BIOLOGY OF THE STRAWBERRY LEAF-ROLLER

Ancylis comptana FROHL.

by

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INTRODUCTION

During the past few years the strawberry leaf-roller, Ancylis comptana Frohl., has appeared in certain localities in numbers sufficient to cause considerable damage in spite of the present known control measures and in many places has disappeared almost as rapidly as it appeared. Mr. L. L. Vilven of the Harmony Gardens, Wamego, Kansas, informs me that in the spring of 1928 five acres of strawberries were so completely ruined by the leaf-roller that all except a very small strip was plowed under. Spraying had been done to save the crop but with no avail. The strip left unplowed revived and suffered little more damage and he believes the damage was done before the berries were plowed under, and that they, too, would have recovered, and apparently the time and cost of spraying was of no value. The leaf-roller throughout the rest of the season became less abundant. Several outbreaks were reported from different parts of the state with the result that they became less abundant as the season progressed. These experiences would indicate that some natural or unknown factor was responsible for the disappearance of the pest. Because of these facts it was thought advisable to make a thorough study of the leaf-roller in Kansas.

REVIEW OF LITERATURE

History of the Strawberry Leaf-roller

According to Webster (28) the strawberry leaf-roller was first described in 1828 by Frohlich who called the insect *Tortrix comptana*. Walker described it later (1863) as *Grapholita conflexana*. Walsh and Riley, in 1869, described it as *Anclylopera fragariae*. The insect is now placed in the genus *Ancylis*. Webster gives the following synonyms:

"*Ancylis comptana* - Frohlich, 1828
conflexana - Walker, 1863
fragariae - Walsh and Riley, 1869"

Fernald (7) also gives the above list of synonyms but gives in addition the name *Phoxopteris fragariae*.

Origin and Spread of the Insect

Writers agree that the strawberry leaf-roller is of European origin and most of them agree fairly well as to the time that it was imported into America. Swenk (23) says that it was probably imported about 1860. Steadman (20) gives the time of importation as some time prior to 1867. Riley (4) reports that he first heard of the insect in 1866. According to Steadman (20) it was first reported from Canada in 1867. It is probable that no definite study has ever been made of the rate of spread of the insect or of the place or places where it first gained entrance to this continent, so that it is only a guess as to the exact time or place of entrance; but as Swenk (23) says it probably was not later than 1860 and quite probably earlier than that, as it usually takes some time for an insect to become established and to become numerous enough to cause much damage. It changed its food habit, as will be shown later, which also usually slows up the progress of the insect in migration. It seems quite probable that the readjustment period was six or more years.

It does not seem from the literature that it is known where or how the strawberry leaf-roller gained entrance into this country. The first account of it came from Canada (Steadman 20). Garman (11) in 1890, says according to reports of entomologists it seems that the leaf-roller was a northern pest and spread southward. In 1878 it seldom occurred south of central Illinois. In 1883 it was reported as being injurious in the southern part of that state. Steadman (20) in 1901 says, "this insect formerly was confined to the northern part of the state (Missouri) but has spread southward until now it is found in northern Arkansas as well as southern Missouri." From these citations it appears that the insect probably was imported into the north central section of the United States, or probably into Canada, and has spread southward.

Early Literature

According to Steadman (20) the first account we have of the insect in the literature appeared in the "Canadian Farmer" for August, 1867. Steadman (20) also states that Walsh and Riley gave a description of the insect in the American Entomologist for 1868. Forbes (8) also mentioned this description as being the "first clearly discriminating description". Following this, considerable mention is found in the literature concerning the strawberry leaf-roller, most of which consists of inquiries as to what should be done to control it and the replies to such inquiries.

Description

Egg. Several descriptions have been given of the egg. Webster (28) sums up the literature and gives the description as follows: "J. M. Steadman (1901) seems to have been the first to observe the eggs and they were described by him, although no measurements were given. J. B. Smith (1909) also described the eggs and C. A. Heart (1911) working over notes made by J. J. Davis and the writer, employed by the Illinois state entomologist in 1905 and 1906 gave a description and measurements. A detailed description is given herewith:

The egg: Oval, varying greatly, much flattened; pale yellow-green, translucent; surface pitted with numerous slight hexagonal depressions. Length .68 mm. Eggs deposited on the glass in insectary cages were quite uniform in shape; a true oval. The fine hairs on the surface of the strawberry leaf make considerable difference in the shape of an egg on the leaf." Swenk (23) says, "The eggs are very small, about one-fiftieth of an inch in diameter, much flattened, roundish or oval in shape and of a pale greenish color. They are placed in the fine network of the leaf veins, their softness allowing each to fit into one of the little irregularities and just fill a mesh of the network so that they become very difficult to see."

