THE LIFE HISTORY,
HABITS AND DISTRIBUTION
OF THE APPLE MAGGOT

THESIS FOR DEGREE OF M. S
DONALD TIMMERMAN RIES
1926

Apple - Bensaude + pilc
Apple-maggot

Entomology

THESIS

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INTRODUCTION

The apple maggot or "railroad worm" (Rhagoletis pomonella, Walsh) during the past few years, has again become a serious problem to the fruit-growers, after an absence or dormancy of about a quarter of a century. The damage in 1925 was not confined to small, isolated spots but was quite generally distributed throughout the apple growing regions of the state. In 1926, however, the more serious ravages seemed to be confined to localized areas.

The economic losses caused by this insect are of particular interest to the fruit grower of Michigan, since this state stands fourth in acreage of bearing trees, being surpassed only by New York, Pennsylvania and Ohio.

The work leading up to the preparation of this paper was done in partial fulfillment of the requirements for a Master of Science Degree, and was performed under the direction of Professor R. H. Pettit and Miss Eugenia I. McDaniel, to both of whom I wish to express gratitude for their help throughout the work. Thanks are also due to the farmers in the vicinity of Stockbridge, for their cooperation and the use of their orchards.

Besides working out the life-history and possible control measures, much time also was spent in compiling a bibliography of all important published

articles concerning not only apple maggot, but also other fruit-flies.

HISTORY

The apple maggot seems to have been known in many orchards in the northeastern United States for some years before it was described in 1868 by Walsh.

Calvin Ward (1866) says that even previous to 1865, his apple crop had been severely damaged by larvae boring in the apples in all directions.

During the winter of 1866 Walsh (1868) received some pupae from Massachusetts, Connecticut and Long Island. Adult flies emerged from these in July 1867. The flies bred from these pupae were found to be identical with those bred five or six years previously from Haws in Illinois.

Riley (1872) published an account of the maggot and included a letter from J. H. Spatter of Keene, New Hampshire, thus giving the first record from that state. In a later article (Riley 1876) we find the first reference to its occurrence in Maine. While Comstock (1882) first reported the pest from Ithaca, New York, collected in 1881, Several years later Cook (1884) recorded the maggot from Shiawassee County, Michigan and Delavan, Wisconsin. Williams (1889) first reported the pest from New Jersey, but

adds that it had been doing damage for about twelve years. Osborn (1891) states that during 1890 there were many reports of this insect sent in from Iowa and that it had been introduced from Missouri apparently, although no one had recorded its presence in that state. In 1890 it was also reported by Weed (1891) to be damaging fruit in Delaware County, Ohio. Doctor L. O. Howard (1894) seems to have recorded the maggot's southern limit in apples from Waynesville, North Carolina, while Gillett (1896) found it in apples at Colorado Springs. He supposes that the insect was introduced in eastern apples.

Dr. Fletcher (1897) reported receiving maggot-infested apples in August 1896 from Ontario. In 1902 it was reported plentiful in Prince Edward County where over half the fruit was destroyed in some orchards. In 1905 Dr. Fletcher reported it in Quebec while later (1907) it was reported from New Brunswick.

Professor Washburn (1903) included this insect as an apple pest in Minnesota.

It has also been recorded from California. (Can. Ent. 51; 2-4, 1914.)

CLASSIFICATION AND SYNONYMY

The apple maggot (*Rhagoletis pomonella*) belongs to the order Diptera and to the family Trypetidae. This family formerly contained two genera: *Trypeta* and *Dacus*, the two genera being separated by the following characters:

Five segments of abdomen before borer - *Trypeta*
Four segments of abdomen before borer - *Dacus*

Dr. Loew in his monograph of European Trypetidae published in 1862, split the genus *Trypeta* into several subgenera, one being *Rhagoletis*. However, Coquillet (1899) points out that sometimes these groups were referred to as genera and sometimes as subgenera. Osten Sacken (1878) in his catalog of Diptera of North America terms these groups subgenera, however, the name *Rhagoletis* is now recognized as a valid genus by Doane (1898) and by Aldrich (1909).

The insect was first described by Walsh in 1867 under the name of *Trypeta pomonella*, the description having been based on six females bred July 15th to 23rd, from apples, and two females and one male bred July 23rd to 28th from Haws received from Illinois.

It was known by that name until the publication of Doane's paper in 1898 when it was placed in the genus *Rhagoletis*. From that date it has borne the name *Rhagoletis pomonella*.

COMMON NAMES

The name "apple maggot" given this insect in 1868 by Walsh is still the one used most generally. In New England it has often been called the "railroad worm", this term being also quite commonly used among the farmers in the middle west. Many people also refer to it simply as the "apple worm", thereby causing considerable confusion.

FOOD PLANTS

The apple maggot being a native insect, it seems probable that its primitive food plants were members of the genus Crataegus, although only Walsh (1868), Comstock (1882) and Cook (1889) reported them as being found in Crataegus. It will be remembered that Walsh, in working up his original description, based it partly on males and females reared from Haws in Illinois. Professor Comstock reported rearing them from species of Crataegus at Washington, D.C., while Professor Cook reported the insect as "well known" in the thornapples of Michigan, Wisconsin and Illinois.

Throughout the earlier manuscripts are reports of the maggots feeding on wild crab-apples, but the only records based on actual observation are those

by Riley (1872) and Fletcher (1906). The latter states that, "although very badly infested, the fruit does not drop, as do other varieties of apples". Comstock (1882) thinks that the insect probably occurs throughout the country wherever hawthorns or crab-apples are found, while Harvey supposed that its original food-plant was the haw and that when civilization moved in and the haws were cut down, the insect migrated to our cultivated apples and made itself "perfectly at home" as so many other of our native insects have done.

In 1889 in Professor Cook's Annual Report, he mentions having received plums and cherries from northern Michigan, that were infested with this insect. However, these records are doubtful, since no adults were reared and it is quite probable that these might have been the larvae of one of the cherry fruit-flies, (Rhagoletis cingulata), which is damaging the cherries of northern and western Michigan to-day. In 1926, I observed adults of R. pomonella resting on sour cherries at Stockbridge, Michigan, but did not observe any ovipositing, nor have I found any evidences of their presence in the few stray cherries still on the trees up to the first of August. I have never observed any flies at all on plums, although there were several plum trees adjacent to infested apple trees.

Harvey (1893) records flies reared from Vermont pears. He also reports them working on pears in Maine.

I have examined a large number of both wild plums and hawthorns, but have seen no evidence of any maggot work in them.

Dr. Britton (1906) reported the apple maggot working on huckleberries in Connecticut in August 1904. He also reared the adult flies. Dr. Smith (1910) also recorded this insect working on the same fruit in southeastern New Jersey and the following season bred the flies from such larvae. This insect was also bred from Snowberry, (Symphoricarpus racemosus) in British Columbia by Downes. The same insect is also found in Maine, infesting blueberries. I believe also it has been reported on huckleberries in northcentral Michigan around Bay City, but no printed data are available. Huckleberries were collected this year in the vicinity of Stockbridge, Michigan, but no evidences of maggots were found.

Cultivated apples are by far its most important food plant. It has been reported as attacking over seventy different varieties of apples. The commoner varieties which I have found infested with maggots are Early Harvest, Yellow Transparent, Red Astrachan, Primate, Maiden Blush, Tolman Sweet, Grimes Golden,

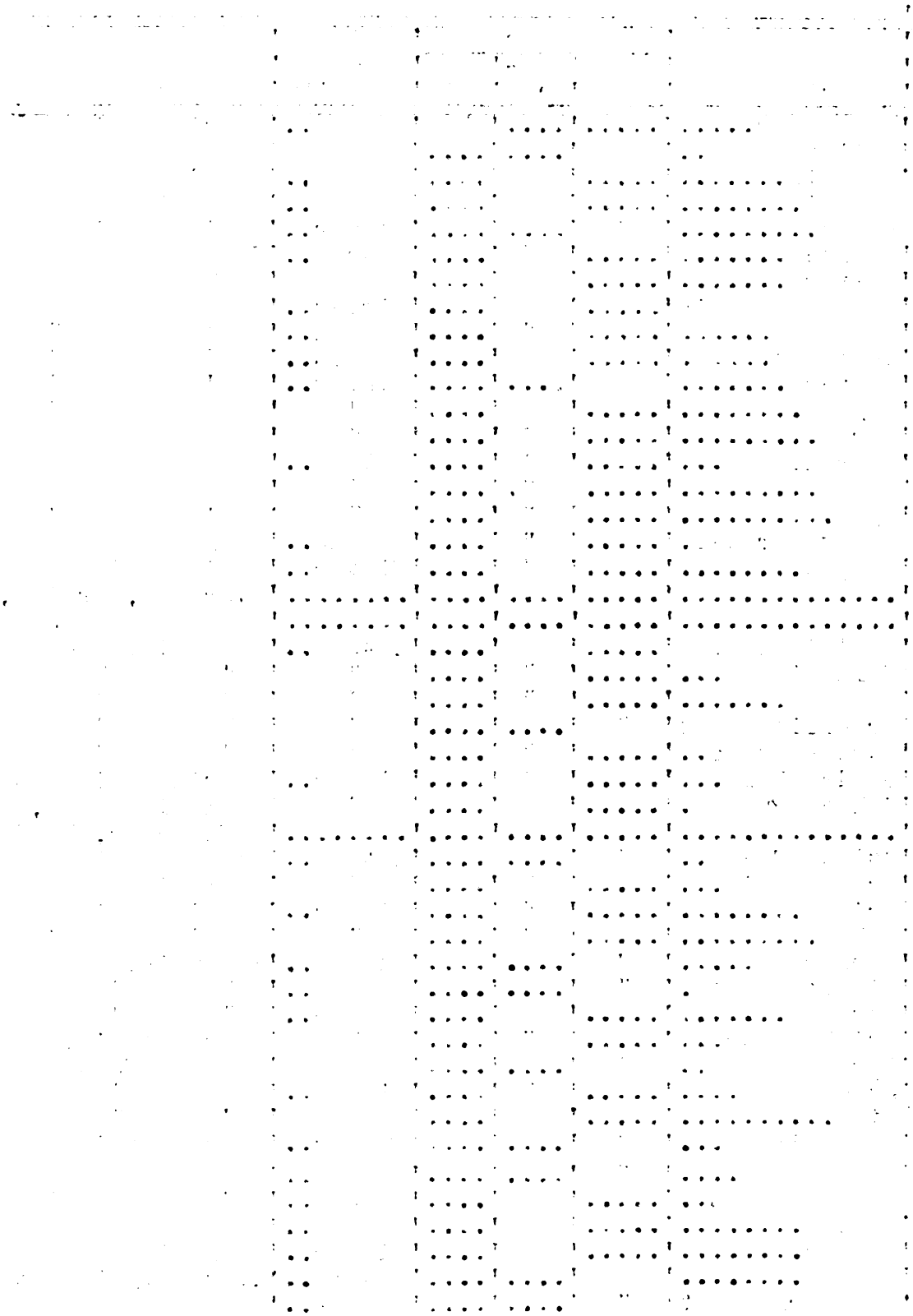
Tompkins King, Winter Sweet Benoni, Pound Sweet, Johathan, Shiawassee Beauty.

The early varieties seem to be worst infested although in 1925 the late summer and winter apples were all literally riddled in the vicinity of Stockbridge. In the case of the late apples, the injury was not apparent when they were picked.

Harvey (1889) published a list of apple varieties showing their relative infestation in Maine. Illingworth (1912) brought this list up to date and this revised list is given below. The varieties marked with asterisk have been found to be infested in Michigan.

VARIETIES OF APPLES, WITH RELATIVE INFESTATION BY THE APPLE MAGGOT

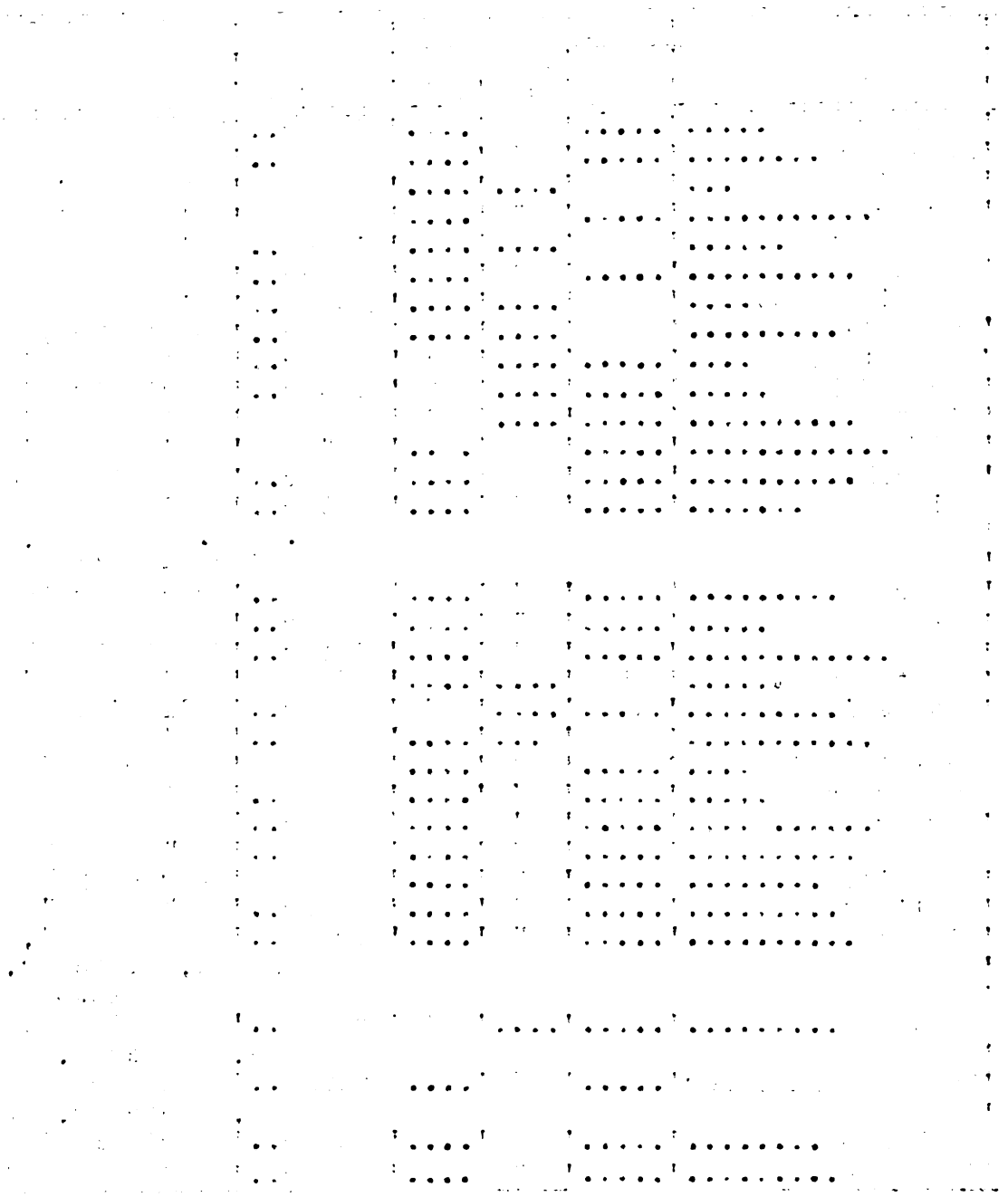
Variety	Flavor: Sweet	Flavor: Sub-acid	Flavor: Acid	Time of Maturity	Remarks
Alexander			"	Autumn	Sparingly infeste
Bailey Sweet	"			"	"
*Baldwin		"		Winter	"
*Benoni		"		Autumn	Badly infested
*Bough	"			Summer	"
Bullock		"		Autumn	Sparingly infeste
Calvert		"		"	"
Canada Baldwin		"		Winter	"
Catshead		"		Autumn	"
Chenango		"		Autumn	"
Danvers	"			Winter	"
Dayton		"		"	"
Derby		"		"	"
Detroit Red		"		Autumn	"
Diana		"		"	"
Dyer		"		"	"
*Early Harvest		"		Autumn	Badly infested
Esopus		"		Winter	"
					Vermont, Perkins, 1893
Fall Jenneting		"		Autumn	Badly infested
*Fall Pippin		"		"	"
Fameuse		"		"	"
Franklin Sweet	"			"	"
Garden Royal		"		"	"
Golden Ball		"		Winter	Sparingly infeste
Golden Russet		"		"	Badly infested, Fletcher, 1896
Golden Sweet	"			Autumn	Sparingly infeste
Gravenstein		"		"	Badly infested
*Grimes		"		Winter	Sparingly infeste
Haley		"		"	"
Henderson	"			Autumn	Badly infested
Hightop Sweet	"			Summer	"
Hurlbut		"		Autumn	"
Irish Peach		"		"	Sparingly infeste
Jersey Sweet	"			"	Badly infested
Jewett Red		"		Winter	"
*King		"		"	"
King Pippin	"			Summer	Sparingly infeste
Lady Sweet	"			Winter	"
*Maiden Blush		"		Autumn	"
Mexico		"		Autumn	"
Mother		"		Winter	Badly infested
Munson	"			Autumn	Sparingly infeste
New York Sweet	"			Summer	Badly infested



