit and leaves. For this reason stomach poisons, generally arsenicals, are employed to kill them. Both calcium and lead arsenate sprays kill the fly and lead arsenate dust is reported to be effective. In dusts of this sort the lead arsenate may be combined with the usual sulfur carrier or may be used with lime, the percentage of

lead arsenate in either case being 10 percent. Rotenone products¹ destroy the flies more rapidly but are not so permanent as lead arsenate, remaining effective usually less than a week. Their quick action, and the fact that they may be used within a few days of harvest without leaving an objectionable residue makes them useful as supplements to the regular program.

From laboratory observations it appears that better kills are obtained with lead arsenate when some moisture is present. This, however, has not been apparent in tests with rotenone-oil dusts.

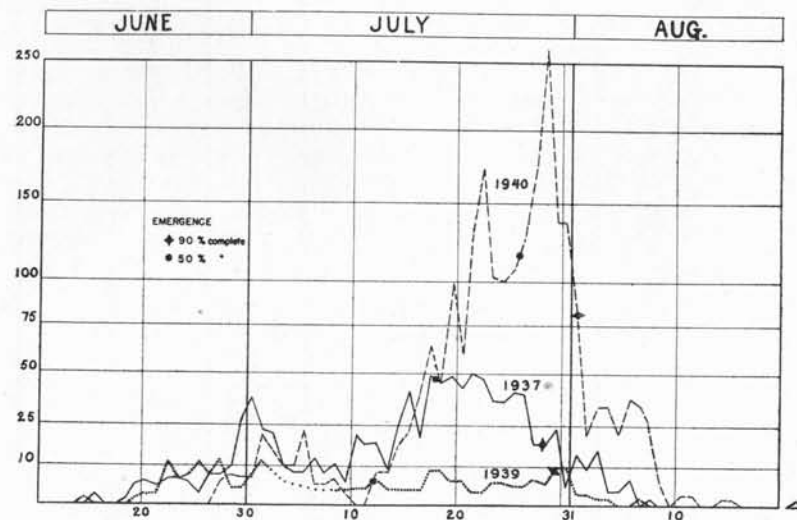


FIGURE 7. Chart showing emergence of flies from ground cages at Mount Carmel in three different seasons. Points indicate when 50 percent had emerged and also 90 percent. Note similarity of the 90 percent point in all three seasons. Chart prepared by J. F. Townsend.

Both lime and lead arsenate have some deterrent or repellent action and appear to reduce the number of eggs laid by the female. It seems reasonable that the action of lead arsenate may fall entirely in this category during dry seasons.

Where severe infestations occur, it is advisable to remove or spray neglected trees near the commercial orchard, also to collect and destroy windfalls within the orchard itself. A successful practice consists of removing all drops from the ground whenever fruit is harvested from the tree. Collected fruits may be buried in a trench with two feet of closely tamped soil above, or, if it is neces-

¹Rotenone dusts used by the Connecticut Station with success for two years are composed of derris, pyrophyllite and white lubricating oil. The rotenone content is approximately .5 percent and the oil 4 percent. Amounts applied per tree were considerably less than with other types of dust carrying no oil.