Larvae. Numerous descriptions of the larvae are to be found in the literature, probably as good as could be found is that given by Steadman (20) which is as follows: "The larvae when full grown are about one-third of an inch in length. The first segment is the largest, and each succeeding one is a trifle smaller, so that the body gradually tapers to the caudal extremity. The color varies from light yellowish brown to dark olive green; the body is dull and somewhat translucent; the piliferous spots large, shining, light in color, and contrasting with the general color of the body. The hairs are stout and stiff. Segments two and three have no spots on their caudal half, otherwise the spots are normally arranged. The head is horizontal and of a shining pale yellow or fulvous color, with a dark eye-spot and tawny upper lip. The cervical shield is also shiny. The anal segment has two black spots at the caudal edge which in some specimens coalesce. The legs, prolegs and ventral surface of body is of the same color as the body."

Pupa. Forbes (8) gave a description of the pupa which is as follows: "The pupa is slender-ovate, pale brown, 5 mm. long by 1.4 mm. wide. The abdomen is smooth beneath, and armed at the posterior extremity with several slender hairs, which are abruptly hooked at tip. Above, each abdominal segment bears two transverse rows of stout, recurved, spinous tubercles, one near the anterior and one near the posterior margin of each segment excepting the last, which bears three rows. The anterior row on each segment contains fewer but larger spines than the posterior, the former becoming larger from before, backwards and the latter smaller."

Adult. There are many good descriptions given in the literature among which is that given by Steadman (20) which is as follows: "The adult leaf-roller is a small moth measuring from four-tenths to nearly one-half an inch in the expanse of its wings. The head and thorax are of a light reddish to ash brown color; abdomen pale fuscous above and paler beneath; palpi fuscous on outside, lighter at base and inside than at tip; antennae dark fuscous. Fore wings with a large, semi-ovate spot of the same brown color as the thorax, resting on the basal half of the hinder margin, and extending two-thirds of the way across to the costa, where it is not always clearly limited from the costal third of the wing, which is white, tinted with brownish or ochery and marked with a series of minute brown costal streaks with more or less sprinkles of the same color. The outer edge of the semi-ovate spot varies somewhat in form as in other species of this genus. The ground color of the basal half of the costa, changing more or less to a silvery grey in its course, extends across the wing beyond the semi-ovate spot, as a narrow, oblique hand, to the hinder margin, where it expands outward and upward covering a large area on the anal angle and including an oblique brown spot before the angle. The part of the wing above this is concolorous with the semi-ovate spot and marked on the outer half of the costa with four pairs of oblique white streaks, the inner one of which extends to the outer margin a little below the middle. Some specimens show one or two horizontal black streaks near the middle of the outer part of the wing. Fringes sordid white or tinged with ochery brown at the apex and cut immediately below by two white streaks with brown between. Hind wings and abdomen above pale fuscous, paler beneath. Under side of the fore wings fuscous and showing the costal marks of the upper side."

Economic Importance

Food Plants. Niswander (10) states that in Europe this insect does not feed on strawberries, but obtains its food from several species of plants belonging to the same family. Steadman (20) also agrees with this statement and goes on to say that in this country it is confined almost entirely to strawberries, being occasionally found on raspberries and blackberries. Smith (21) reported it feeding upon blackberry and raspberry in 1891 and 1892. Wadley (32) says, "The writer has been unable to find this species in Kansas on any plant other than strawberry." From the foregoing citations the conclusion might be drawn that while it is found to some extent on blackberries and raspberries it is primarily a pest of strawberries and as an economic pest it is of importance only for this fruit. It is further brought out that a change of food habit has taken place, changing it from an insect of minor importance in Europe to an economic pest in America.

Nature of Damage

Swenk (23) says, "When it is fairly started in its work the presence of the leaf-roller is easily detected by the folded condition of the leaves and if these are opened numerous small, very active, greenish caterpillars will be seen squirming within a mass of white silk webbing and fine pellets of black excrement. While upon closer inspection the internal leaf surface will show numerous gnawed patches. The damage by this insect is caused not so much by the amount of leaf tissue it consumes as by the folded condition of the leaf which it brings about, this interfering with the normal function of the leaf and soon kills it. The injury becomes very manifest by fruiting season, many of the leaves having become perfectly brown and dry ...." Many times the entire patch becomes so injured and so many leaves affected that the plants look as if they had been scorched by fire and at times patches are killed, and at other times they are so injured as to reduce the crop of berries for the following year. Under normal infestations there is usually one caterpillar to the folded leaf.

History and Amount of Damage

Riley (5) states that in 1866 when he first heard of the strawberry leaf-roller it so completely destroyed ten acres of strawberries for Mr. N. R. Strong of Valpariso, Indiana, that there were not enough plants left to reset one-half an acre. With added injury by white grubs the grower was compelled to abandon strawberry growing. Forbes (8) says it is by far the most destructive known enemy of the strawberry. It often ruins the crop year after year. He placed the loss to strawberry growers of Illinois and adjacent states as many thousands of dollars. This was in 1884 when money values were much greater than now and to compare values with present standards would mean a much larger sum of money. Discussing the situation in Iowa Webster (28) says, "Several years ago in certain localities in Scott county strawberry growing was practically abandoned." He further relates that one grower of Des Moines had a loss of $1000.00 in 1916. Macoun (30) states that for Canada the strawberry leaf-roller has not done a great deal of damage. It has been quite troublesome in Kansas in the past few years. The Harmony Gardens at Wamego lost five acres of berries in 1928 just before harvest time. Smith (24) says the strawberry leaf-roller rarely gives trouble for more than a year or so and that the trouble is usually local. Swenk (23) agrees with Smith as to the duration and distribution of the damage done by the leaf-roller.