VARIETIES OF APPLES, WITH RELATIVE INFESTATION BY THE APPLE MAGGOT (Continued)

Variety	Flavor: Sweet	Flavor: Sub-acid	Flavor: Acid	Time of Maturity	Remarks
Northern Spy	.....	"	....	Winter..	Badly infested
Oldenburg	.....	"	....	Autumn..	" "
Paradise Sweet	"	....	....	"	" "
Porter	.....	"	....	"	" "
*Pound Sweet	"	....	....	Winter..	" "
*Primate	.....	"	....	Summer..	" "
*Pumpkin Sweet	"	....	....	Autumn..	" "
Ramsdell	"	....	....	Winter..	Sparingly infe
*Red Astrachan	.....	....	"	Summer..	Badly "
Rhode Island	.....	....	"	Winter..	Sparingly "
Ribston	.....	....	"	"	" "
Rolfe	.....	"	....	"	" "
Russell	.....	"	....	Summer..	Badly infested
*Shiawassee	.....	"	....	Winter..	" "
				Como. Que. Fletcher, (1903-1904)	
Somerset	.....	"	....	Autumn..	Sparingly infe
Sops of Wine	.....	"	....	Summer..	Badly "
Swaar	.....	"	....	Winter..	Sparingly "
Sweet Russet	"	....	....	"	" "
Tetofski	.....	....	"	Summer..	Badly infested
*Tolman	"	....	....	Winter..	" "
*Tompkins King	.....	"	....	" "	Sparingly "
*Twenty Ounce	.....	"	....	Autumn..	Badly "
Wagner	.....	"	....	Winter..	" "
*Wealthy	.....	"	....	Autumn..	" "
Westfield	.....	"	....	" "	Sparingly "
Williams	.....	"	....	Summer..	" "
Winesap	.....	"	....	Winter..	Badly ", Canada, Fletcher, 1896
*Winthrop	.....	....	"	Autumn..	Badly infested Canada, Fletcher, 1896
*Yellow Bellflower	.....	"	....	Autumn..	Badly infested Canada, Fletcher, 1896
*Hubbarson	.....	"	....	Autumn..	Sparingly infe
*Jonathan	.....	"	....	Autumn..	" "

* Have been used during observation in Michigan.

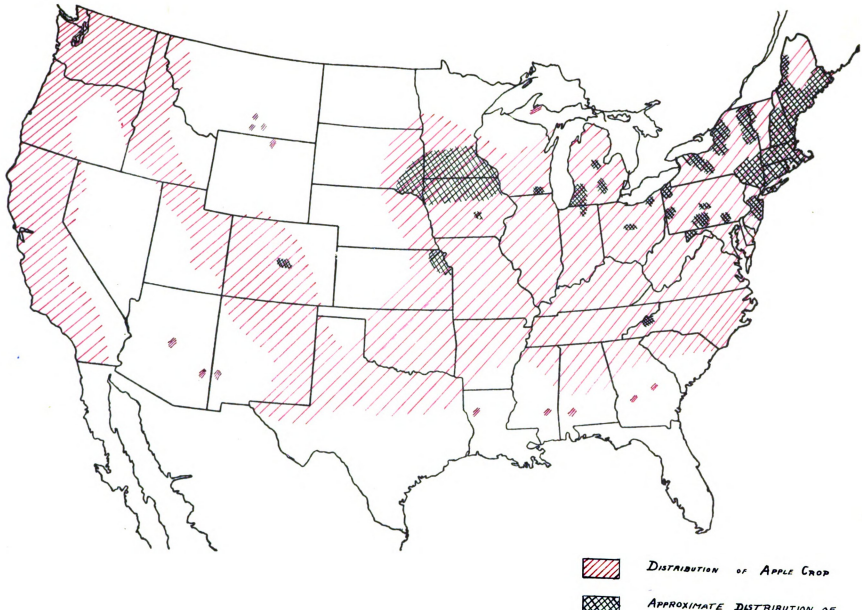


Maggots resembling R. pomonella have been collected in huckleberries, chokeberries, wild grape, plum and haw, but no adults have as yet been reared from this material.

DISTRIBUTION

This insect is a native to this country. From available data it would seem that its first appearance was in the east and northeastern part of the United States. Its range was gradually increased to the westward until to-day we find it quite abundant throughout the northern United States from Maine to the Dakotas and south to Maryland and Kansas. An isolated record in North Carolina and another in Colorado are believed to have been caused through the importation of infested eastern apples.

O'Kane published a distribution map in 1915, but as this seemed too general and covered too much territory, inquiries were made, by letter, of entomologists in the apple growing states in order to work out a new distribution map. This 1926 distribution data will be taken up by states. The accompanying map shows the approximate distribution of the apple maggot in the United States and Canada to date.


DISTRIBUTION OF APPLE CROP
APPROXIMATE DISTRIBUTION OF
RHAGOLETIS POMONELLA - 1927
D.T.R.-21

Illinois - Although early papers reported that the adults of apple maggot had been reared from haws in Illinois, Dr. W. P. Flint, State Entomologist, advised me that they had no records whatever of the occurrence of the apple maggot in Illinois.

Pennsylvania - Mr. T. L. Guyton reports that the insect is quite generally distributed throughout Pennsylvania and their records show its presence in Perry, Franklin, Adams, Cumberland, Lancaster, Beaver, Butler, Lawrence, Erie, Philadelphia and Union Counties.

New York - It is found quite generally distributed throughout the state's apple growing regions with the exception of the western part.

New Jersey - In this state it is found quite generally distributed, although part of its ravages are recorded upon blueberries.

New England - This insect is very common throughout this section of the country and does much damage to unkept and unsprayed orchards.

Ohio - As far as records are obtainable, only two counties, Delaware and Lorain, are the only places infested by this insect.

Maryland - There is one locality from which this insect is recorded in Maryland, namely, Garret County in the extreme western part of the state.

North Carolina - One record is found of its occurrence in the western part of North Carolina. This

is probably due to accidental dispersal.

Virginia - Although Virginia grows quite a large acreage of apples and stands fifth in trees of bearing age, it does not record the maggot.

Indiana - Professor J. J. Davis in a personal communication, states that Goshen is the only place where the maggot has been recorded in the state.

Michigan - Practically all the apple growing area of the state is infested by this insect, although it seems to be more injurious in the southern counties, particularly the southern parts of Ingham, Washtenaw and Shiawassee Counties.

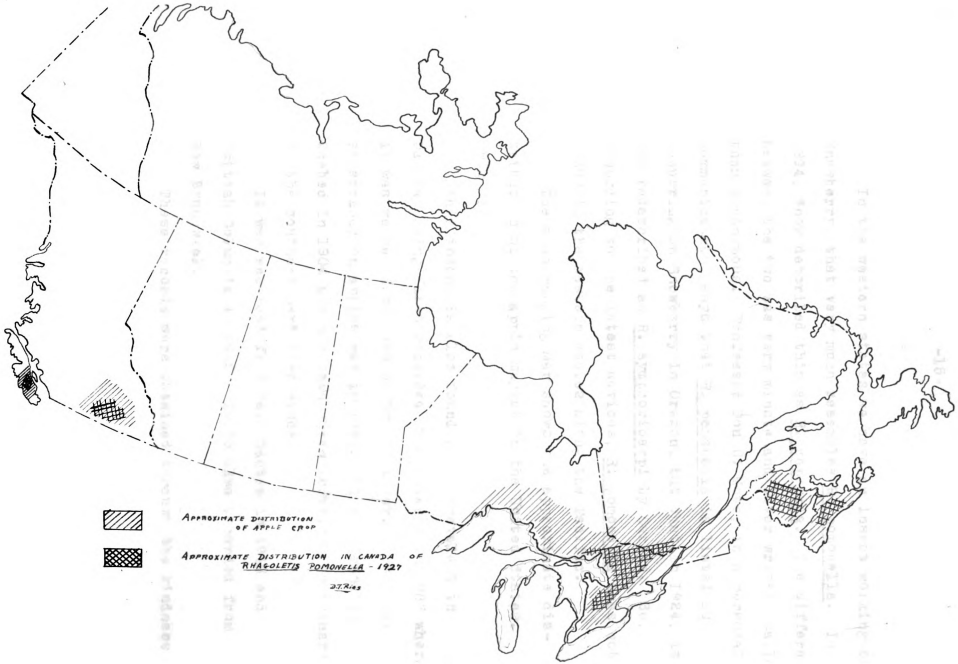
Wisconsin - One locality is recorded by Professor A. J. Cook. It was found near Delavan, but recent reports from that state do not indicate its presence.

Minnesota - Reports it fairly well distributed throughout the apple growing regions which are in the southern part of the state.

Iowa - Dr. Fenton reports this insect scattered throughout the orchards in the northern part of the state.

South Dakota - Dr. Severin in a personal communication enclosed a map showing the distribution of the insect in the southeastern corner of the state.

Colorado - Gives us one isolated record made quite a number of years back, but Professor Gillette informed me that none had been found since.


APPROXIMATE DISTRIBUTION OF APPLE CROP
APPROXIMATE DISTRIBUTION IN CANADA OF RHAGOLETIS POMONELLA - 1927
J.T.R.

In the western states we have an insect working on Snowberry, that very much resembles R. pomonella. In 1894, Snow described this as R. zephyria. The difference between the two was very minute and later writers called them synonymous. Professor Don C. Mote, in a personal communication, says that R. pomonella is listed as occurring on Snowberry in Oregon, but that in 1924, it was redescribed as R. symphoricarpi by Curran. So, according to the latest advices, R. pomonella does not occur in the western states along the Pacific.

The accompanying map shows the approximate distribution of the apple maggot in the United States. (Fig. 1).

This insect is also found quite prevalent in Canada, being first recorded from Ontario in 1887 where it was reared from haws by Dr. Fletcher. Its first appearance on apples was in 1896. It was found in Quebec in 1904 and has been quite injurious to orchards in the southern part ever since.

It was recorded from Nova Scotia in 1913 and British Columbia in 1916. It is also recorded from New Brunswick.

These records were obtained through the kindness of Mr. J. M. Swaine who said it was reared from Snowberry in British Columbia as well as apples and haws, but there are no records of it attacking blueberries. (Fig. 2)

TECHNICAL DESCRIPTION *

The female (Fig.4)

General color shiny black, marked with white; length, maximum 6.5 mm., minimum 5mm., average 6.25 mm.; spread of wings, average 12 mm.

Head. - Light brown above, blending into pale lemon-yellow on lower face; sides of face and hind margin of eyes white. Eyes bright green, with rich brown and sometimes steel-blue reflections, in life; but dull, dark green, with purplish reflections, in pinned specimens. Antennae orange, .5mm. long. Prominent black hairs border the distal front margin of the first segment, and cover the inner face and outer distal margin of the second; the third segment is flattened on its inner face and rounded without, pubescent; arista dark brown, two-jointed, slender, with fine pubescence. The usual frontal bristles present; all black except a small, yellowish white, erect pair (postvertical) located behind the ocelli. Mouth large, broad; proboscis and palpi lemon-yellow, both covered with a yellowish pubescence; palpi short, not extending outside the anterior edge of the mouth.

Thorax. - Shiny black; a white strip extending along each side from the humeral callus to the base of the wing and the white alula. The dorsum marked with four silvery gray longitudinal stripes, arranged in pairs, confluent in front and very slightly divergent posteriorly; the pairs separated by a median broad space

* Illingworth (1912).

that shows the shiny black of the rest of the thorax; the two stripes of each pair separated posteriorly by a very narrow, similar, black interval, in which is a prominent black bristle near the posterior end of the inner stripe, which is considerably shorter than the outer one; the silver-gray appearance of the stripes is due to a snow-white pile, this making a sharp contrast with the rest of the thorax which is black. The scutellum prominent, raised, bearing the usual two pairs of black bristles; top flattened and pearly white, sides and base black.

Legs. - Middle pair longest, about 4.5 mm.; femora and tibiae about equal, 1.5 mm.; tarsi somewhat shorter, 1.3 mm. Front pair shortest, about 3.8 . Femora black with lighter ends, the front pair often lighter; tibiae and proximal segments of tarsi, straw color; distal segments covered with black hairs, giving the feet a black appearance.

Wings. - Length 4.5 to 5.5 mm.; width 2 to 2.5 mm.; the smaller sizes being from wings of males and dwarfed females. Four irregular dark bands cross the hyaline membrane of the wing; the first lies near the base of the wing and joins the second near the posterior margin; the last three are connected near the middle of the anterior margin of the wing and diverge widely toward the posterior margin. Professor Harvey has suggested that these markings resemble the picture of a turkey: the end nearest the body representing the head, with

a clear spot usually present for the eye, the second band the body, the third the legs, and the fourth the tail, which reaches nearly to the tip of the wing. The entire wing is covered with a very fine pubescence, which is white in the hyaline parts and black in the bands. The entire margin of the wing, and the vein R_1 on the upper surface, are armed with small black bristles, as is characteristic of the genus.

Abdomen. - Shiny black; four rather uniform white bands bordering the posterior margins of the second, third, fourth, and fifth tergites; the scattered pile of the first of these bands is white, that of the rest black as on other parts. The abdomen without the ovipositor is a little longer than broad; it is composed of seven segments; the tergites of the first and second are so closely fused in this family that they were formerly considered as a single segment (Loew, 1873), although the sternites are clearly defined. The first two segments rapidly widen to the third, which is the broadest; the fourth, fifth, and sixth narrow abruptly to the seventh, which is in the form of a truncate cone, with no indication of the union between the tergite and the sternite, the two being so closely fused as to form a solid, chitinous protection for the ovipositor, and also to act as a firm attachment for the several sets of muscles which manipulate this organ and support the egg-tube within. At first this seventh segment was

thought to be the ovipositor (Loew, 1873), which is described as "very broad but short" and having a black pubescence; the real ovipositor being observed and described later (Harvey, 1889).

Ovipositor. - This organ is very slender and terminates in a sharp point. When not in use it is entirely retracted within the last abdominal segment. The general structure is horn-like, hard, and chitinous, with a groove on the lower surface which is covered by two chitinous rods or flaps extending from the sheath about half way to the tip. These flaps are attached at the sides to the main body of the ovipositor by thin, transparent membranes, their function being to guide the egg in its passage downward. The sheath is a thin membrane that attaches the ovipositor to the last abdominal segment. It bears many triangular, chitinous projections on its surface; these are arranged in definite rows that extend backward each way from a median line, above and below, the lower surface being the more beautiful. There is a triangular space on each side, at the base of the sheath, with no tubercles. When the ovipositor is retracted it carries the sheath with it, as in pushing in the end of the finger of a glove - the whole sheath and ovipositor being finally concealed within the seventh abdominal segment.

The Male (Fig. 4)

As shown in Fig. 16, the male has the same general appearance as the female but is considerably smaller. Length, 4 to 5 mm.; the principal difference in length is in size of abdomen, which shows only five of the seven segments, the sixth and seventh being retracted beneath the fifth, and white bands terminating only the second, third, and fourth tergites.

Harvey states that there are only five segments in the male, but he evidently overlooked the two terminal segments. The sixth segment is usually entirely covered by the fifth, and the seventh tergite can barely be seen extending behind the caudal margin of the fifth. The sixth tergite is very unsymmetrical, on the left side extending downward and meeting the sternite, while on the right there is only a small, triangular part at the top, chitinized, due to the position of the coiled penis which rests against that side. The seventh segment bears a pair of chitinous appendages, which aid in copulation. Extending from the caudal end of the seventh segment is the rectum, which is covered with stiff hairs and remains outside the body at all times; it can be seen as a noticeable light-colored speck in even the living flies. Within the sixth and seventh segments is a chitinous framework which supports the very long, chitinous penis - an organ which extends in almost a complete circle around the caudal end of the body, to the back, when partly uncoiled. Ordinarily

the penis remains in a tight coil in a pocket under the fifth tergite, just to the right of the median line. The spiral, chitinous rod in the penis makes it difficult to straighten out when the fly is dead, and causes the soft margin on the inner part of the circle to pucker, forming overlapping folds. Near the end is a rectangular part with a chitinous center, and terminating the penis is a spiral brush with numerous, somewhat stiff hairs. The other markings are as in the female.