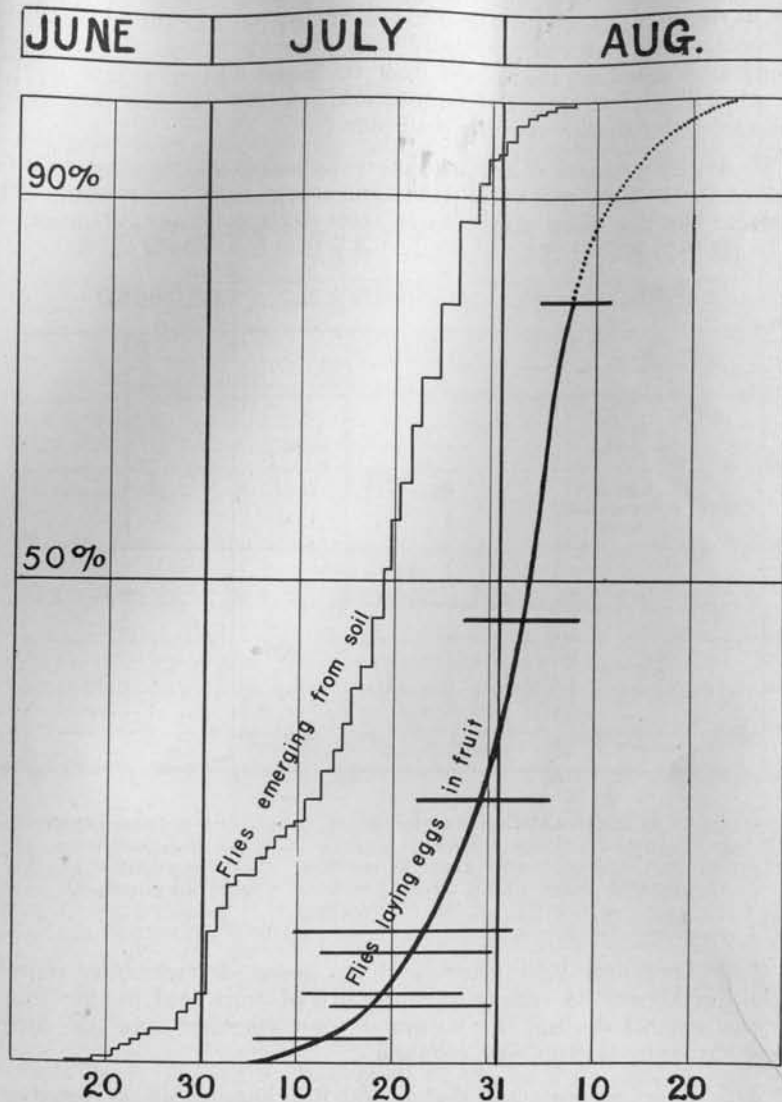


FIGURE 8. Emergence of flies by percentages, together with dates when these flies would normally lay eggs. Data from ground cage records at Mount Carmel and insectary breeding, using flies that emerged on different dates during the season. Chart prepared by J. F. Townsend.

sary to dispose of large quantities, they may be dumped in a concrete or dirt pit and covered with crankcase oil in late fall or early spring. If removed from the orchard and dumped, it is well to remember the distance from which flies may return to the orchard (300 yards) and not dump within that limit. Some growers report feeding infested apples to livestock with good results. There are probably many methods of successfully disposing of infested fruit, but the important point to emphasize is the advisability of getting fruit out of the orchard before maggots leave it to enter the ground. Successful drop removal greatly simplifies any control program the following season.

Spray or dust operations should include bearing trees whether they contain a crop of apples or not (that is, during the off year) because of the habits of the flies which feed on the leaves of non-bearing as well as bearing trees. If non-bearing trees are not treated, flies may remain there until mature and then migrate to bearing trees. Flies are also known to feed on trees or bushes in hedge rows immediately surrounding an orchard, so it is advisable to spray or dust these at least once during the summer in order to reduce heavy infestations. Light to moderate infestations do not require it.

Apples suspected to contain eggs, or apples in which the young maggots are just beginning to work, should be placed immediately in cold storage (32° - 34° F.) and held for about one month before using. This treatment destroys eggs and larvae.

SUMMARY OF CONTROL SUGGESTIONS FOR CONNECTICUT

Sprays and Dusts

For varieties ripening from July to September 15. Dust Yellow Transparent and Astrachan (or other varieties ripening at the same time) during June with 80-10-10 lime sulfur-lead arsenate dust. Use rotenone-oil¹ dust during the first half of July, discontinuing treatments as the fruit begins to ripen. Duchess may be grown successfully with two cover sprays, but if the flies appear in July, it may be advisable to apply dust during the first week of that month. Wealthys and Gravensteins ripening near the first of September should receive at least one spray in July, followed preferably by an arsenical dust about July 20 to 25. Supplementary treatments, if necessary, should be applied in August, using the milder rotenone products. With any arsenical treatment, particularly sprays, it is wise not to continue within six weeks of picking dates because of objectionable residues.

For winter varieties ripening September 15 or later. Spray the first week in July; repeat July 20 to 25 and again August 5. Two pounds of lead arsenate in 100 gallons, with or without a fungicide, is sufficient. Dust may be substituted for the last application with the earlier ripening varieties such as McIntosh.

¹See footnote, page 23.

Supplementary Measures

Attend to all neglected apple trees within 300 yards of the orchard and either spray or remove them if possible. The feasibility of spraying such trees in bloom with materials containing dinitro-o-cresol or similar material is mentioned since this offers an easy way of removing the fruit without serious injury to the tree. Only one treatment would prevent development of maggot and other pests that infest the fruit. In case of valuable home garden fruit which the owner desires to retain, one or two sprays with lead arsenate during July may give maggot control enough to protect orchards nearby. Sprays of this sort have occasionally been applied by commercial orchardists without cost to the owner of the property.

Collect windfalls of all infested varieties and destroy them. In order to be completely successful, this measure should be carried out before the maggots leave the apples to enter the ground. Theoretically, it requires collections several times a week, but this is usually impossible unless only a few trees are involved. It is very helpful, however, to clean up all the drops whenever fruit is picked from the tree and the most successful controls in Connecticut combine this type of collection with spray or dust applications.

In the home orchard, where there are trees on neighboring property providing a constant source of reinfestation, results may be disappointing with any method of control, unless there is a community effort along these lines.

If fruit appears to be infested at harvest, place immediately in cold storage and hold at least one month before using.

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