Distribution

Webster (28) says the states of the Mississippi valley apparently have had the most trouble from this pest. Damage is recorded in the literature from practically every state between the Appalachian and Rocky mountains. It is less common outside of these states. Smith (15) gives the range for this insect as extending from Canada to Virginia and probably farther south and west to the Mississippi Valley.

Life History

Winter Stage. Dunnam (38) says, according to observations in Iowa, "It is a definitely established fact that the strawberry leaf-roller spends the winter in strawberry beds as nearly full grown caterpillars." Garman (13) in 1891 decided from the development of the genital organs of those moths found in the summer that the larvae must live over winter in the folded leaves. Steadman (20) states that the last brood did not pupate but remained in the folded leaves until October 2 at which time many of them left the leaves and crawled under rubbish and mulching about the plants. On the sixteenth of November he made a search for pupae but failed to find any, although larvae were found in great abundance. A search was made on April 4 at which time the larvae had pupated. Forbes (8) stated that the winter was passed as pupae. It seems from the evidence presented that the winter is passed either as larvae or pupae but quite probably when there is a late fall many of the leaf-rollers pupate in the fall and pass the winter in this stage. Dunnam (38) says that early in the spring when food is available, the caterpillars feed to some extent but soon transform to the pupal stage and a few days later the adults emerge and lay eggs which give rise to the first generation of caterpillars. Wadley (32) states that in Kansas the moths emerge in April.

Egg Stage. Dunnam (38) says the incubation period is from five to eight days. Five days with a temperature of 81.8 degrees F. Eight days with a temperature of 73 degrees F. Doubtless this might vary even more as the temperature varies. McBride (34) gives the egg stage as about one week. Steadman (20) agrees with McBride. Wadley (32) says six days for Kansas.

Larval Stage. Dunnam (38) states that the length of the larvae period is sixteen days at 79.8 degrees F. of temperature, to thirty-one days with a slight decrease in temperature, and twenty-two and seven-tenths as an average for all records considered. Wadley (32) says the larvae reach maturity in about one month.

Pupal Stage. Dunnam (38) says the length of the pupal stage is from six to fifteen days with an average of nine and six-tenths days. The temperature seemed to have a direct bearing on the number of days required for development. In some cases there seemed to be little correlation between the temperature and the time required for development. The optimum for development was ten days with a temperature of seventy-three and five-tenths. Webster (28) does not give the length of the larval stage as a whole but does give the length of the different instars, which when added together gives nineteen and one-half days.

Adult Stage. Webster (28) on the length of adult life says in a test he conducted, twenty-four female moths lived on an average of ten and two-tenths days, with a range of from three days to twenty-eight days. Nineteen male moths lived an average of ten and one-tenth days with a range of three to twenty-three days. He thinks the males died more quickly than did the females but the averages are very close.

Miscellaneous Notes. According to Webster (28) the preoviposition period was from three to four days. The average number of eggs laid by each female was about seventy-three. Thirty-five females were used for the test.

Generations per Year. Dunnam (38) gives three broods or generations for Iowa. Wadley (38) says it seems likely that there are four generations in Kansas, though some of the larvae of the third generation hibernate, but in long seasons a small fifth generation may develop. McBride (34) gives three full broods for Missouri and a partial fourth. Swenk (23) reports three broods for Nebraska. It may be seen from the citations above that there is at least some doubt as to the exact number of generations per year in Kansas. It is quite likely that the length of the season and other climatic factors have something to do with the number of generations. The overlapping of generations, too, makes the problem more difficult to study under field conditions.

Ecology

Relation to Soil. There seems to have been very little done along this line. Smith (24) studied the relation of the insect to soil and moisture. His studies were field observations. He says, "In New Jersey I have found the species in some numbers every year in the southern counties on sandy land and almost never in the north and rarely on the heavier or loam soils, even in the southern counties." This would indicate that there is some correlation between the type of soil on which the berries are grown and the amount of injury caused by the leaf-roller.

Moisture. In speaking of control measures Smith (24) says, "A much more effective check is found in meteorological conditions. A few days of wet, chilly weather almost invariably checked the insect so effectively that little was seen of them afterward. A cold, wet spring would, therefore, be bad for them. A warm, dry season would, on the other hand, favor their development." This seems to indicate that there is a definite relation between weather conditions and the development of the leaf-roller. Doubtless, this is a good phase of the work for further study.

Strawberry Variety Preference

There seems to be no record in the literature of any work done on variety preference, or in other words to find out if this insect has any preference for any one or more varieties of strawberries.