Internal Genitalia of Female

Careful dissections were made of the reproductive system, in order to determine the time of development and the number of eggs. The ovaries are spherical masses made up of numerous egg-tubes, as is common among flies. The egg-tubes are surrounded by connective tissue and are tied together by closely anastomoxing tracheae; the oviducts are short and lead into the vagina, which also receives the ducts from the three spermathecae and the pair of accessory organs on the dorsal surface. The vagina has a cluster of tiny papillae also on the dorsal surface, the function of which the writer has been unable to determine. Two sets of muscles extend from the sides of the vagina to the chitinous walls of the seventh abdominal segment,

entirely surrounds this organ and holds it firmly in place. Another set of muscles, similarly attached, controls the movements of the ovipositor. The vagina gradually narrows and seems to unite with the intestine just before it passes into the chitinous covering of the ovipositor. Whether these two tubes actually unite or are only fastened together very closely with the connecting tissue, the writer is unable to state from the dissections made. This condition does not exist in other flies; although the two organs often open to the outside very near together, they have separate openings in all cases known to the writer.

The Egg

The mature egg is pearly white when taken from the ovary, but shows a distinct cream color after being in the fruit for a short time. The shape is fusiform, almost four times as long as wide; the pedicellate end being gently rounded, the other end more pointed. The pedicel is short, not much, if any, longer than wide. The eggshell around the pedicel is covered with reticulate markings having the appearance of cells, with raised papillae extending from their margins giving a spinose appearance. The markings and papillae are distinctly darker near the pedicel and

extend for only about one fourth of the total length of the egg, where they are gradually lost in the smooth surface of the remainder of the shell. Measurements of a large series show the following sizes: length, .8 to 1 mm.; width, .2 to .3 mm.; the shorter eggs usually having the greater width. The developing larva can be clearly seen within the egg; the black rasping apparatus, or head, being in the pointed end of the egg, the posterior part toward the pedicel.

The Larva (Fig. 3)

The larva is white or cream-colored unless it is feeding on green pulp from near the skin of the fruit, in which case the food shows through the skin of the larva, giving a greenish cast. The body is made up of fourteen segments; the ninth, tenth, and eleventh are thickest, those from the ninth to the first rapidly tapering to the small, pointed head. From the eleventh segment the body decreases very gradually to the last segment; this has the dorsal half cut off, leaving a sloping surface on which is located the pair of caudal spiracles. Below the sloping part the body ends squarely, giving it the appearance of being cut off. On each side of the dorsal surface, at the union of the third and fourth segments, is a conspicuous out-growth. By the aid of the microscope this structure

is seen to be made up of a double row of about twenty papillae extending from the margin of a funnel-shaped structure that is attached to a bulb-like enlargement at the base. These structures are the cephalic spiracles, which open into the pair of longitudinal tracheae extending caudad to the last segment of the body, where they end in the caudal spiracles mentioned above. Only two branches connect this pair of longitudinal tracheae, the first at the junction of the fourth and fifth segments and the other just in front of the last segment. When the head is fully extended, the black hooks are clearly seen protruding from the lower surface of the front segment. These hooks are attached to a black or brown framework inside the second, third, and fourth segments. This structure can be clearly seen through the skin by transmitted light, especially when the larva is young. The first three segments of the body are usually withdrawn into the fourth whenever the larva is disturbed; in this condition the cephalic spiracles appear to be at the anterior end of the body and the rasping apparatus cannot be seen. This is the condition seen normally in the anterior part of the puparium. There are two pairs of sensory papillae on the front of the first segment. Length of larva, 7 to 815 mm.; width, 1.75 to 2 mm.

The Pupa (Fig. 3)

As in most flies, the pupal stage is passed within the larval skin, the maggot shortening up and becoming inactive. The shape is a long oval, a little more than twice as long as wide and tapering about equally at the two ends. The head segment being retracted, the cephalic spiracles protrude from the front margin. The posterior end is slightly contracted but not enough to cover the caudal spiracles, which remain exposed. The color, at first light yellow as in the larva, changes in a few hours to a yellowish brown, becoming darker with age. Within two days the real pupa formed inside the larval skin, in all cases observed. Fletcher (1905) states that the pupa forms inside the puparium only a few days before the perfect insect appears the next summer. The pupa, when removed from the puparium, is pure white; the legs and wing buds closely folded toward the ventral side; the head also tipped ventrally so as to economize space. Length of puparia, 4 to 5 mm.; width, 2 to 2.5mm;

INJURIES AND LOSSES

The apple maggot causes two distinct types of injury to the apple. The first results from the oviposition punctures of the female. These show up as small depressions in the mature fruit. The second and most serious is due to the feeding tunnels made by the larvae throughout the pulp of the apple.

The "dimples" (Fig. 5 & 6) that result from oviposition may be confused with the injuries caused by several other insects. One of these is the Redbug, but the depressions caused by this latter insect are somewhat deeper and more pronounced than those of the maggot, they also appear much earlier in the development of the fruit.

Aphid injury, when slight, may also be confused with apple maggot injury, but aphis injury also usually appears on the apples when they are still quite small.

In some parts of its range, we find reports where the depressions are caused by the apple seed chalcid. In the case of this insect, however, the depressions are usually more numerous and more generally grouped around the calyx end of the apple.

The primary injury (Fig. 7,8,9,10) done by this pest is the tunneling of the maggots around through the fleshy parts of the apples. Soon after hatching

the larvae begin to tunnel indiscriminately throughout the apple, causing it to ripen prematurely and usually to drop to the ground. This tunnel soon turns brown and the whole apple finally decays. Very often the small, white, very active maggot will be found imbedded in the pulp near the end of the burrow.

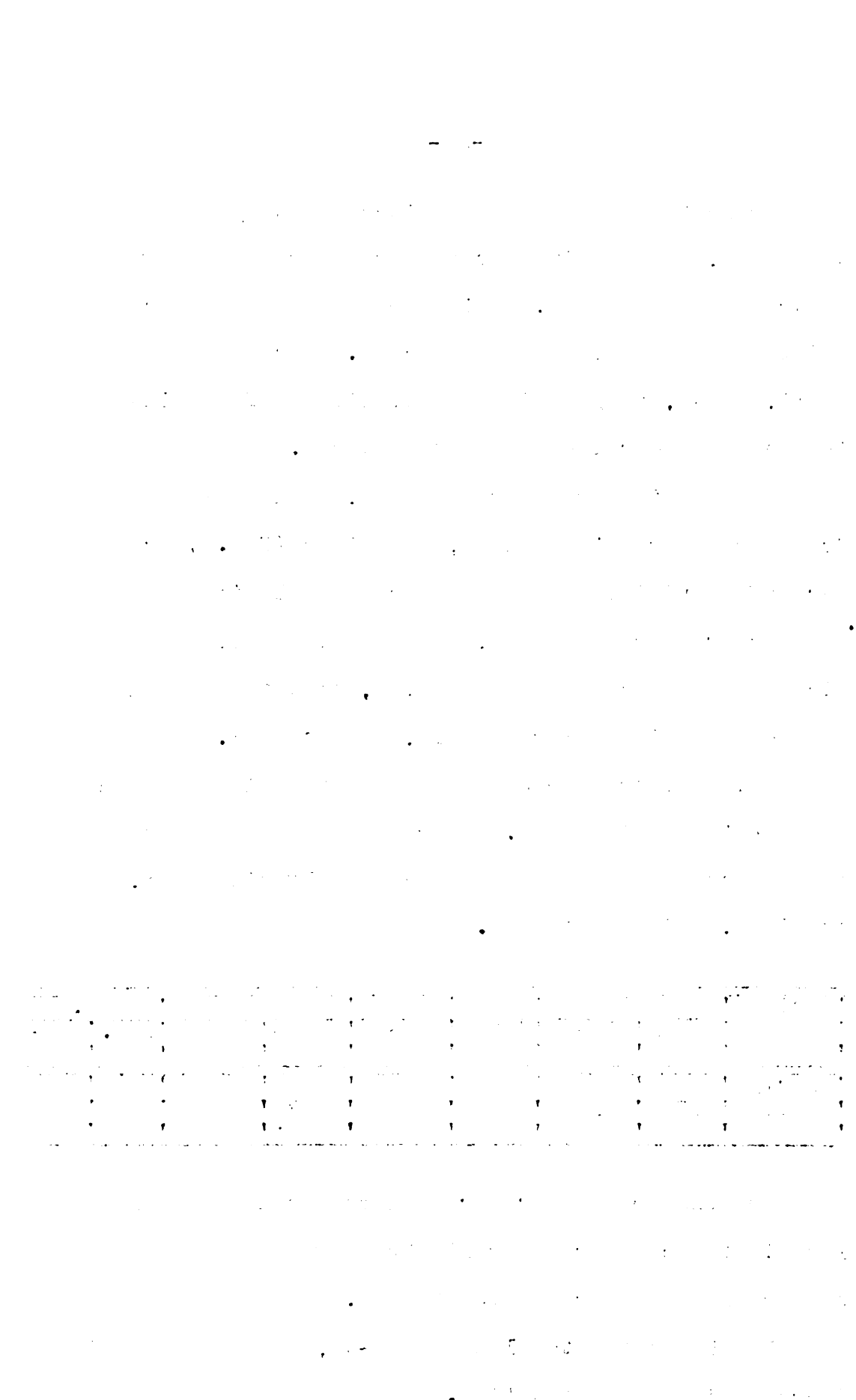
In the lighter colored apples, such as Yellow Transparent or Maiden Blush, the mines (Fig.9) are very often visible through the skin while in the later and darker skinned apples, they may very often be picked and graded as sound apples, only to be found full of dark irregular tunnels, when opened.

A few figures to show the amount of infestation would not be amiss here. A tree of early Harvest apples was used and the drops carefully picked up, examined, and counts made.

Variety	August 12		August 25		August 31		Sept. 8	
	Total	In-fested	Total	In-fested	Total	In-fested	Tot.	In-fested
Early Harvest	178	163	147	97	97	22	25	8

In 1925 in some orchards there was nearly a 199% loss in the crop from certain trees while the total orchard loss was around 75% to 80%.

In 1926 after the 1925 clean-up, there was a slight decrease in the infestation.



LIFE-HISTORY AND HABITS

These insects hibernate over the winter as puparia, in the ground under their host tree. The adult flies begin emerging in the spring during the early part of July. The first adults collected in 1926 were on July 13th. One male was collected at Mr. Nichol's orchard about 2½ miles north of Stockbridge and one female was observed in Mr. Craig's orchard just southeast of the same place. However, pupae that were collected in September 1925, and placed in an indoor cage, began producing adults as early as June 20th, and continued to do so quite regularly throughout the summer, August 27th being the last emergence record from that cage. When the flies began to emerge in the field, the apples were about one and one-half inches in diameter.

The orchards that were used in the experiments during 1925, were of several different types. The orchard of Orville Jones was a small one of about a dozen trees and although there was tall grass throughout the lanes between the trees, the ground beneath them was cultivated and clear from weeds. Mr. Craig's orchard was divided into two parts, the smaller one on the south side of the road containing about two dozen trees. This place was not cared for and was grown up with grass and weeds until late in the summer when the grass was cut. The other and older part of the orchard was located north of the road. This latter part

contained all old trees and was not bearing except for the two Tolman Sweets, Yellow Bellflower and one or two other varieties. The third orchard was at Mr. William Nichols. This was an orchard of about three dozen trees and sowed to potatoes and corn. The other orchard observed was that of Mm. Steffie. This was a large orchard and was well cared for and also contained a number of hogs that kept the ground cleaned up and free from windfalls. These orchards will be referred to throughout as Jones, Craig, etc. All of these orchards were quite heavily infested in 1925 with the exception of Mr. Steffie's, where only two trees of Ramblers were infested. One of these was cut down and the other thoroughly cultivated around the base.

The general emergence of the flies began about July 15th and they continued to be abundant in orchards around Stockbridge until August 23rd which was the last date any adults were observed in the field until September 27th when a few adults, probably belonging to the second generation, were found among the apples on the ground under a Maiden Blush tree.

An interesting fact concerning the emergence of the flies is that they do not seem to migrate very far from the place of emergence. The adults seem to fly directly up into the tree from under which they have emerged. If fruit is present they

are almost sure to stay right there. So it would seem that distribution over long distances is not by wing, but by being transported in infested fruit.

During the period that the adults are at large, they are continually feeding, seeming mostly in search of moisture. During the dry spell in July, many of the flies were observed seemingly lapping up the exudation from fire-blight cankers and also around the frass thrown out by codling moth larvae. They were apparently in search of water, as much water seems to be needed. Flies in emergence cages without water die within a few days while those in cages where an abundance of water is available live for several weeks. Early in the morning, or immediately after a shower, the flies were observed drinking the moisture that was still standing in the hollow at the stem end of the apple.

Both sexes do a large amount of feeding, both on the surface of the fruit and also on the surface of the leaves, but mostly on the former. Their methods of feeding are very similar to those of the house-fly, and the structure of the mouthparts is also very similar. At times the fly walks over the surface of the fruit, with the head slightly raised, and at such times a drop of saliva may be seen forced out between the lobes of the labella. The fly then applies this droplet to the surface of the fruit so that it seemed

to be spread over a small surface by means of the labella. Evidently this fluid acts as a solvent for it is immediately taken up and the process repeated on a nearby spot. Only occasionally have the flies been observed going through this feeding procedure on the leaves. Most of the time spent on the leaves is devoted to rest. While emerging from the cages in the insectary, the flies were supplied daily with small pieces of apple on which they seemed to feed almost constantly.

In the field, the adult flies were nearly always found on the sunny side of the tree and as the sun moved around, the flies moved along with it, always keeping on the warm side.

The mouthparts of this insect, as was stated above, are very similar in structure to those of the house-fly. In view of this fact, I take the liberty of quoting an excellent description of the mouthparts and feeding habits of this insect, taken from Dr. Howard's book -"The House-fly - Disease Carrier" (Page 27), since the structure of mouthparts and method of feeding plays a major role in the control of insect pests.

"The mouthparts are very complicated, but form in the main, a proboscis which is not fitted for piercing, but for sucking. This organ can be retracted and expanded to a certain extent. It is

somewhat complicated in structure and consists of an upper and lower portion, the upper portion bearing two curved bristly lobes. The lower portion or true naustellum expands at the tip into two lobes which are called the oral lobes. On their under surface, they have transverse chitinous bars which are called false tracheae (pseudotracheae). The presence of these hard ridges under the oral lobes fit it to a certain extent for rasping solid food. The orifice to the naustellum occurs between the lobes."

"In feeding upon fluid or semi-fluid substances, the oral lobes are simply applied to the surface and the fluid is sucked up. When, however, they feed upon soluble solids, the process is somewhat different. Dr. Graham Smith has carefully watched them feeding upon crystals of brown sugar and has done this through the Zeiss binocular microscope. He states that the oral lobes of the proboscis are very widely opened and closely applied to the sugar. Fluid (saliva) seems to be first deposited on the sugar and then strong sucking movements are made. Dr. Graham Smith watched a fly sucking an apparently dry layer of sputum. It put out large quantities of saliva from its proboscis and seemed to suck the fluid in and out until a fairly large area of the dry layer of sputum was quite moist; then as much as possible was sucked up and the fly moved to another

spot. The same observer noticed that flies which had the opportunity of feeding either on fluid or partly dried milk, often chose the drier portions and states that under natural conditions they can often be seen sucking the dried remains near the top of a milk jug. They constantly apply their mouth-parts to the surface over which they are walking, attempting to suck up some nutrition and under certain conditions, the imprints of their oral lobes can afterwards be made out under the lens."

It was observed that the apple maggot adult also "tastes" the surface of everything. Even when placed in vials or cyanide bottles, they immediately began "tasting" the sides of the glass.

Oviposition was also carefully observed and studied both in the field and with caged adults. On August 2nd. the first females were observed ovipositing and it was very easy to carefully study the process since the insect was very tame and did not object to being scrutinized with a hand lens at close range so long as no sudden movements were made. The female was observed to alight upon the apple and in some cases it turned around several times and sometimes even side stepped once or twice. Then she extended the ovipositor and stroked it with her hind legs. Then after slowly raising it she lowers it and places the tip on the surface of the fruit. Rising

up on her legs, she slowly works it into the flesh of the fruit at an angle of about 45°. The process of cutting the opening and laying the egg requires a little more than a minute, by actual timing one minute and seven seconds. After the ovipositor has been forced in to the desired depth, the fly remains nearly motionless during the last twenty-five or thirty seconds. During this time the egg is passing out into the apple. Once the egg was observed passing by the open space on the side of the sheath that is not protected by tubercles. When the egg was in place, the ovipositor was quickly withdrawn and often she was seen to turn around as if to inspect the puncture, or it might have been to sip up some of the juice that had flowed out through the opening. While oviposition was taking place the wings were held at an angle of about 30° and slightly curved downward at the tip.

When first made, the punctures are inconspicuous, but soon turn dark, leaving a small brown speck on the surface of the fruit. Most of the eggs observed were laid on the sides rather than on the ends of the fruit.

No definite check was made on the number of eggs laid by a single individual during 1926 so I have taken the liberty of quoting Illingworth (1912, p.143) who made an extensive study of the internal anatomy of the adult fly.

"In order that the number of eggs produced during the lifetime of a single individual might be shown with some degree of exactness, careful dissections were made of ovaries of mature females. Masses of tracheae and connective tissue surround these organs, making it rather difficult to separate and extend the egg-tubes so that they can be studied under the microscope. The great number of egg-tubes was at once apparent, there being twenty-four in each ovary. As in flies generally, the nurse cells are contained within the so-called egg, and the egg-tube is composed merely of a terminal filament, a germarium, and a series of eggs gradually increasing in size up to the fully developed form. Surrounding each series is a delicate membrane, so fragile that it is a difficult task to separate the egg-tubes from the entangling tracheae and connective tissue without dislodging the fully developed eggs; only occasionally is an entire series with the terminal mature egg separated. Usually after the tracheae are removed, the ripe eggs are seen scattered about and free from the enclosing membrane of the egg-tube.

The maximum number of eggs observed in an egg-tube was six, although often there were only four or five besides the germarium. Professor Harvy (1889) figures six or seven in the series. However, the total number of eggs produced is in no way dependent

on the number found in the ovaries at any one time, even though a large figure is obtained if five to seven be taken as an estimate for each of the forty-eight egg-tubes. As was discovered in later dissections, the germaria are constantly producing new eggs as long as the flies are active. Again, none of the dissections of flies that had been ovipositing for some time showed shorter egg-tubes, except when the flies were in poor condition through confinement. Hence, the writer would conclude that the flies are able to continue ovipositing during the remainder of their activity after they once begin, three or four hundred eggs being a moderate estimate for each female."

Since the first adult flies were observed on July 13th and the first oviposition was recorded on August 2nd, it would seem to take about two weeks for the ovaries to reach maturity. Although on the date when the first oviposition was observed upon cutting into the fruit, a number of very small larvae, one or two days old, were found. Illingworth also reaches the same conclusion that about two weeks were needed for the maturing of the ovaries. Flies emerging September 28th and 29th, that were placed in cages and fed daily, began mating in October.

Soon after oviposition and about the time that the larvae begin to hatch, the oviposition spots

turn brownish and as the apples develop, may form a dimpled surface. This surface is similar to that produced by the Red-bug and by aphids and may easily be confused with them until one gets to know the difference.

To determine the incubation period of the egg, two methods were used. One of the methods used by Illingworth consisted in placing the egg on a piece of apple in a hollow ground glass slide. Only a few eggs were hatched in this way, but not very good results were obtained. The other method was to mark the apples at oviposition and then place cheese cloth bags over the apples. Eggs were recorded as hatching in from two to seven days, depending upon the variety of apple and the temperature.

Soon after hatching, the maggots begin their tunneling within the apple. At first the maggot may work directly under the skin before going down into the flesh, or it may head directly for the interior of the fleshy part. The tunnels are very irregular and may easily be distinguished from curculio or codling moth work as they are clean tunnels and without the frass of the codling moth or the corkiness and dirtyness of the curculio channels. Besides, the apple maggot nearly always confines the major part of its work to the fleshy

part of the apple and very seldom works around the core as does the codling moth.

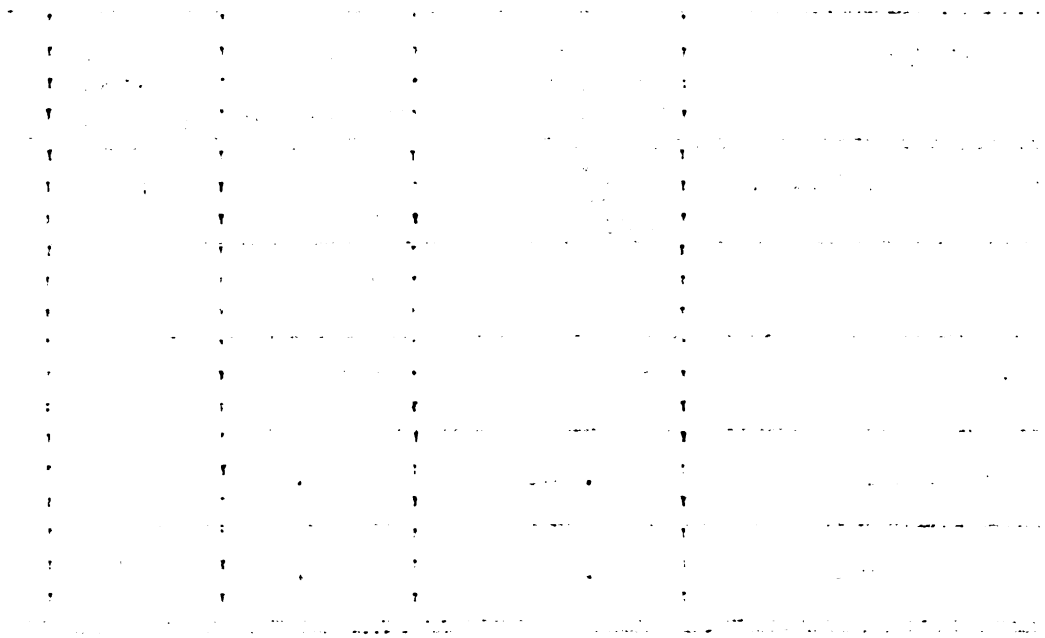
The length of time for the maggot to come to maturity varies greatly with the variety of apple. Apples were labeled when oviposition took place and when larvae emerged. These figures are given in table below:

TABLE SHOWING LENGTH OF LARVAL PERIOD

Variety	Date of Hatching (approximate)	Date of Emergence	Larval Period (days)
Yellow Transparent	July 2 July 8	July 17 July 21	15 13
Early Harvest	July 2	July 19	17
Primate	July 5	July 19	14
MacIntosh	Aug. 20	Sept. 8	20
Pound Sweet	Aug. 20	Sept.15	27

In Starks Delicious, oviposition was observed on August 23rd. and up to October 9th. no maggots had left the fruit. The same was true with Grimes Golden.

Some of the fruit growers who stored apples over the winter, told me that their Northern Spies, Starks Delicious and Grimes Golden, as well as other winter apples that were placed in storage in the fall and



which seemed to be perfectly sound when put in, were literally "shot full of holes" when taken out for use in the winter.

It seems that not only the ripening of the fruit and temperature, but also the texture of the fruit influences the larval period of this pest. In most cases, it was found that the presence of maggots in the fruit cause the latter to drop through premature ripening. In one case, however, a tree of Greasy Pippins was found infested and emergence holes of the maggots were found in the decaying apples still hanging on the tree. When leaving the fruit, each larva cuts an irregular hole in the skin. This exit hole is about two millimeters in diameter. It was noticed that in early, soft-pulped apples or where several larvae were present, the hole was very ragged, but in the later, hard apples, the hole might be quite clean cut.

Soon after the apple drops, the larvae leave and enter the ground to pupate. (Fig. 11 & 12) Several writers have advocated picking up "drops" twice a week in summer in an attempt to keep most of the larvae from entering the ground. This does not always prove effective, however. In the case of several trees of Early Harvest apples, the orchard was visited on Tuesday at which time 178 apples picked up, apples that had fallen since Sunday afternoon. Of these,

163 were found to contain from one to ten maggots apiece and 125 of the 163 contained exit holes, so it would seem that the larvae had left the fruit very soon after the fruit dropped, as no exit holes were found on infested apples still on the tree.

On the other hand, in the case of a number of decaying "drops" examined, pupae were found in the tunnels in the fruit.

Upon leaving the fruit, the larvae burrow into the ground and pupate very soon after reaching the desired depth. Pupa have been dug up from a depth of inches below the surface. These were supposed to have passed the winter as pupa, to emerge the following spring as adults. Records are to be found in literature from other states, of a second brood being found. Experiments were started to find out whether this was true for the state of Michigan.

On August 3, 1926, 137 Yellow Transparent and Early Harvest apples were placed in a cage in the insectary. The records from this cage are as follows:

Sept. 19 - 2 males emerged
" 21 - 1 female emerged
" 22 - 2 males, 2 females emerged
" 26 - 4 males, 5 females emerged
Oct. 3 - 1 male emerged
" 9 - 2 females emerged.

On August, 1926 another cage of 151 apples of the same variety was placed in a cage out of doors. On September 22nd, 3 males and a single female were

found in the cage. These were the only emergences.

On August 23rd, 1926, a cage containing 50 Primates was prepared. By September 10th all the maggots had left the apples with the exception of one or two that pupated within the apple itself. The soil in this cage became dry and when examined on October 11th, all the puparia were dead. It would seem that a certain amount of moisture is demanded in order that the puparia may remain alive.

It would seem likely that about a third of the flies emerge from larvae developed early in the season of the same year, the remainder hibernating over the winter in the ground as puparia to emerge the following spring.

It also seems probable that some of the pupae lay over for two years instead of emerging the following spring. The reason for thinking this is the fact that at Mr. Jones' place every apple was picked up daily during the season of 1925, although this year there has been quite a heavy infestation.

NATURAL ENEMIES

The natural enemies of Rhagoletis pomonella are very few, in fact, only two are reported from this insect.

The first of these is a small hymenopterous parasite, Anaphoidea conotracheli, Girault. This insect is an egg parasite of the plum and grape curculio as well as of the apple-maggot. Nothing is known of its life-history and as far as data are obtainable, it has only been reared from material collected near Wallingford, Connecticut.

The only other parasite of this insect that has been recorded, belongs to the family, Braconidae. This one is Opius melleus, Gahan (of which Biosteres rhagoletis, Richmond is a synonym). Adults of this species were reared from infested blueberries collected in Washington County, Maine in 1914.

CONTROL MEASURES

The control of the apple maggot in Michigan presents a problem that as yet seems to be unsolved, for which reason the following measures, suggested as possible means of reducing the ravages of the pest, are presented merely as recommendations rather than as proven control practices. The three most important measures suggested are: spraying,- picking up drops, - running hogs or other fruit eating animals in the orchard. It would seem from the study of the feeding habits of this and other fruit-flies that they might be controlled by the use of a poison spray applied to the leaves and surfaces of the fruit in the ordinary way. The adult flies are known to sip dew from leaf and fruit surfaces and many may be killed by the application of arsenical sprays. Such sprays should be applied on the first appearance of the adult flies in order that the flies may be destroyed before the egg laying commences.

SPRAYING WITH ARSENICALS

In other states, fairly satisfactory control is said to have been obtained by the use of an arsenate of lead spray (¾lb. to 50 gal. of water) applied very lightly. Accordingly, attempts were made to control the fly with such a spray in the vicinity of Stockbridge, but with rather indifferent success.

In the Jones orchard (about 15 trees), the trees were sprayed with arsenate of lead (¾lb. to 50 gal. of water) and a single Grimes Golden located at a moderate distance from the others received a similar spray differing merely in that an excess of lime was added. These trees seemed to profit by the spray until late in the season. During the latter part of August, the minute tunnels of the maggots appeared quite plentifully in the fruit of the single tree of Grimes Golden. The sprays were put on every week beginning June 23rd until the Yellow Transparents began to ripen late in July. It would appear from these few tests that spraying alone produced little improvement.

In another orchard, that of Mr. Nichols, the trees were sprayed with arsenate of lead (¾lb. to 50 gal.) with the addition of kayso. This orchard was heavily infested in 1925 and did not show much

improvement in 1926 at which time Yellow Transparents and Baldwins were heavily infested.

In Mr. Steffie's orchard a number of sprays of arsenate of lead were applied and hogs were allowed the run of the orchard throughout the summer. In this orchard a very marked improvement was noted except in the case of a fall Pippin tree located in another field where no hogs were kept.

THE USE OF POISON BAITS APPLIED AS SPRAYS

Experiments in the use of poison baits applied as sprays have been made elsewhere, not only when used against the apple-maggot, but also against other fruit-flies having similar habits. The Olive fruit-fly has been studied in some detail and a bait made as follows, recommended by Berlese (1907):

65 parts molasses
31 " honey
2 " glycerine
2 " arsenate of soda.

Dr. Berlese reports having obtained excellent results from the use of this spray.

FERROUS SULPHATE

Cartright, in 1904, recommends having tried ferrous sulphate against the larvae and pupae of Trypeta capitata working on oranges. The material was sprinkled on the ground under the trees after which the ground was well watered. No reports as to the effectiveness of this treatment have been recorded.

THE DESTRUCTION OF "DROPS"

For many years, it has been believed that immediate destruction of all apples as soon as they drop to the ground would destroy the larvae therein and control the pest. This treatment should be started early in the season as soon as the first apples begin to drop, since it is known that the maggots leave the fruit very soon after the apples reach the ground. In one orchard in Michigan where the infestation was heavy during 1925, the apples were systematically picked up during that season and a general clean-up was practiced. In this orchard, the infestation of 1926 was markedly reduced.

Another method of accomplishing the same result consists of allowing hogs or sheep to run in the orchard during the summer months and depending on

these animals to clean up the fallen fruit as fast as it reaches the ground. Hogs are preferable to sheep because hogs do not browse and sheep are liable to injure the lower branches which may be within reach of the ground.

SUMMARY

The apple maggot, Rhagoletis pomonella, a native insect, was first described in 1868 by Walsh, from material received from Massachusetts, Connecticut and Long Island. The first record for Michigan was made by Dr. A. J. Cook in 1884 and its ravages were recorded for several years in that state after which time it is not often mentioned in published reports until 1924 when it again began to be the cause of serious losses in the apple crop. It is now distributed throughout Michigan as well as the north central and northeastern part of the United States as well as Canada. The adults emerge in Michigan during the first two weeks of July and remain at large depositing eggs in the fruit most of the summer. The infested apples fall to the ground and the larvae bury themselves to pupate. Some of these early individuals, at least some of those from early apples (Yellow Transparent and Early Harvest), pupate and emerge in September resulting in a partial second generation. The adults of this second generation oviposit in the late winter apples and the larvae work in these after the apples are placed in storage.

The adult is a small two-winged fly belonging to the family Trypetidae and to the genus Rhagoletis. There are also two very closely related species,

R. zephryia and R. symphoricarpi which occur in the western United States and Canada and which were once thought to be merely varieties of pomonella.

R. pomonella has been recorded from apples, haws, crabapples and blueberries, while similar maggots have been collected from plum, chokecherry and wild grapes, although no adults have been as yet bred from these later hosts.

Only two
No parasites apparently have been reared from this insect.

Recommendations for reducing the ravages of the insect are:

1. - Clean cultural methods of picking up and destroying all drops.
2. - Pasturing hogs and sheep in the orchard to clean up drops.
3. - Spraying with arsenate of lead (¾lb. to 50 gal. of water) immediately after the emergence of the flies.

BIBLIOGRAPHY

This bibliography contains only those references that make more than just a mere mention of the insect. Those marked with asterisk (*) have been seen by the writer.

1866 - Ward, C. - Pract. Ent., Vol.II, pp.20-21, Apple maggot reported in Vermont 1865.

*1867 - Glover, I. - Trypeta pomonella. Rept. Ent., Rept. U.S.D.A. 1867, pp. 72-73.

1867 - Trimble, P.T. - New York Semi-weekly Tribune. July 19, Maggot reported prevailing in Hudson River Valley.

*1867 - Walsh, B.D. - The Apple Worm and Apple Maggot. Amer. Jour. Hort. Vol.II, pp.338-343. Illus. This contains original description apple maggot and codling moth work carefully compared.