Natural Enemies

Parasites. Webster (28) says, "Rarely was a Braconid cocoon found on an infested leaf-roller." Lewis (35) says, "In the account of the outbreaks of the strawberry leaf-roller which are more or less sudden and local, at no time have parasites been mentioned as common. In a study under normal infestation six species of Hymenopterous parasites and three more probable parasites and one Tachinid fly were found. Four additional species are mentioned in the literature." Those listed by Lewis are:

1. Cremastus cookii - Ill. Described by Weed, 1888.
2. Glypta phoxopteridis - Ill. Described by Weed, 1888.
3. Microgaster comptanae- Colo. Described by Vierick, 1911.
4. Iseropus alboricta - Iowa. Reported by Webster, 1918.
5. Macrocentrus ancylivora - N. J. Described by Rohwer, 1923.

Those reared by Lewis were:

1. Sympiesis ancylae - Gir.
2. Epirhyssalus atriceps - (Ashm.)
3. Elacterus aeneoniger - Gir.
4. Cryptus incertus - (Cress.)
5. Microgaster comptanae- Vier.
6. Pleurotropis sexdentatus - Gir.

Smith (24) reports an external parasitic caterpillar from Cologne, which proved to be a Hymenoptera, Goniozus platynotae. He states that this parasite was parasitized. Smith says Goniozus does not get its work in until the leaf-roller has done its mischief. After testing less than half a dozen parasites he reaches the conclusion that they could not be the limiting factor responsible for the quick disappearance of the leaf-rollers. Dunnam (38) says occasionally hymenopterous parasites become numerous enough to check rapid multiplication of the leaf-roller. He reports that during 1923 he reared Sympiesis ancylae Girault, Meteorus trachynotus Vier., Hoplocryptus incertulus (D.T.), Spilochalcis albifrons Walsh, and Spilocryptus polychrosidis Eusk. Fink (37) gives an extended discussion of the biology of Macrocentrus ancylivora Rohwer, as an important parasite of the strawberry leaf-roller. In his introduction the reason is given for the study as follows: "Subsequent investigations indicate that in some localities of New Jersey parasitism frequently attains 60 per cent, was due entirely to this braconid. In view of its importance, and the fact that it is not known to occur in other sections of the United States where the leaf-roller is present, a study of its life history and habits seemed desirable. It was hoped that such a study would throw light on the advisability of introducing it into other sections where its host is destructive." He says further, "Hibernation of Macrocentrus takes place as a mature first-stage larva within the body of the full grown leaf-roller." This, no doubt, would produce the parasite in time to parasitize the first generation of larvae. Fink (37) says, "The active period of the parasite agrees with that of the host in that every generation of the latter is parasitized." He further points out the fact that there are three generations per year of the parasite and that under New Jersey conditions there are three generations of the leaf-roller also. The length of the life cycle for both occupy about the same length of time and quite probably, as mentioned above, both emerge about the same time in the spring. It can be seen from the citations that this parasite promises to be an important factor in the biology of the strawberry leaf-roller.

Predators. Under this heading Dunnam (38) states that spiders were found in the field and were thought to be feeding on the larvae of the leaf-roller. Webster (28) states that at no time while his study was being carried on did natural enemies appear in abundance. Smith (21) observed a number of ground beetles but as the well-cultivated ground is not so favorable for their development he does not think they could be of much importance.

MATERIAL AND METHODS

Field Observations. Trips were made to different strawberry fields from time to time and anything that could be learned about the leaf-roller was noted and recorded.

Life History Tests. For the study of the life history, potted plants and lantern globes were used to make cages. Thin cloth was stretched over the top end of the globe and the globes were set over the plants. It was found also that in changing from one plant to another it was much easier to keep the adults from getting away if a small hole was cut in a piece of cardboard just large enough for the plant to go through, this placed over the plant before putting the globe over the plant. This reduced the size of the opening which was made when the globe was picked up to transfer it to another plant.

Several adults were placed in this cage and allowed to remain on one plant for a twenty-four hour period. They were then transferred to another plant for the next twenty-four hour period. The date that the eggs were laid was written on a small stake placed in the pot by the side of the plant. These plants were observed daily and when the young caterpillars hatched they were transferred to another plant by means of a camel's hair brush. This was done to prevent counting the same larvae twice. The date that the eggs were laid, the date of hatching, and the number hatched on that date were recorded in tabular form. All the caterpillars which hatched on one day were put on one or more plants and the date of hatching marked on a small stake as described for the egg stage. These plants were observed daily for pupation and the date of hatching, the date of pupation and the number that pupated on that date were recorded in tabular form. These plants were kept out of doors and as nearly under natural conditions as was possible, until about the time that normal pupation should have occurred, but natural enemies became so abundant that it was found necessary to transfer the larvae to salve boxes if the test was to be continued. After pupation took place the boxes were examined daily for moisture content and to determine the date of emergence. When emergence took place records were kept of the date of pupation and emergence so that the length of the pupal stage could be determined. So few larvae escaped natural enemies that the test was supplemented by collecting larvae in the field and putting them in salve boxes to pupate and furnish a greater number of records.