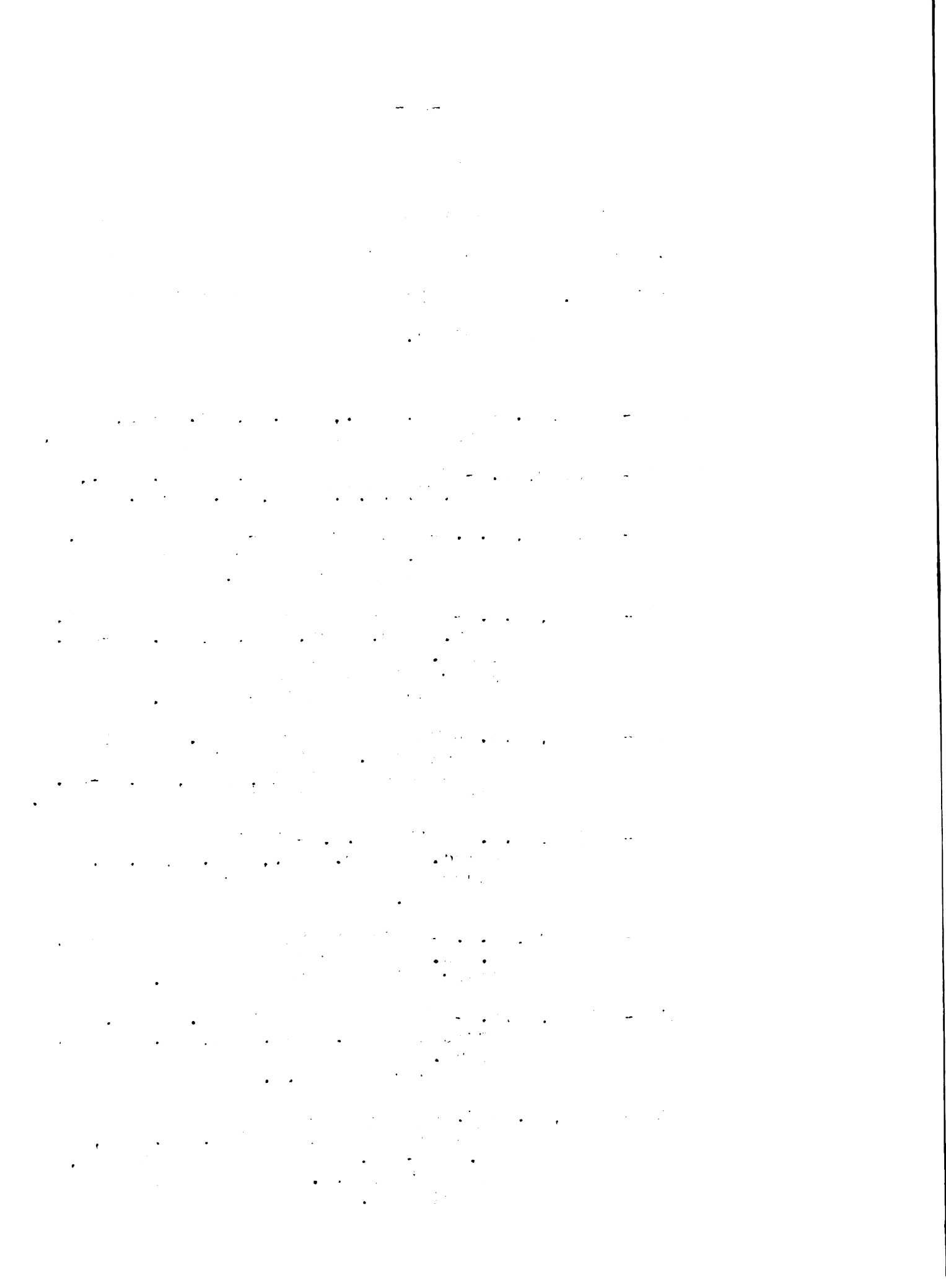
1868 - Walsh, B.D. - The Apple Maggot Fly. First Annual Rept. on the Noxious Insects of State of Illinois, 1868, pp.29-33. Gives notes on distribution and habits.

1868 - Walsh, B.D. & Riley C.V. - Noxious Insects Named. Amer. Ent., Vol. I, p.59. Records gradual westward spread in New York.

*1869 - Packard, A.S. - Guide to the Study of Insects. P.415. Reference to maggot as destructive to stored apples.

1872 - Riley, C.V. - The Apple Maggot Fly. Amer. Agriculturist. Vol.XXXI, pp.263-264. Illus. Remedies suggested also new record from N.H.

*1873 - Loew, H. - T. pomonella - Monograph of the Diptera of North America. Pt. III, pp. 265-268. Smithsonian Institute, Washington, D.C. Gives excellent description.



BIBLIOGRAPHY (Con't)

1874 - Glover, T. - Manuscript Notes From My Journal. Diptera, p.58, Pt. IX. Fig.4. Gives references to authorities on T. pomonella.

1876 - Riley, C.V. - Apple Maggot - New York Semi-weekly Tribune, Dec.15. Gives descriptions of larvae and adults, ravages, food plants, habits, control and bibliography.

*1878 - Osten Sacken, C.R. - Cat. Dept. N.A., 2nd. Ed., p.191, Smithsonian Institute, Washington. Considers Rhagoletis as a subgenus of old genus Trypeta.

1880 - Riley, C.V. - Amer. Ent., Vol.III, p.160. Notes regarding change in feeding habit, from haws to cultivated apples.

*1882 - Comstock, J.H. - The Apple Maggot - Rept. U.S. Comm. Agr. 1881-1882, p.195-198, Pt.1. A very good paper on discussion of importance compared with codling moth, also, description of larva, pupa and adult, also, control remedies. Use sweet varieties as traps and destroy drops.

1882 - Treat, M. - The Apple Maggot. Injurious Insects of the Farm and Garden. p.164, Illus.

1883 - Harlow, S.C. - Trans. Maine Pom. Soc., 1882, p.108. Gives list of Golden, Hightop Sweets, Danver's Winter Sweet, Gravenstein, Jenneting & Porter as varieties injured by apple maggot.

1883 - Lintner, J.A. - The Apple Maggot, Bul.LXXV, N.Y. (Geneva) Agr. Exp. Sta. General notes on life-history and distribution.

1883 - Anonymous - The Apple Maggot. 26th Rept. Maine Bd. Agr., 1882, p.409-412.

*1883 - Riley, C.V. - The Apple Maggot or Railroad Worm. Stoddart's Encyclopedia Americana. Vol.I, p.135. Description, habits and remedies.

1883 - Saunders, W. - The Apple Maggot - Insects injurious to fruits. pp.135-136, Illus. Description, habits, life-history.

BIBLIOGRAPHY (Con't)

1884 - Cook, A.J. - The Apple Maggot. Country Gentleman. Vol.49, p.857, Early records from Michigan.

1884 - Cutting, H.A. - The Apple Maggot. 8th. Rept. Vt. St. Bd. Agr. 1883-1884, pp.259-263, Illus. Reprint of Comstock's paper, 1881.

1884 - Gardiner, R.H. - 27th. Rept. Main Bd. Agr. 1883, p.332. Reports maggot very destructive in Tolman Sweets, Red Astracans and Mother apples, not found in other varieties.

1884 - Gilbert, Z.A. - 27th. Rept. Maine Bd. Agr., 1883, pp.363-364. Reports damage to tart apples, Benoni, as well as sweet.

1884 - McLellan, T.S. - 27th. Rept. Maine Bd. Agr., 1883, p.345. Reports new "worm" in Maine apples that had been prevalent five or six years. Mostly sweet apples. Harley, Hurlbut, Nodhead, Primate and Porter more or less infested.

1885 - Cook, A.J. - The Apple Maggot. Rural New Yorker, Vol.44, pp.86-87, Illus. Reports pest as doing damage in Michigan. Notes of life-history, figures from Comstock. Remedy, feed drops to stock.

* 1885 - Lintner, J.A. - The Apple Maggot. 2nd. Annual Rept. N.Y. St. Ent., p.117-124. Illus. General notes on life-history and distribution, reported from Ancona, Michigan as eating apples in January. Gives discussion also of insects having similar habits.

*1888 - Augur, P.M. - The Apple Maggot. Trans. Main St. Pom. Soc., pp.101-102. Reports serious trouble from pest. Some varieties completely ruined. States that after thorough arsenical spraying, pest practically disappeared.

1888 - Knowlton, D.H. - Trans. Maine St. Pom. Soc., pp.9-10. Advocates spraying with arsenate and feeding infested fruit to stock.

BIBLIOGRAPHY (Con't)

*1889 - Cook, A.J. - The Apple Maggot. 2nd. Annual Rept. Mich. Agr. Exp. Sta., pp.96-97. Remedy of feeding infested fruit to stock a success. Plums and cherries in northern Mich. said to show attacks from same insect.

1889 - Davis, G.C. - A New Departure by Apple Maggot. Ohio Farmer, November, p.291. Records of insect on plums and cherries in Michigan. Only larvae and pupae seen.

*1889 - Harvey, F.L. - The Apple Maggot. Bul.2, s.s. Maine Agr. Exp. Sta., pp. 1-5. Gives notes on life-history and control measures.

1889 - Perkins, G.H. - Trypeta pomonella, Walsh. 2nd. Annual Rept. Vt. Agr. Exp. Sta., 1888, p.135-138.

*1889 - Pope, C.S. - Trans. Maine St. Pom. Soc., p.26. Reports maggot as widespread and as working in sheltered places.

1889 - Williams, E. - Trypeta pomonella in New Jersey. Garden and Forest, Oct. 30, p.527. Reports it near Montclair, New Jersey in Jersey Sweets and Golden Sweeting, noticed about twelve years before.

*1890 - Harvey, F.L. - The Apple Maggot. Rept. Maine Agr. Exp. Sta., 1889, pp.190-241, pt. 1-10. A very extensive paper.

*1891 - Osborn, H. - The Apple Maggot. Bul.13, Iowa Agr. Exp. Sta., p.109-113, Illus. Many reports of damage done by this insect during past year. Thought pest was introduced from Missouri.

*1891 - Riley, C.V. - Prof. Harvey's Bulletin on Apple Maggot Insect Life, Vol.3, pp.253-255, Illus. Review of report in Maine Bul.

1891 - Weed, C.M. - The Insect Record for 1890. 9th. Annual Rept. Ohio Agr. Exp. Sta., pp. Insect reported doing damage in Delaware County, Ohio.

*1891 - Anonymous - Some of the Most Common Fungi and Insects, With Preventives. Bul.35 N.Y. (Geneva) Agr. Exp. Sta., p.623. Brief note

BIBLIOGRAPHY (Con't)

*1892 - Osborn, H. - Insects of the Season in Iowa. Bul. 26, Div. Ent. U.S. Dept. Agr., p.62. Reported common during 1890, but not in 1891.

*1892 - Saunders, W. - Insects Injurious to Fruits. Sec. Edition, pp.135-136. Illus. Gives brief description and habits.

1893 - Chambiss, C.E. - Some Injurious Insects of the Apple. Bul. Tenn. Agr. Exp. Sta., Vol.VI, No.1, p.26. Mentioned as injurious to apple.

1893 - Harvey, F.L. - Rept. Maine Agr. Exp. Sta., 1892, p.99. Records work of apple maggot on Vermont pears, also known to work on pears in Maine.

1893 - Osborn, H. - The Apple Maggot. Rept. Iowa St. Hort. Soc., 1892, pp.112-113, Illus. Occasional reports of damage by insect from various parts of Iowa.

1893 - Weed, C.M. - The Apple Maggot or Railroad Worm. 3rd. & 4th. Annual Rept. N.H. Agr. Exp. Sta., pp.254-255.

*1894 - Harvey, F.L. - Rept. Maine Agr. Exp. Sta., 1893, p.148. Brief note that insect is still doing much damage to apples in Maine and adjoining states.

*1894 - Howard, L.O. - The Apple Maggot in North Carolina. Insect Life, Vol.VII, p.279. Brief note of its presence in apples from Wagnesville, North Carolina.

1894 - Perkins, G.H. - The Apple Maggot. 7th. Annual Rept. Vt. Agr. Exp. Sta., 1893, pp.130-135.

1894 - Snow, W.A. - Descriptions of North American Trypetidae, with notes. Kansas University Quarterly, Vol.II, pp.159-174. 2nd. plate.

1896 - Gillette, C.P. - 9th. Annual Rept. Colo. Agr. Exp. Sta., 1896, p.145. The apple maggot taken at Colorado Springs, doubtless introduced from the east.

1896 - Harvey, F.L. - Rept. Maine Agr. Exp. Sta., 1895, pt.II, p.93.

BIBLIOGRAPHY (Con't)

*1896 - Perkins, G.H. - Apple Maggot. 9th. Annual Rept. Vt. Agr. Exp. Sta., 1895, p.118. Reports it as one of most troublesome pests in state.

1896 - Weed, C.M. - Bul.40, N.H. Agr. Exp. Sta., p.92. The flies continue to emerge all summer.

1896 - Willis, J.J. - Apple Maggot - Gardner's Chronicle, Ser.3, Vol.20, p.331.

*1896 - Williston, S.W. - Trypetidae. Manual of the Families and Genera of North American Diptera, Sec. Edition, p.119-123. Gives family characters.

*1897 - Fletcher, J. - Insects Injurious to Ontario Crops in 1896. 27th. Annual Rept. Ent. Soc. Ont., 1896, pp.65-67. First year apple maggot has appeared in Canada, at Adolphustorm, Ont.

1897 - Fletcher, J. - The Apple Maggot. Rept. of Entomologist and Botanist. Rept. Exp. Farms Can., 1896, pp.256-258. Illus. "The pupa state assumed only a few days before perfect insect appears." Gives brief history of distribution.

1897 - Harvey, F.L. - Notes on the Insects of the Year. 12th Rept. Maine Agr. Exp. Sta., 1896, p.120.

*1898 - Doane, R.W. - A new Trypetid of Economic Importance. Ent. News, Vol.9, pp.69-72. Gives tables for separating species of genus Rhagoletis. Refers to R. zephgria Snow, as being indistinguishable from R. pomonella Walsh, although description was from three females from California; only difference being in size.

1898 - Fletcher, J. - The Apple Maggot. Rept. of Entomologist and Botanist. Rept. Exp. Farms Can., 1897, p.201, Illus.

*1898 - Howard, L.O. - Danger of Importing Insects. Ybk. U.S.D.A., 1897, pp.529-552, Illus. Mexican orange fly and Mediterranean fruit-fly fully discussed. Brief mention of apple maggot on p.546.

BIBLIOGRAPHY (Con't)

1899 - Beach, S.A., Lowe, V.H. and Stewart, F.C. - Common Diseases of Insects Injurious to Fruits. Bul.170, N.Y. (Geneva) Agr. Exp. Sta., pp.395-396. Brief notes on habits and spread.

*1899 - Coquillet, D.W. - Notes on Trypetidae, with Description of new Species. Jour. N.Y. Ent. Soc., Vol.VII, pp.259-268. Gives synopsis of genera.

*1899 - Doane, R.W. - Notes on Trypetidae with Description of new Species. Jour. N.Y. Ent. Soc., Vol.VII, pp.177-193, 2 plates. Gives habitat as Mass., Colo., S.Dak., but not known to occur in Washington (state).

1899 - Fletcher, J. - Recent Additions to the List of Injurious Insects of Canada. Trans. Roy. Soc. Can., 2 ser., 1899-1900, Sec.IV, p.223. Brief notes on habits and distribution.

1899 - Froggatt, W.W. - Notes on Fruit-maggot Flies, with Descriptions of New Species. Agr. N. S. Wales, Vol.X, pp.497-504, 3 plates. Gives description of apple maggot at end.

1899 - Harvey, F.L. - Insects of the Year. 14th Rept. Maine Agr. Exp. Sta., 1898, p.127.

1900 - Card, F.W., and Adams, G.E. - 13th Rept. R.I. Agr. Exp. Sta., 1899-1900, pp.247-248.

1900 - Harvey, F.L. and Munson, W.M. - Apple Insects of Maine. 15th Rept. Maine Agr. Exp. Sta., 1899, pp.136-140, 1 plate.

1900 - Smith, J.B. - Rhagoletis pomonella. Insects of New Jersey, 1899, p.687. Injurious to apples around Montclair.

1901 - Card, F.W. and Adams, G.E. - 14th Rept. R.I. Agr. Exp. Sta., 1900-1901, p.227.

1901 - Fuller, C. - The Fruit-fly. 1st. Rept. Gov't. Ent., Natal Dept. Agr., pp.70-74, 1 plate. Paper concerns Ceratitis capitata says life-history is similar to R. pomonella.

BIBLIOGRAPHY

*1901 - Anonymous - The Codling Moth or Apple Maggot. Gardener's Chronicle, Ser. 3, Vol.XXIX, p.32. This paper confuses the apple maggot with codling moth, the latter is the one described.

*1902 - Banks, N. - Principal Insects Liable to be Distributed on Nursery Stock. Bul.XXXIV, n.s., Div. Ent. U.S.D.H., pp.44-45,Illus. Gives brief note on apple maggot, also R. cingulata (cherry fruit-fly).

1902 - Card, F.W. - Improving an Orchard. Bul.83, R.I. Agr. Exp. Sta., pp.149-151. Gives brief account of maggot.

1903 - Lochhead, W. - Insects of the Season. 33rd. Annual Rept. Ent. Soc. Ont., 1902, p.67.

1903 - Walsh, B.D. - The Apple Maggot Fly. 1st. Annual Rept. on Noxious Insects of the State of Illinois, 2nd. Edition, pp.36-42.

1903 - Washburn, F.L. - Apple Maggot. Bul.84, Minn. Agr. Exp. Sta., p.76.

1904 - Cartwright, W. - Notes on two Insects. Jour. Khediv. Agr. Soc. & School, Vol.6, pp.17-19. Larvae of Trypeta capitata found injuring oranges. Treat soil under tree with ferrous sulfate and then water.

1904 - Chittenden, F.H. - The Principal Injurious Insects of 1903. Ybk. U.S.D.A., 1903, pp. 563-566. Reports apple maggot unusually injurious in Ohio and New Hampshire, many apples on sale in D.C. from other regions found to be infested.

*1904 - Osborn, H. - Observations of Some of the Insects of the Season in Ohio. Bul.46, Bur. Ent., U.S.D.A., p.88. Records fruit infested by apple maggot in market at Columbus. May have come from outside localities. Professor Hire observed pest working in fruit in northwestern Ohio.

*1904 - Patch, E.M. - Apple Maggot and Other Insects. Bul.109, Maine Exp. Sta., pp.169-178, Illus.

BIBLIOGRAPHY (Con't)

1905 - Card, F.W. and Stene, A.E. - The Apple Maggot. 17th Rept. R.I. Agr. Exp. Sta., 1903-1904, pp.191-201.

1905 - Fletcher, J. - The Apple Maggot. Rept. of the Entomologist and Botanist. Rept. Exp. Farms Can., 1904, pp.238-239, Illus.

*1906 - Britton, W.E. - Apple Maggot Infesting Huckleberries. 5th Rept. St. Ent. Conn., 1905, p.260. Adult flies reared.

1906 - Card, F.W. & Blake, M.A. - Apple Maggot. 18th Rept. R.I. Agr. Exp. Sta., 1904-1905, p.197-198. Insects partially controlled by hogs in orchard. Thoroughly cultivated orchard had many injured apples.

1906 - Felt, E.P. - Apple Maggot. 21st Rept. N.Y. St. Ent., p.91. Very common and destructive pest of early apples. More abundant in sheltered hollows than on hillsides, probably affected by wind currents.

*1906 - Fletcher, James. The Apple Maggot. Rept. of the Entomologist and Botanist. Rept. Exp. Farms Can., 1905, pp.184-185. Outbreak at Como, Quebec, in 1903-04 has since spread to many orchards. Crabapples badly infested. This fruit, however, does not fall from the tree.

*1906 - Fuller, C. - Cold Storage as a Factor in the Spread of Insect Pests. Natal Agricultural Journal and Mining Record. Vol.IX, p.656. The fruit-fly maggots may remain alive in peaches kept at a temperature of 39°-40° Fah. for a period of 124 days.

1906 - Lounsbury, C.P. - Natural Enemies of Injurious Insects. Rept. Gov't. Ent., Cape of Good Hope Dept. Agr., 1905, pp.98-99. Reports expedition to Bahia, Brazil, to investigate natural enemies of fruit-flies. No parasites were obtained.

BIBLIOGRAPHY (Con't)

*1906 - Patch, E.M. - Insect Notes for 1906. Bul.134, Maine Agr. Exp. Sta., pp.221-222. Apple maggot clearly defined to avoid its confusion with codling moth.

1907 - Berlese, A. - The History of Certain Pest of the Olive. Redia, Vol.IV, p.180, 3 plates. Illus. Account of combating olive fly. Excellent results obtained using 65 pt. molasses, 31 pt. honey, 2 pt. glycerine, 2 pt. arsenate of soda.

1907 - Bethune, C.J.S. - Insects Affecting Fruit Trees. Bul. 158, Ont. Dept. Agr. Apple maggot may be destroyed by pigs or sheep in orchards, picking up drops.

*1907 - Fletcher, J. - Apple Maggot. Evidences of the Botanist Before the Select Standing Committee on Agriculture and Colonization, 1906-1907, pp.134-135, Owatta, Can., 1907. Reports apple maggot had done more harm the past year than any other time. Found in Quebec, New Brunswick and Ontario. First appeared in Canada in 1878 in Bay of Quinte district.

*1907 - Fletcher, J. - The Apple Maggot. Rept. of Entomologist and Botanist. Rept. Exp. Farms Can., 1906, p.219. Insect becoming more abundant and infesting new localities. Severe outbreak recorded at Woodstock, New Brunswick.

*1907 - Hood, C.E. - The Apple Maggot or Railroad Worm. Circ. 3, Mass. Agr. Exp. Sta., Illus. Gives distribution as Maine to North Carolina and west to Minnesota and Wisconsin.

1907 - Quinn, G. - Fruit Maggot Fly Pests. Jour. Dept. Agr. So. Austr., Vol.X, pp. 701-710, Illus. Brief mention of habits of apple maggot. A poison bait used in Italy gives fairly good results. "Kerosene appears to attract flies and may be used to trap them."

BIBLIOGRAPHY (Con't)

*1907 - Sanderson, E.D. - Rept. of Dept. of Ent., Bul.129, N.H. Agr. Exp. Sta., p.264. States that apple maggot almost equals codling moth, thus making apple production nearly impossible in some regions.

1907 - Slingerland, M.V. - The More Urgent Problems of Insect Control Bul.196, Office Exp. Sta., U.S.D.A., pp.104-109. Says real research can be done on a study of life history and remedial measures of apple maggot.

1908 - Card, F.W. - 20th Rept. R.I. Exp. Sta., 1906-1907, pp.211-212. Many maggots found in Early Harvest apples even though hogs had run orchard previous year.

1908 - Felt, E.P. - Apple Maggot or Railroad Worm. 23rd Rept. St. Ent., 1907, Bul.124, Sta. Museum. Pest seems to be becoming more apparent each year, particularly in sweet apples. Presence of maggots hastens ripening.

1908 - Froggatt, W.W. - Progress Rept. Agr. Gay, N.S.Wales, Vol.XIX, p.663-672. Berlese used sweetened bait with good success, but was found to be expensive and washed off. New trying jars with bundles of cotton threads trailing down and thus serve as resting place for flies. Mixture as follows:

40 parts molasses
40 " honey
18 " water
2 " arsenic

*1908 - Garman, H. - Other Insects Attacking Apples. Ky. Agr. Exp. Sta., p.62. Maggot not found in Kentucky except in fruit on market.

1908 - Quaintance, A.L. - The Apple Maggot or Railroad Worm. Circ. 101, Bur. Ent., U.S.D.A. Given as one of chief insect enemies of apple. A native American species. Natural food, Crataegus. Spread is slow. One generation annually. New locality, Dyberry, Pa.

BIBLIOGRAPHY (Con't)

1908 - Stene, A.E. - The Apple Maggot. Rept. R.I. St. Nursery Inspector, pp.30-31, Illus.

*1908 - Williston, S.W. - Manual of North American Diptera, 3rd. Edition. pp.282-287, Illus. Brief description of family Trypetidae, with key to genera.

1909 - Aldrich, J.M. - The Fruit Infesting Forms of the Dipterous Genus Rhagoletis, with one new species. Can. Ent., Vol.41, pp.69-73. Illus. Notes on distinguishing characteristics of genus. Table of species and plate showing wing characters. He agrees with Doane (1898) that R. zephyria, Snow, is indistinguishable from R.pomonella, Walsh. Aldrich cites records of specimens collected in Colorado.

*1909 - Bethune, C.J.S. - The Apple Maggot. 34th Annual Rept. Ont. Agr. Col. and Exp. Farm, 1908, p.31. Pest doing considerable damage in Prince Edward County.

1909 - Froggatt, W.E. - New South Wales Rept. on Parasitic and Injurious Insects. 1907-1908. Sydney, N.S.Wales.
This reports various fruit-flies investigated during trip around the world. Brief description of R. pomonella on p.74. Irrigation destructive to fruit-flies when ground is flooded around trees. Discovered in 1907 that dish of kerosene placed in orchard was very attractive to Mediterranean fruit-fly. Thousands being collected in a few days. General account of family Trypetidae, p.77. Gives destructive genera:- 1) Dacus, 2) Ceratitis, 3) Trypeta, 4) Carpomyia, 5) Anastrepha, 6) Rhagoletis, p.114. Description of apple maggot.

*1909 - Froggatt, W.W. - Fruit-flies. Farmers Bul.24, N.S.Wales, Dept. Agr., Illus.
Summary given of various fruit-flies of family Trypetidae. Grief account and description of apple maggot. pp.4,5,55&56.

1909 - Anonymous - The Mally Fruit-fly Remedy. Agr. Jour. Cape Good Hope, Vol.34, pp.578-581, 1 col. pl.
Sugar or cheap molasses 25 pounds.
Paste arsenate of lead 2 pounds
Water 40 gallons
1 pint applied with hand sprayer to each tree.

BIBLIOGRAPHY (Con't)

*1910 - O'Kane, W.C. - The Apple Maggot. Bul.151, N.H. Agr. Exp. Sta., pp.42-44.
95% apple orchards of state infested. Only one or two varieties seem immune. 71 varieties investigated. Baldwins badly infested, gathered during October, failed to mature a single maggot.

*1910 - Patch, E.M. & Johannsen, O.A. - Apple Tree Insects of Maine. Maine Agr. Exp. Sta., pp.49-51, Illus. Notes on life-history of apple maggot, methods of control by feeding drops to hogs. "No use to try to destroy pest by spraying."

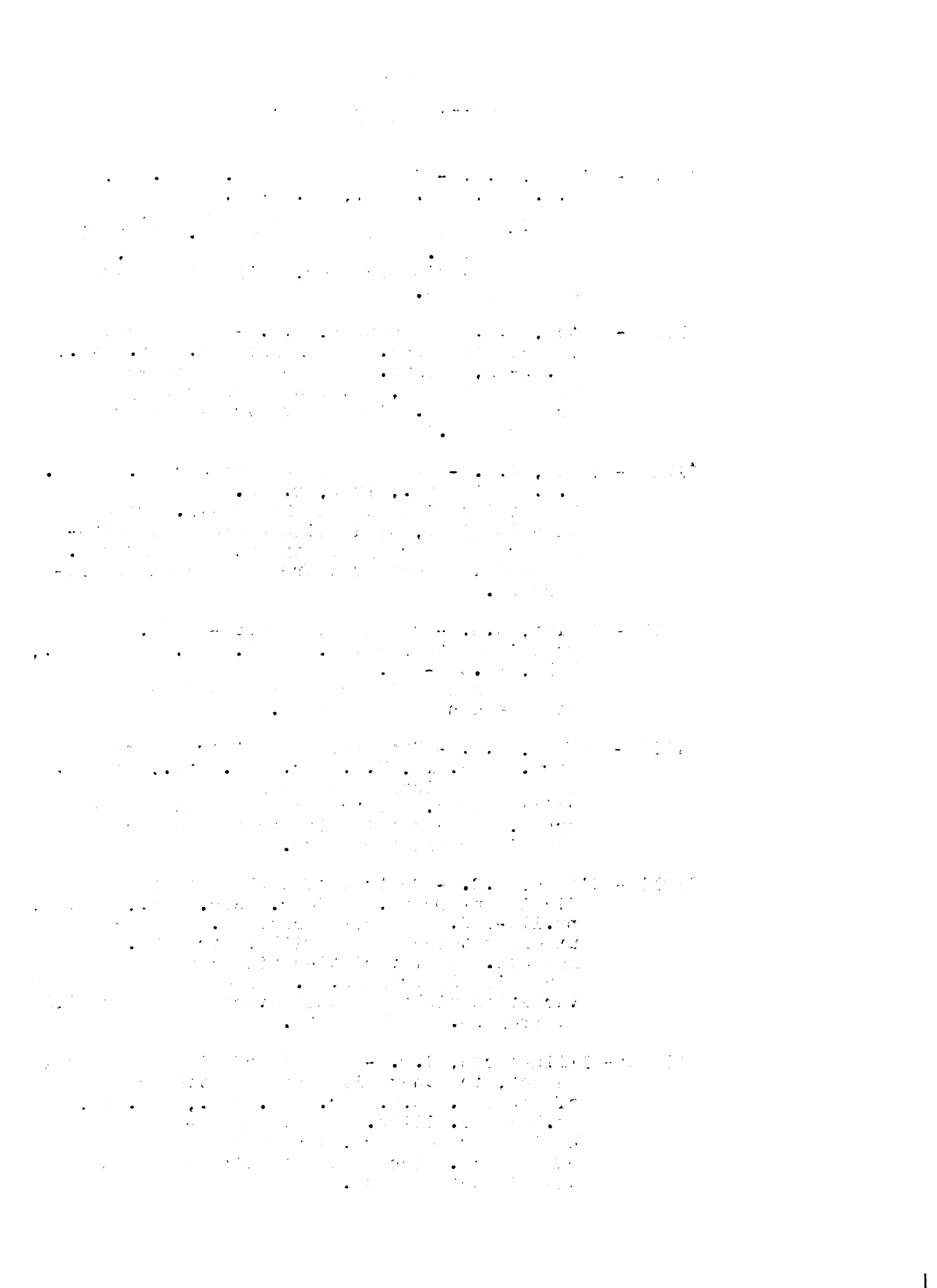
*1910 - Smith, J.B. - The Insects of New Jersey. Rept. N.J. State Mus., 1909, p.802,
Maggot injurious around Montclair. Found also in light, sandy pine barrens of south-eastern New Jersey at Weymouth and DaCosta. These flies were bred from larvae on huckle-berries.

1911 - Hewitt, C.G. - The Apple Maggot - Rept. of Dominion Entomologist. Rept. Exp. Farms Can., 1910, pp.238-240.
Maggots killed if fruit is kept in cold storage a number of weeks.

1911 - O'Kane, W.C. - The Apple Maggot or Railroad Worm. Cir. 14, N.H. Agr. Exp. Sta., Illus.
Cannot be poisoned by sprays as used for codling moth. Control pest by picking up drops. Some possibility that some worms stay in ground two years.

*1911 - O'Kane, W.C. - Control of Apple Maggot by Picking up Drops. Jour. Econ. Ent., Vol.VI, pp.173-179. Early varieties. By picking up drops twice a week will destroy 97.6% of maggots. Fall varieties picked up once a week will destroy 99.6%. Late fall and winter varieties picked up once every two weeks will destroy 98.2% of maggots.

*1912 - Illingworth, J.F. - A Study of Biology of Apple Maggot, together with investigation of methods of control. C.U. Agr. Exp. Sta., Bul.324, pp.127-288. Illus. Gives life-history and habits for New York, also much work on biology of species. The most extensive work done on this insect to date.



BIBLIOGRAPHY (Con't)

1912 - Caesar, L. - Ont. Ent. Soc. Rept. 42, p.29.

1912 - Crendall, - Ill. Hort. Soc. for 1911, p.343.

1912 - Gibson, A. - Can. Horticulturalist. Vol.XXXV, p.254.

1912 - Lamson, - Conn. Exp. Sta., Bul.71, p.70

1912 - O'Kane, W.C. - New Hampshire Exp. Sta., Bul.163, p.30

1912 - Sanderson, E.D. - Insect Pests of Orchard, Farm and Garden. p.632, Illus.
Gives brief account of maggot and injuries and methods of control.

1912 - Swaine, J.M. - Ont. Ent. Soc. R. 42, p.72.

*1913 - Schoene, W.Y. & Fulton, B.B. - Apple Insects. New York (Geneva) Exp. Sta., Circ.25, pp.11, 11 fig., 4 plates.

*1913 - Ross, W.A. - Recent Work on Apple Maggot in Ontario. Annual Rept. Ent. Soc. Ont., pp.67-72.
A brief account of work accomplished on apple maggot during recent years.

*1914 - Stewart, J.P. - The Apple In Pennsylvania,- Varieties, Planting and General Care. Pa. State Agr. Exp. Sta., Bul.#128, 27 pp. 10 fig.

1914 - Anonymous - Reports on Insects of Year 1913 in Ontario. Annual Rept. Ent. Soc. Ont.1913, XLIV, pp.15-25.
Says that apple maggot was scarce during year.

1914 - Du Porte, E.M. - Insects of 1913. 6th Annual Rept. Quebec Soc., Prot. Plants from Insects and Fungi Dis. 1913-14, pp.38-43.
Mentions the fact that apple maggot continues to be a pest.

BIBLIOGRAPHY (Con't)

*1914 - Severin, H.P., Severin, H.C. & Hartung, W.Y. - The Ravages, Life-history, Weights of Stages, Natural Enemies and Methods of Control of the Melar Fly. Annual Ent. Soc. America, Vol.VII, #3, pp.178-207, 6 plates, 4 figures.
Mentions apple maggot was also used in testing effectiveness of poison bait spray.