Egg Record Test. Three methods were used in this test. First, tin cans were cut to fit the lower part of a lantern globe and the globe fitted into the can. The can was cut to leave a strip about two inches wide at the bottom of the globe and a hole was made in the tin for putting leaves into the cage. This was placed in a flower pot filled with dirt. This arrangement made it possible for a plant to be placed by the side of the cage and one or more leaves could be put through the hole into the cage for the moths to lay their eggs. The hole around the stem was filled with cotton. One or more leaves, but usually only one, was exposed for a twenty-four hour period then taken out and the eggs counted and the number recorded, or the leaves were tagged with a string and tag, giving the designation of the female which laid the eggs and the date that they were laid, so that they could be counted at a later time.

The second method differed from the first only in that the leaves were detached from the plant and put in the cage. This had the advantage of being far less trouble than to have so many pots to work with and the counting of the eggs was much easier. The eggs must be counted every day by this method, which might seem to be a disadvantage, but proved otherwise.

In the third method lamp chimneys were used. Screen wire was fastened over the larger end and cloth was put over the smaller end. The larger end was set on damp earth to prevent too dry an atmosphere. When this method was first used the chimneys were laid down and the moths would usually die if the weather was hot and dry for a day or two. By keeping them in contact with the damp earth they lived and this method gave more satisfaction than any other method tried.

A pair of adults was confined in each of these cages and a fresh leaf was placed in the cage each day and the old leaf taken out, the eggs counted and recorded.

Variety Preference Test

To determine whether or not the leaf-roller had any preference for any certain variety of strawberry, a cage of screen wire was made six feet long and three feet wide. Seven of the more common varieties which are grown over the state were secured, six plants of each variety, and set out in the cage. Adults were placed in the cage and allowed to select the plant on which to deposit their eggs. At different times the plants were inspected and a record made of the infested leaves.

Attrahents. To determine whether or not the adult leaf-rollers could be attracted to certain baits a cage was made of screen wire. The cage was three feet long, one and one-half feet wide and one and one-half feet high. Adults were placed in the cage and a number of liquid baits were placed in shallow dishes, a strawberry leaf being placed in each dish for the leaf-roller to rest on while feeding. Observations were made at different times during the day and records made of any indications of feeding or of being attracted to the food.

Disease

Caterpillars which seemed to be affected by disease were taken to Dr. O. H. Elmer, who made cultures to determine if there was any specific disease causing the death of the insect in the larval stage.

Parasites

To determine what parasites, if any, were affecting the behavior of the leaf-roller, caterpillars were collected from the fields and were confined in vials and salve boxes. Blotting paper was put in the vials and boxes to regulate the moisture content. The vials were closed with cotton. Small pieces of strawberry leaf were put in these containers each day and observations made for parasites and to see that the moisture content was as near what it should be as was possible to determine.

Preditors

The methods used to study preditors were field observation and rearing of spiders which were fed leaf-roller larvae.

Ecology

Relation of Weather Conditions to Leaf-roller Activity. A study was made of the rainfall and temperature for a period of six months prior to and during infestations, for three localities and for a like period for one of the localities when there was no infestation.

A study was also made of the letter files of the Department of Entomology and Horticulture, Kansas State Agricultural College, to determine the years in which this insect had given the most trouble and a study was made of the weather conditions for that locality and year. This was to determine the influence of climatic conditions.

Light. Several attempts were made to attract the adults to light. A gasoline lantern was used, hung up in front of a sheet. The lantern was also carried and waved over the rows of strawberry plants.

RESULTS OF INVESTIGATION

Variety Preference Test

On April 11 the variety preference test was started. Six plants each of the following varieties, Aroma, Cooper, Gandy, Progressive, Premier, Mastodon and Dunlap, were set in the cage as described under methods. Adult leaf-rollers which had been collected in the field and put in a cage for this purpose were transferred to this cage so that the females could choose the plant on which to lay their eggs. Other adults were put into the cage on April 16 and again at different times as they were available. Careful examinations of the plants were made on two different dates and as nearly as possible the exact condition calculated on these dates. Folded leaves, whether larvae were present or not, were counted as evidence of infestation and counted as infested leaves. Leaves which had young larvae were also counted as infested leaves but eggs were not considered. No attempt was made to discover whether eggs were present or not since no eggs should have been present at that time. Table I gives the conditions as they were found. This is not considered conclusive but it presents conditions which make it advisable to carry the test further.

TABLE I. VARIETY PREFERENCE

Variety	Infested Leaves May 27	Infested Leaves June 20
Aroma	10	14
Cooper	3	8
Gandy	3	6
Progressive	0	0
Premier	3	1
Mastodon	0	0
Dunlap	1	8

It may be seen from this table that this test seems to show that certain varieties are preferred to other varieties and that Aroma, Cooper and Dunlap seem to be preferred to the other varieties while Progressive and Mastodon are the least preferable. It is known, however, that Mastodon is not to be considered as abhorrent to a marked degree, since plants of this variety were used for life history work and egg-laying records and eggs were laid on them. A field at Wamego was observed in which two varieties were being grown, Mastodon being one of the varieties and the other being either Dunlap or Gibson. Both varieties were infested. On April 16 and 27 adults seemed to be less plentiful in the Mastodon than in the other variety and it was thought that field observations were going to bear out the test. As far as could be determined on June 11 there was not enough difference to be considered. There seemed to be fewer rolled leaves on the Mastodons, but there were fewer leaves to be rolled. The percentage of infestation seemed to be about the same. It is of interest to note that the least preferable varieties are everbearing varieties and the most preferable are late varieties.