1914 - Severin, H.H. - A Review of the Work on the Poisoned Bait Spray, Dry Method and Mixed Treatment of Controlling Fruit-flies, (Trypetidae). Canadian Entomologist, Vol.46, No.7,8,& 9.
Says O'Kane used mixture of arsenic, molasses and water to control apple maggot in N.H.,- Results were mostly negative. Gives detail description of Illingworth preventing oviposition of some insect by using same mixture in New York.

1914 - Hewitt, C.G. - Rept. for Div. of Entomology for fiscal year ending 31st. March, 1913. Dominion of Canada Dept. Agr., pp.501-508.
First infestation of apple maggot observed at Smith's Cove, N.S., appeared to be localized and infestation was light.

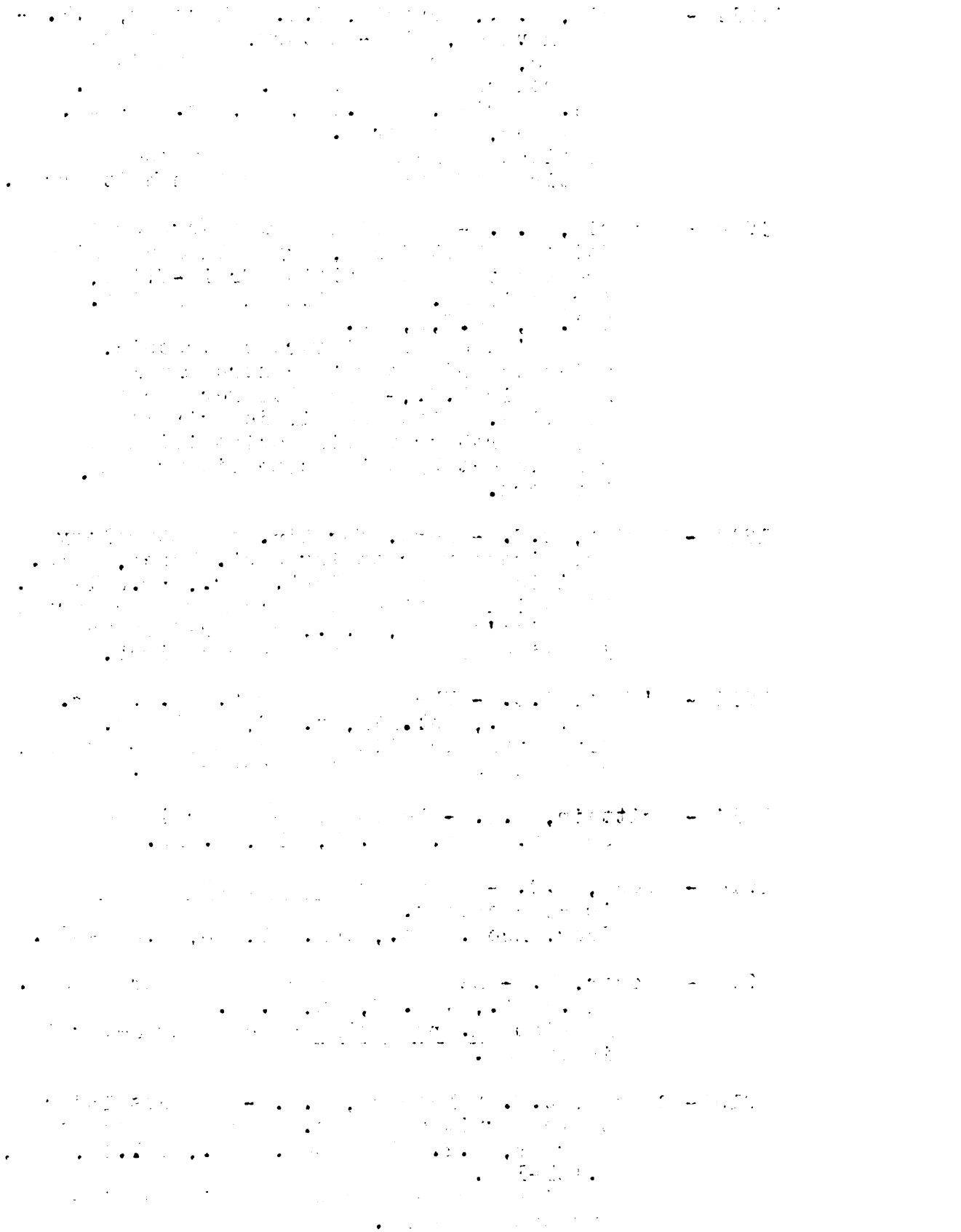
1914 - O'Kane, W.C. - The Apple Maggot. N.H. Agr. Exp. Sta., Bul.171, p.120, 8 plates.
Gives very detailed notes on life-history, control measures and distribution.

1914 - Brittain, W.H. - Pests of the Year in Nova Scotia. Agr. Can. I, #10, p.819.

1914 - Woods, W.C. - A Note on Rhagoletis pomonella in Blueberries.
Jour. Econ. Ent., Vol.VII, #5, p.398-400.

1915 - Caesar, L. - Deformed Apples and Their Causes. Can. Ent., Vol.47, #2, p.49.
Mentions R. pomonella as causing deformity in apples.

1915 - Crosby, C.R. & Leonard, M.D. - Insects Injurious to the Fruit of Apple. Cornell Reading Courses, N.Y. State Col. Agr., Vol.IV, #84, p.121-144.
Mentions apple maggot as an insect injurious to apple.



BIBLIOGRAPHY (Con't)

1915 - Sanders, G.E. - Some of the Benefits From Spraying with Arsenates in the Apple Orchards of Nova Scotia. Can. Ent., Vol.47, #5, p.137.

1915 - Anonymous - Rept. on Insects of the Year. 45th. Annual Rept. Ent. Soc. Ont., 1914, pp. 13-28. Mentions fact that apple maggot was recorded as an orchard pest that year.

1915 - Petch, C.E. - Insects Injurious in Southern Quebec in 1914. 45th Annual Rept. Ent. Soc. Ont. for 1914, p.70. Mentions presence of insect.

1915 - Saunders, G.E. - Spraying with Arsenates in Nova Scotia. Can. Horticulturalist, Vol.38, #7, pp.169-170. Mentions sprays used for apple maggot.

1915 - Parrot, P.T. - Insects Affecting Production and Grading of Fruit. Proc. 60th. Annual Meeting of Western N.Y. Hort. Soc., PP.1-10.

*1915 - Wood, W.C. - Biosteres rhagoletis, Richmond sp. n., a Parasite of Rhagoletis pomonella, Walsh - Can. Ent., London, Ont., SLVII, #9, pp.293-295, plate. Reared from puparia of R. pomonella. Obtained from wild crab or cultivated apples in Orono.

1915 - Caesar, L. - Poison Sprays & Poison Baits in Their Relation to Bees. Can. Hort., Peterboro, Ont., Vol.XXIII, #12, pp.275-278, 1 fig.

1915 - Hewitt, C.G. - Rept. for Division of Ent. for the year Ending March 31st, 1914. Dom. of Can., Dept. of Agr. Dom. Exp. Farms, Ottawa, pp.851-876.

1915 - Franklin, H.J. & Morse, J.W. - Rept. on Experimental Work in Connection with Cranberries. Mass. Agr. Exp. Sta., Amherst, Bul.150, pp.37-68, 10 tables. A small Trypetia was reared from cranberries, identified as a small variety of apple maggot.

BIBLIOGRAPHY (Con't)

1916 - Anonymous - Entomological Features of 1915. Rept. Conn. Agr. Exp. Sta., 1915, pp.181-183. Apple maggots infested early ripening varieties of maggots.

1916 - Woods, W.C. - Blueberries in Maine. Maine Agr. Exp. Sta., Orono, Bul.244, pp.249-288, 3 figs. 4 plates.

1916 - Parrott, P.J. - Injurious Insects, Old & New. Proc. 61st. Annual Meeting, Western N.Y. Hort. Soc., 10 pp. 2 plates.

*1916 - Good, C.A. - A Few Observations on the Apple Maggot Parasite. Can. Ent., London, Ont. Vol.XLVIII, #5.
This parasite probably causes high mortality among larvae and pupae of apple maggot. Account is given of method of oviposition of Biosteres rhagoletis.

1916 - Good, C.A. - Apple Maggot in Nova Scotia. Proc. Ent. Soc., Nova Scotia, #1, pp.54-69, 5 figures.

1916 - Felt, E.P. - 31st. Rept. of State Ent. on Injurious and Other Insects of State of N.Y. 1915. N.Y. State Mus. Bul., Albany, #186, pp.55-88, 13 plates, 22 tables.

1916 - Petch, C.E. - Controlling Apple Insects in Orchards of Quebec. Agr. Gaz. Canada, Ottawa, Vol.III, #8, pp.697-698.
During year, experiments are being carried out on the biology and control of apple maggot.

1916 - DuPorte, E.M. - Insect Notes 1915. 8th. Ann. Rept. Quebec Soc. for the Protection of Plants from Insects and Fungus Diseases, 1915-16, pp.73-77, 1 plate.

*1917 - Hewitt, C.G. - Insect Behavior as a Factor. Applied Ent., Jour. Econ. Ent., Concord, N.H., Vol.X, #1, pp.81-94.
A form of Rhagoletis pomonella infesting vaccinium (blueberries) and Gaylussacia-baccata (huckleberries) is below the normal size and appears to be long established, while the large apple bred race refuses to oviposit on blueberry and vice versa.

BIBLIOGRAPHY (Con't)

1917 - Treherne, R.C. - Insects Affecting Agriculturists in B.C. During the Past Year., Agr. Jour., Victoria, B.C., Vol.I, #10, Dec. 1916,p.168

1917 - Brittain, W.H. - The Apple Maggot in Nova Scotia. Can. Hort, Toronto, Vol.XL, #1, Jan.1917, pp.3-4.
This popular account of apple maggot contains no information which has not been previously abstracted.

*1917 - Severin, H.H.P. - Soluble Poisons in Poisoned Bait Spray to Control the Adult of Apple Maggot. Maine Agr. Exp. Sta., Orono, Bul. 251, Apr. 1916, pp.149-168.

*1917 - Brittain, W.H. & Good, C.A. - The Apple Maggot in Nova Scotia. Nova Scotia Dept. Agr. Truro, N.S., Bul.9, Jan., 1917, 10 pp. 6 plates, 1 fig.
Continuation and extension of work on apple maggot.

1917 - Headlee, T.H. - Rept. of Entomologist. Rept. N.J. Agr. Col. Exp. Sta., 1915. New Brunswick, 1916, pp.306-335.
Apple maggots were unusually scarce.

1917 - Hewitt, C.G. - Rept. of Dom. Ent. of Quebec. Year ending Mar.31, 1916. Control methods and investigations were continued on apple maggot.

1917 - Parrott, P.J. - Insects That Factor in Grading of Apples. Address to Western New York Hort. Soc. Geneva, N.Y. Jan.24,1917,10pp.
Mentions apple maggot.

1917 - Brittain, W.H. - The Nova Scotia Division of Entomology. Proc. Soc. Nova Scotia for 1916, Truro, #2, Jan.1917, pp.15-17.
Lab. is in center of apple maggot infestation.

*1917 - Treherne, R.C. - Apple Maggot in British Columbia. Can. Ent. London, Ont., Vol.XLIX, #10, Oct.1917, pp.329-330.
First examples taken in B.C. Five specimens of this species collected in southern California, 1894, described as R. zephrina, since not found in Ca. but observed in Colorado and eastern border of state of Washington.

BIBLIOGRAPHY (Con't)

*1918 - Treherne, R.C. - The Natural Immunity of Resistance of Plants to Insect Attack. Agr. Gaz. Can., Ottawa, Vol.IV, No.10, Oct.1917, pp. 855-859.
Rhagoletis pomonella infects the sweet and sub acid summer varieties in preference to acid autumn and winter sorts.

1918 - Hewitt, C.G. - Rept. of the Dominion Entomologist for the Year Ending 31st of March,1917. Dom. of Can. Dept. of Agr., Ottawa 1917, 24pp.
Rhagoletis pomonella has been recorded for B.C. (See this Review, Ser. A, V, p.581)

1918 - Department of Entomology - 43rd Annual Rept. (1917) Ont. Agr. College. Toronto, 1918, pp.18-24.
Apple maggot can be controlled by spraying with lead arsenate when the adults begin to appear and again two weeks later.

1918 - Severin, H.H. - Oils Tested to Trap Trypetidae and Ortalidae. Monthly Bul,, Cal. State Com. Hort., Sacremento, Vol.VII, No.6, June, 1918, pp.419-423, 2 fig.
Rhagoletis pomonella used oil of citronella and kerosene, but it was found that the exposure of crude petroleum in shallow pans for the purpose of repelling ovipositing females, resulted in their capture. Then it tells of exhaustive experiments.

*1918 - Felt, E.P. - Injurious and Other Insects of the State of New York, 1916. 32nd. Rept. of State Entomologist. N.Y. State Museum Bul., Albany, N.Y., No.198, June 1,1917, 276 pp. 8 plates 54 figures.
Deals with more important insect pests as Rhagoletis pomonella.

1918 - Dudley, J.H. & Eaton, S.H. - The Apple, Tree and Fruit. Maine Dept. Agr. Quarterly Bul., Augusta, Maine. Vol.XVI, No.2, June 1917, 48 pp., 14 fig., 5 plates.
It is noted that one of the insects that cannot be reached by such sprays is apple maggot. To exterminate this pest, fallen apples should be picked up, and destroyed, sheep or pigs should be pastured and then a spray is given.

BIBLIOGRAPHY (Con't)

1919 - Ross, W.A. - Rept. on Insects for Year. Division No.7, Niagara District. 48th Ann. Rept. Ent. Soc., Ont., 1917, Toronto,1918, pp.29-30.
Fruit pests numerous and injurious including apple maggot.

1919 - Felt, E.P. - Injurious and Other Insects of State Ent., N.Y. State Museum Bul., Albany, N.Y., No.202, 1918, 240 pp. 12 plates, 82 figures.

1919 - Knight, H.H. - An Investigation of the Scarring of Fruit Caused by Apple Redbugs. Cornell Uni. Agr. Exp. Sta., Ithaca, N.Y. Bul.396, Feb.1918, pp.187-208, 37 figures.
Injuries inflicted by adult Lygidea mendax (June 22).
May resemble the work of apple maggot flies.

*1919 - Brittain, W.H. - Miscellaneous Notes on the Apple Maggot. Proc. Ent. Soc. Nova Scotia, 1917, Truro, No.3, January 1918, pp.37-41.
Table gives record of emergence of adults of apple maggot in 1917 for outdoor cages. It was observed that 30% of the entire emergence took place in second year, a habit that would enable insect to live thru a total failure of its food plants for one year. Oviposition may take place in as short a time as four days after emergence. Percentage of fertility of eggs varies greatly with variety of host, and the season. The tests of previous year regarding the effect upon the pupae (Review Ser. A, Vol.IV, p.370 & Vol.V, p.269) were completed, and confirmed the opinion that this method of dealing with the pest is unsatisfactory.

BIBLIOGRAPHY (Con't)

*1919 - Downes, W. - The Apple Maggot in British Columbia, Can. Ent., London, Ont., Vol.LI, No.1, Jan.1919, pp. 2-4. Rhagoletis pomonella. Three only authentic records on west coast of British Columbia, taken in city of Victoria and all over the Saanich Penninsula wherever its food plant, Symphoricarpus racemosus (Snowberry) grows. Berries attacked by the fly do not drop to the ground, and the larvae remain on the fruit until the last vestige of pulp has been eaten. Later they bore through the shrunken skin, pupate among the dead leaves and below the bushes. The fly prefers bushes growing on high and dry spots, stunted bushes on hillsides generally having the heaviest infestation. The variety in question is evidently an example of a biological race, similar to, and perhaps identical with that infesting the blueberry. It is very abundant in Province, but is heavily parasitized by a new species of Opius.

1919 - Caesar, L. & Ross, W.A. - Control of the Apple Maggot.
Can. Horticulturist, Toronto, Vol.XLII, No.2, Feb.1919, pp.27-28.

1919 - Brittain, W.H. - Further Notes on Apple Maggot, 1918, Rhagoletis pomonella, Walsh. Proc. Ent. Soc. Nova Scotia. Tells of emergence of adults.

*1919 - Anonymous - Insects of the Season.
44th. Annual Rept., 1918, Ont. Agr. College, Toronto, 1919, pp.15-18. Experiments have shown that for the control of Rhagoletis pomonella, the gathering and destruction of fallen fruit is not the only remedy, but that at proper times, will completely control this fly and in a couple of years almost annihilate it. A bulletin on this insect is being prepared. Also speaks of effectiveness of Bordeaux mixture and lead arsenate as good results as lime sulphur and lead arsenate - as far as dropping of fruit is concerned, and indicated that calcium arsenate may be substituted for lead arsenate with lime sulphur and is much

BIBLIOGRAPHY (Con't)

cheaper, but cannot be used above owing to injury to foliage. The results with dust sprays were again almost as good as those from liquid sprays, though in some orchards examined, the liquid spray produced much cleaner fruit.