Attrahents

About fifty adult leaf-rollers were put in the cage described under methods and materials for attrahents and the following materials were used to attract the moths: sweetened water, without any flavor, sweetneed water flavored with lemon juice, sweetened water flavored with orange juice, grape juice, amyl acetate, geranoil, and syrup, honey and an extract made by boiling the leaves of strawberry plants in water. Observations were made at 6, 8, 10, 12, 2, 4, 6 o'clock and at other convenient times during the day. Occasionally a moth was found sitting on one of the leaves in the dishes of baits or found dead in the material but they were never attracted in sufficient numbers, if at all, to draw any conclusions. It would rather appear that they were not influenced in any way by the presence of the baits.

On April 24 a number of baits were tried out in the field to see if the adults could be attracted. It had been observed that some lepidoptera were attracted to such solid materials as apple, so apples cut into slices were tried; also Irish potato cut into slices. Strawberries were mashed and used as a bait. Syrup and honey were put on bits of paper and placed in the field near the plants. These baits were visited each 15 minutes from 6:00 p.m. to 8:00 p.m.

The field was visited the morning of the 25th and the baits observed. This was repeated the next evening but at no time were moths observed to be attracted to any of the baits.

Life History Studies

Size of Egg. Based on the measurements of 100 eggs the length or greatest measurement was found to be 0.671 ± 0.0054 mm. The width or smallest diameter was found to be 0.440 ± 0.0034 mm. The length or greatest diameter of any egg measured was 0.918 mm. and the width 0.540 mm. The length or greatest diameter of the smallest egg measured was 0.486 mm. and the width or smallest diameter was 0.270 mm.

TABLE II. OVIPOSITION RECORDS

Pair Number	RECORD OF FEMALE IN DAYS: Emerged	Pre-oviposition Period	Oviposition Period	Post-oviposition Period	Length of Life	Number of eggs Laid	RECORD OF MALE IN DAYS: Emerged	Length of Life
1			25	2		92	---	---
2	6-16	3	10	6	19	87	6-17	8
3	6-17	3	2	10	15	4	6-17	17
4	6-17	3	13	10	26	105	6-17	---*
5	6-18	2	16	0	18	35	6-18	19
6	6-18	2	5	8	15	3	6-18	15
8	6-21	2	19	5	26	143	6-21	19
9	6-21	2	19	6	27	140	6-21	20
10	6-21	1	14	2	17	18	6-21	6
11	6-21	2	11	4	17	103	6-21	12
12	6-21	6	6	7	19	116	6-21	19
13	6-21	2	14	5	21	197	6-21	21
14	6-21	3	18	1	22	120	6-21	21
15	6-21	3	13	5	21	159	6-21	13
16	6-21	4	11	3	18	128	6-21	8
17	6-21	4	8	5	17	11	6-21	17
19	6-21	3	15	1	19	12	6-21	19
20	6-22	1	9	1	11	145	6-22	12

The females of 7 and 18 were considered abnormal physically and for this reason their records are not included in the main part of the table but are presented below, and it may be of interest to call attention to such abnormalities.

7	6-18	12	8	6	26	4	6-18	26
18	6-21	14	1	1	16	2	6-21	12

*Male escaped

SUMMARY OF TABLE II

Average preoviposition period based on 17 records, 2.7 days.
Average oviposition period based on 18 records, 12.66 days.
Average postoviposition period based on 18 records, 4.5 days.
Average length of life of female based on 17 records, 19.3 days.
Average length of male based on 18 records, 15.78 days.
Average number of eggs laid by each female based on 18 records, 89.89.

Two methods were used in securing this data, both of which have already been discussed. The first sixteen pairs were caged in lamp chimneys and the others in lantern globes set in flower pots. The data secured from the lantern globes is not considered as very reliable, since in three of the cages the record is very low and it is believed there is a possibility that eggs were deposited either on the ground or on the strip of tin used at the bottom of the globe and were not discovered. Several times eggs were found around the edge of the glass in the lamp chimney cages, just at the edge of the cloth and as the cages made of the lantern globes and flower pots were never taken apart it seems possible that eggs may have been laid where they were not found. The data is presented for what it may be worth.

In both methods the leaves were taken from the plant and put in the cage.

The summary of Table II is given at the bottom of the table and is self explanatory.

It is likely that all of these numbers are too small since the insects were in unnatural conditions.

Attention is called to a few facts that otherwise might be overlooked, namely, the wide variation in the number of eggs different individuals will lay, the wide varia-

TABLE III. LENGTH OF EGG STAGE

Eggs Laid	Length of Egg Stage	Number of Eggs	Average Length for Each Lot	Mean Temperature
April 13	27 days	1	27	55.1
April 14	19 days	1		54.1
April 14	20 days	3		53.8
April 14	28 days	4		53.5
April 14	29 days	3		53.9
April 14	30 days	1	25 2/3	54.0
April 15	18 days	5		56.3
April 15	28 days	2	21 3/7	55.7
April 16	23 days	12		55.8
April 16	24 days	1		55.4
April 16	26 days	2	23 7/15	56.4
April 17	22 days	14		54.7
April 17	23 days	4		54.8
April 17	25 days	13		55.5
April 17	33 days	1	23 22-32	56.6
April 18	16 days	4		55.6
April 18	22 days	6		55.2
April 18	24 days	12		55.9
April 18	25 days	2		56.0
April 18	26 days	1		53.4
April 18	27 days	1		54.2
April 18	31 days	1		55.1
April 18	36 days	1	24 1/4	55.9
April 19	23 days	14		55.8
April 19	26 days	1	23 1/5	56.7
April 23	17 days	1		55.5
April 23	20 days	1	18 1/2	56.4
April 27	30 days	1	30	59.3
April 28	17 days	8		56.8
April 28	20 days	2	17 3/5	59.7
April 29	24 days	2	24	57.7
April 30	18 days	2		56.6
April 30	19 days	2	18 1/2	56.9
May 2	18 days	1		56.4
May 2	19 days	2	18 2/3	56.4
May 5	16 days	1	16	57.6

tion in the number of days before and after the oviposition period.

It may be seen from data in Table III that in early spring when the temperature is low the egg stage is considerably longer than for summer temperature as brought out in the review of literature. It may also be seen that the length of the egg stage is not in direct proportion to the average temperature but that in general it does hold true. It may also be pointed out that there may be a critical temperature at which development takes place or some other factor may be responsible for the variation.

Mean temperature for the entire period from the day the first eggs were laid until the last larvae hatched, 56.8°F. Records of 133 eggs show the mean length of the egg stage at the time and under the conditions this study was being made to be 22.78±0.668 days. The longest length of egg stage was 36 days and the shortest was 16 days.

Table IV shows the length of the larval stage. Due to the fact that parasites and preditors and possibly other factors were working on the larvae of the life-history test only five larvae survived to reach the pupal stage and the last part of the larval stage was passed in salve boxes, the larvae being transferred to the boxes June 11.

TABLE IV. LENGTH OF LARVAL STAGE

Hatched	Pupated	Number	Length of Larval Stage	Mean Temperature
May 10	June 16	1	37 days	66.8°F.
May 11	June 16	1	36 days	66.9°F.
May 9	June 17	1	39 days	67.1°F.
May 11	June 18	1	38 days	67.2°F.
May 15	June 19	1	35 days	68.0°F.

Average length of larval stage - 37 days
Average daily temperature - 67.2

It may be seen from the table that the length of the larval stage does not differ greatly from that recorded in the literature. It is some longer, which may be due to the cool weather of spring and when this is averaged with the length of the same stage in the later generations would very probably, be about the same as that recorded in the literature. The average, or mean temperature is given for the length of each larval life so that it may be compared with records made later. Also the average or mean temperature for the entire period that the larval period was studied is given.

Table V gives the dates of pupation, emergence and the length of the pupal stage in each case. The first line of the table gives the data on the only adult completing the life history test started with 133 larvae, five reaching the pupal stage and only one reaching the adult stage. Two of the five pupae yielded adult parasites and two failed to produce anything. The rest of those which pupated in June were collected in the larval stage at Manhattan, Kansas, June 15 and put in salve boxes and allowed to pupate and records kept on them to supplement the life history test. Those which pupated in March were collected from the field at Wamego, Kansas, or from cages where they had been placed in September. They were taken into the greenhouse and passed the pupal stage under greenhouse conditions. It may be seen that the length of the pupal stage in the greenhouse was not very different from that found in the literature or where the pupal stage was passed in salve boxes.

TABLE V. LENGTH OF PUPAL STAGE

Pupated	Emerged	Length of Pupal Stage
June 18*	July 1	13
June 21	June 29	8
June 20	June 29	9
June 21	July 1	10
June 22	July 2	10
June 21	July 2	11
June 22	July 2	10
June 22	July 2	10
June 22	July 3	11
June 21	July 3	12
June 28	July 5	7
June 23	July 6	13
March 7	March 17	10
March 8	March 19	11
March 8	March 19	11
March 9	March 20	11
Average for June		10 1/3 days
Average for March (in greenhouse)		10 3/4 days

*Data secured in June is presented in table before that secured in March because it is felt that it more nearly approaches natural conditions.

Ecology

It will be recalled from the review of literature that Smith (24) makes the following statement, " ..... a few days of wet, chilly weather almost invariably checked the insect so effectively that little was ever seen of them afterward. A cold, wet spring would, therefore, be bad for them. A warm, dry season would, on the other hand, favor their development."

In order to study the relation between weather conditions and infestations of the strawberry leaf-roller, a study was made of the weather conditions for three localities for a period of six months prior to and including the time of infestation. Table VI shows the total rainfall for each month and the total for the period, the average rainfall for a long period of time for each month and the average for the same period during a long period, so that the rainfall for this period, or any month of the period may be compared with a normal year. The table also gives the mean temperature for each month of the period, the mean for the entire period, the mean for each month for a long period of time, and the mean temperature for the period, for a long period of time so that comparisons may be made with the normal year. This data is also given for the same periods for two years for one of the localities.