*1919 - Caesar, L. & Ross, W.A. - The Apple Maggot. Ent. Dept. Agr. Toronto, Bul.271, May, 1919, 32 pp., 17 figs.
Bulk of information in this bulletin has been noticed elsewhere.

1919 - Blackmore, E.H. - Ent. Rept. British Columbia, Provincial Museum National History, 1918, Victoria, Mar. 7, 1919, 6-T.13, 2 plates.
Apple maggot has been found, but so far, no evidence of attacking the apple.
British Columbia Dominion plant being the common Snowberry, Symphoricarpus racemosus.

*1920 - Gahan, A.B. - U.S. Bur. Ent. Descriptions of seven new species of Opius.
Proc. Ent. Soc., Washington, D.C. Vol.XXI, No.7, Oct.1919, pp.161-170.
Opius downesi, from pupae of Rhagoletis pomonella, Opius richmondi and Opius lectus, swept five blueberry varieties where they occur in company with Opius melleus, Gahan, and may have same host, viz. Rhagoletis pomonella.

1920 - Cole, F.R. - Notes on the Lunate Onion Fly, Eumerus strigatus (Dip., Syrphidoe).
Ent. News, Philadelphia, Vol.XXI, No.2, Feb.1920, pp.31-35, 1 fig.
There may be biological races of this fly, as in the case of apple maggot. Adult is described and figured.

1920 - Grittain, W.H. - General Results in Spraying and Dusting.
56th. Annual Rept. Nova Scotia. Fruit Growers' Association, Kingston, 1920, pp. 68-82.
Tells about quantity of lead arsenate.

*1920 - Sanders, G.E. - Apple Spraying. 18th Annual Rept. Maine Commission Agriculture. Augusta, 1919, pp.199-209.
Apple maggot also called "railroad worm."

BIBLIOGRAPHY (Con't)

*1921 - Herrick, G.W. - The Apple Maggot in New York. Cornell University, Agr. Exp. Sta., Ithaca, New York. Bul.402, March, 1920, pp.89-101, 7 figures.

*1921 - Herrick, G.W. - Some Orchard Pests of Past Seasons. Proc. 2nd. Ann. Meeting of Hort. Soc., 1919, pp.15-24, 21 figures.

*1921 - Herrick, G.W. - Field Experiments for Control of Apple Maggot. Jour. Econ. Ent. Concord, N.H., Vol.XIII, No.5, Oct. 1920, pp.384-388.

1921 - Hewitt, C.G. - Rept. of the Dom. Ent. and Consulting Zoologist for the two years ending March 31, 1919. Canada Dept. Agr., Ottawa, 1920, 23pp. 1 figure. Speaks of insects affecting fruit crops including Rhagoletis pomonella.

*1921 - Parrott, P.J. - Seasonable Facts of Special Interest in Orchard Spraying. Proc. 1st. Ann. Meeting New York Horticultural Society, 1919, pp.51-63.

*1921 - Parrott, P.J. - The Apple Maggot. Proc. 1st. Ann. Meeting New York Hort. Soc., 1919, pp.222-224, 3 figures. Account of injury to apples in Hudson River Valley which is particularly injurious in neglected orchards.

1921 - Porter, B.A. & Alden, C.H. - Anaphordea conotracheli, Girault (Hym), an Egg Parasite of the Apple Maggot. Proc. Ent. Soc. Wash. D.C., Vol.XXIII, No.3, March 1921, pp.62-63.

1921 - Fulton, B.B. - Insect Injuries in Relation to Apple Grading. N.Y. Agr. Exp. Sta. (Geneva). Bul.475, May 1920, 42pp., 4 plates, 2 charts, 17 figures. Insects dealt with include apple maggot.

*1921 - Ruggles, A.G. - Rept. of State Ent. for Year Ending Dec.1, 1920. 18th Rept. Minnesota State Ent. Agr. Exp. Sta., University Farm. St.Paul, 18, June, 1921, pp.3-12. Usual insect pests were more or less troublesome during the year. Those recorded for first time from Minnesota as causing

BIBLIOGRAPHY (Con't)

serious injury are Rhagoletis pomonella which occurred practically over the whole of the southern half of the state, on the common varieties of apple Crataegus and the Wolfberry Symphiocarpus occidentalis.

*1921 - Anonymous - The Destructive Insects and Pests of Order of 1920. Statutory Rules and Orders, 1921, No.931, H.M. Stationery Office, London, 31st.May, 1921, 5 pp. This order required adoption of certain remedial measures within prescribed time should any of following pests be found among the Rhagoletis pomonella.

1922 - Britton, W.E. - 21st. Rept. of the State Entomologist of Connecticut for 1921. Conn. Agr. Exp. Sta., New Haven, Bul.234, 1922, pp.115-188, 7 plates, 5 figures. Insects recorded during year. Rhagoletis pomonella among them.

1922 - Britton, W.E. & Zappe, M.P. & Stoddard, E.M. - Experiments in Dusting Versus Spraying on Apples and Peaches in Connecticut, 1921. Conn. Agr. Exp. Sta., New Haven, Bul.235, Feb. 1922, pp.209-226, 6 plates, 3 figures.

1922 - Caesar, L. & Ross, W. A. - Insects of the Season in Ontario.
51st. Annual Rept. Ent. Soc., Ontario,1920, Toronto, 1921, pp.35-43, 3 figures. Rhagoletis pomonella reported in two counties not previously infested.

1923 - Petch, C.E. - Spraying Vs. Dusting. 13th Annual Rept. Quebec Soc. Prot. Plants, 1920-21, pp.68-72, Quebec, 1921. Advantages of dusting discussed and more effective than spraying against apple maggot.

1923 - Severin, H.C. - 13th Annual Rept. of State Entomologist of South Dakota for Period Ending June 30, 1922, 67 pp., 26 figures. Brookings, S.D. (n.d.).
List given of most harmful insect pests, including Rhagoletis pomonella.

BIBLIOGRAPHY (Con't)

1923 - Anonymous - Fruit-fly Menace to America. Jour. Dept. Agr. Union S.Africa, Vol.VI, No.5, pp.413-420. Pretoria May, 1923.
Should S.Africa fruit be forbidden entry, it is possible that S.Africa fruit growers would on their side refuse admission to America, apples, pears, owing to danger of introducing the apple fruit maggot, (Rhagoletis pomonella), apple seed chalcid and other insects.

*1923 - Britton, W.E. - 22nd. Rept. of State Entomologist for 1922. Conn. Agr. Exp. Sta. Bul. 247, pp.269-381, 16 plates, 11 figures. New Haven, Conn., 1923.
Lists pests, among them Rhagoletis pomonella.

1923 - Riley, W.A. & others - Division of Entomology & Economic Zoology. 30th. Annual Rept. Minn. Agr. Exp. Sta., 1921-22, pp.68-73. University Farm. St.Paul, Minn., 1922.
Says apple maggot has become a serious problem in last three years. Adults found from August to December. In hard varieties, it does not develop until after pulp has begun to soften. The only feasible remedial measure depends on the fact that the adult flies are on the wing for a considerable period before oviposition, when they obtain moisture and nourishment by rasping the surface of fruit and leaves, and so may be exposed to an arsenical spray.

*1924 - Snodgrass, R.E. - Anatomy and Metamorphosis of Apple Maggot.
Jour. Agr. Res., Vol.XXVIII, No.1, pp.1-36.
Title gives contents of paper.

*1924 - Britton, W.C. - 23rd. Rept. of State Ent. of Conn. for 1923. Conn. Agr. Exp. Sta.
Says apple maggot which was abundant as usual through apples sprayed or dusted with lead arsenate after July 1st. were almost free from injury.

1924 - Petch, C.E. - Apple Maggot and its Control in Quebec. Can. Dept. Agr. Circ. 28, 4 pp.
An account of life-history and habits is given, as occurring in Quebec, with latest suggestions of control. Dusting experiments

BIBLIOGRAPHY (Con't)

are in progress, but more definite results are required before making any recommendations.

*1924 - Curran, C.H. - Rhagoletis symphoricarpi. A new Trypaneid from British Columbia. Can. Ent., Vol.XVI, #3, pp.62-63.
R. symphoricarpi (n.s.) here described from B.C. was previously thought to be only a race of R. pomonella. The characters of both sexes and also male of R. zephyria, Snow, are discussed. R. symphoricarpi does not attack apple but confines itself to berries of Snowberry (Symphoricarpus racemosus).

*1924 - Curran, C.H. - Rhagoletis pomonella and two allied species. 54th Annual Rept. Ent. Soc. Ont., 1923, pp.56-57.
The author gives brief account of Trypetid of British Columbia previously reported as R. pomonella but now recognized ad R. symphoricarpi with notes on R. zephyria described from California. The food plant of the latter is not yet known.

1924 - Walker, G.P. - Spraying in Relation to the Renovation of Old Orchards in New Brunswick. Proc. Canadian Ent. Soc. 1923, pp.8-13.
Records good results against R. pomonella by using five sprays including two sprays of sulphur, nicotine sulphate and calcium arsenate, one of Bordeaux mixture and two of lead arsenate.

*1924 - Mundinger, F.G. - Experiments with calcium cyanide as an insecticide. Proc. 69th Annual Meeting of N.Y. State Hort. Soc., pp.134-138.
Experiments with granular calcium cyanide as a soil fumigant gave promising results against pear thrips and apple maggot. The cyanide was scattered on the ground and worked in an inch or so with a rake.

*1924 - Snodgrass, R.E. - The Anatomy and Metamorphosis of Apple Maggot.
Jour. Wash. Acad. Sci., Vol.XIII, 260-261.

1924 - Ruggles, A.G. - Sen. Rept. on Activity of the Entomologist Including Insect Conditions and a Financial Statement. 19th Rept. Minnesota St. Ent., 1921-22.
Records R. pomonella and says where present lead arsenate spray should be applied about middle of July and first of August.

BIBLIOGRAPHY (Con't)

*1924 - Patch, E.M. & Woods, W.C. - Blueberry Maggot. Maine Agr. Exp. Sta. Bul.308.
Gives detailed account of biology of blueberry maggot (R. pomonella).

*1924 - Severin, H.C. - 14th Annual Rept. of State Ent. of S. Dakota for period Ending June 30, 1923.
Records R. pomonella as one of the important insects in 1922-23.

*1925 - Fenton, F.A. - The Apple Maggot and its Control. Trans. Iowa State Hort. Soc., pp.56-63.
Injury of many varieties of apple by R. pomonella has been increasing recently in Iowa. The life-history and remedial measures worked out in other states are described. Experiments in poisoning adult flies by means of lead arsenate sprays in Iowa, though only extending over one season, gave promising results, suggesting that one or two sprays applied late in July and early August would protect most susceptible varieties of apples. These sprays also considerably reduced the injury done by apple fruit miners.

*1925 - Cory, E.N. - The Control of Insects in 1921. Rept. of Maryland Agr. Soc., Vol.VI, pp.159-168.
R. pomonella reported for the first time in Maryland.

*1925 - Woods, W.C. - The Blueberry Leaf-beetle and Some of its Relatives. Part II, Economics and Biology. Maine Agr. Exp. Sta. Bul.319, pp. 92-140.
Reports R. pomonella very serious pest of blueberries.

*1925 - Guyton, T.L. & Knull, J.N. - Apple Maggot or Railroad Worm. Penn. Dept. Agr. Circ. I,8pp.
Clean cultivation given as essential in infested orchards. If self sown trees cannot be cared for, they should be cut down.

1926 - Anonymous - Ann. Rept. for 1925 of Zool. Jr. R. Agr. Soc. England. Vol.LXXXVI : 284-291.
With regard to fruit pests, attention is called to the need of protecting English grown cherries from fruit-flies by restricting the importation of infested fruit.

BIBLIOGRAPHY (Con't)

1926 - Mites, H.W. - Fruit pests and Winter Control Measures.
Jour. Both, West & Southern Counties Soc.
Vol.XX : pp.53-71

*1926 - Anonymous - Spray Calendar for Apples, Quinces, Peaches, Plums, Cherries and Grapes.
N.J. Agr. Exp. Sta. Circ. 180-183.

*1926 - Fryer, J.C.F. - The Apple Fruit Miner and the Apple Fruit Fly.
Jour. British Agr., Vol.XXXIII, #4, pp.339-342.
Brief descriptions of Argyresthia conjugella Zee, (Apple Fruit Miner) and American Rhagoletis pomonella. Also life-histories and the nature of damage they cause to apples, in view of the fact that A. conjugella in English apples has sometimes been mistaken for R. pomonella, giving rise to a fear that the latter has been introduced into the county.
A. conjugella, although not an uncommon moth in England and Wales, is rarely a pest of importance in the chief apple growing districts, but sometimes causes considerable losses in Northumberland and Westmoreland in Scotland. It also occurs in Japan and is a serious pest of apple in North Europe and parts of Canada. It is probably indigenous in all the cooler parts of the northern hemisphere where mountain ash (Sorbus aucaparia) and crab apple occur.

*1927- Ries,D.T. - The Apple Maggot in Michigan.
Jour. of Econ. Entomology, Vol. XX,#1: 144-146,

PLATES

Figure 3 - Larvae and pupae of Apple Maggot

Figure 4 - Adult flies of Apple Maggot
Female at left
Male at right

Fig. 3.

Fig. 4.

Figure 5 - Surface of apple showing egg-punctures

Figure 6 - Enlarged portion of apple showing egg-punctures.

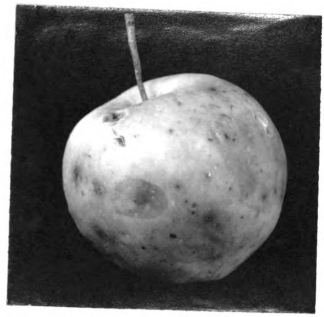


FIG. 5.

FIG. 6.

Figure 7 - Cross section of apple showing the tunnels of maggots, also a maggot emerging from fruit.

Figure 8 - Cross section of apple showing tunnel of maggot, also maggot emerging from the fruit.

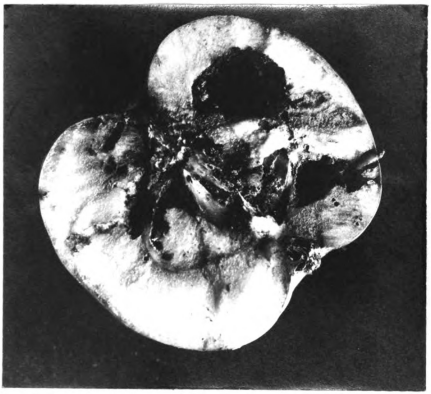


Fig. 7.

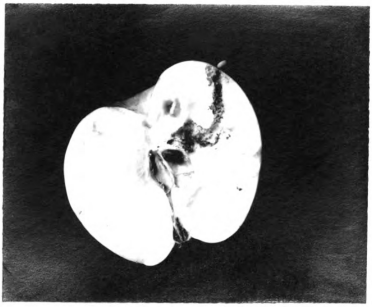


Fig. 8.

Figure 9 - Tunnel of maggot showing through the skin of a Maiden Blush.

Figure 10 - Cross section of apple showing tunnels of maggots,

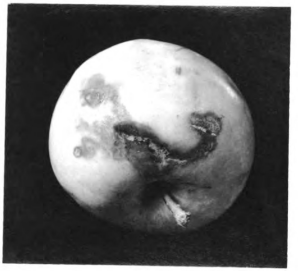


FIG. 9.

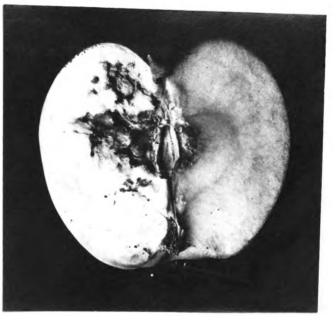


FIG. 10.

Figure 11 - Surface of apple showing emergence holes of maggots.

Figure 12 - Enlarged portion of apple showing a maggot emerging.

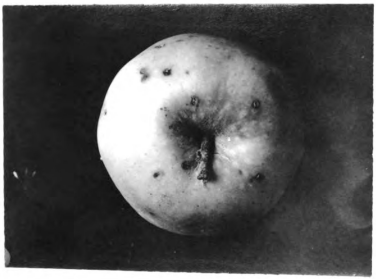


FIG. 11.

FIG. 12.