TABLE VI. MOISTURE AND TEMPERATURE RECORDS

Wamego, 1928

Month	Total rainfall, 1928	Normal rainfall 36 yrs.	Mean temperature, 1928	Normal temperature 36 years
Jan.	.05		33.2	
Feb.	1.70		37.3	
March	.73		48.5	
April	3.55		52.3	
May	1.99		67.0	
June	7.29		69.3	
Total	15.31	16.88	51.3	49.93

Wamego, 1929, January to June inclusive:

	1929		1929	
Jan.	1.32	.84	22.1	29.7
Feb.	.97	1.41	24.5	31.5
March	1.21	1.65	48.4	44.1
April	4.21	3.07	58.3	54.5
May	3.53	5.09	61.9	65.8
June	6.06	4.82	74.6	75.0
Total	17.30	16.88	48.3	49.9+

Leavenworth for 1929:

	1929	for 75 yrs.	1929	for 75 yrs.
Jan.	2.05	1.09	22.0	28.4
Feb.	1.53	1.38	24.4	31.9
March	2.00	1.94	48.6	44.1
April	6.47	3.01	57.6	55.0
May	5.83	4.60	62.0	64.5
June	8.32	4.91	72.3	75.3
Total	26.20	16.93	47.8	49.86+

Lincoln from May to October inclusive:

	1928	for 16 yrs.	1928	for 16 yrs.
May	1.99	3.01	65.8	64.2
June	5.95	3.52	67.8	74.1
July	12.77	2.87	77.9	80.6
Aug.	3.07	2.03	77.5	78.1
Sept.	1.22	1.89	69.2	70.5
Oct.	2.30	1.51	58.2	57.5
Total	27.30	14.83	69.4	70.8+

There was a heavy infestation at Wamego in the spring of 1928 and a very light infestation in 1929. The infestation of 1928 completely ruined five acres of berries while the infestation for 1929 was so light that little uneasiness was felt. It will be seen from the table that the total rainfall for the corresponding periods of 1928 and 1929 was 15.31 and 17.30 inches, respectively, which makes 1929 the wetter of the two years. Comparing the temperature for the two seasons the mean temperature for the period of 1929 was 51.3° F. as compared with 48.3° F. for 1929. This much of the table seems to verify Smith's conclusion. Likewise in comparing the rainfall and temperature for the season studied with the rainfall and temperature for this period of a normal year it is found that for 1928 it was drier and warmer than normal which again bears out the conclusion drawn by Smith. But when a comparison of weather conditions for the same period for Wamego and Leavenworth is made the opposite seems to be true. The table shows that weather conditions for Leavenworth were abnormally wet, 26.2 inches for Leavenworth as compared with 17.3 inches for Wamego and 26.2 inches as compared with 16.93 inches for the normal year for that period. The temperature too, is lower for Leavenworth than for Wamego (47.8°F. as to 48.3°F., respectively). As compared with the normal temperature it is still cooler (47.8°F as to 49.86°F.). If this hypothesis is true this should have been a very bad year for the leaf-roller at Leavenworth, and yet they were there in sufficient numbers to cause a great deal of damage. If weather conditions were the dominating factor they should not have been as bad at Leavenworth as at Wamego, but the opposite conditions were true.

It is inconsistent to compare the temperature of the period from January to June, inclusive, with the temperature from May to October and ordinarily there would be more rainfall in the spring than in the summer, but it will be seen from the table that for Lincoln the period studied was the wettest of any shown in the table. When the rainfall for this period for 1928 is compared with the normal it will be seen that it was very abnormally wet (27.30 inches for 1928 as to 14.83 inches for the normal year). In comparing the temperature for this period and for the same period during a normal year, it is found to be cooler than normal. It might then be considered a wet, cool spell which should have been bad for the leaf-roller and yet there was an infestation there in October, 1928.

This table seems to indicate that while weather conditions may play a part it is only a minor part and is not the big factor responsible for the fact that the infestations are local and appear and disappear suddenly.

The table shows that for Lincoln for a period of six months, May to October, inclusive, that the weather was abnormally wet. The total rainfall for this period being 27.3 inches, whereas normally there should have been 14.83 inches. There was nearly twice as much rainfall as usually occurs in that locality for that period. The mean temperature for the period was 1.4^{o} F. below normal. If a wet, cool season is bad for the leaf-roller this should have been a rather bad one unless temperature is the greater factor and even then it was abnormally bad, and yet in October of 1928 there was quite a heavy infestation at that place.

These facts seem to indicate that though Smith's (24) observations in New Jersey might have been true for conditions there, the same does not hold true for Kansas conditions. Here rainfall does not seem to be the factor responsible for sudden and local infestations nor for their rapid disappearance. Nor does temperature seem to play any great part.

As a further study of the influence of weather conditions on the activities of the strawberry leaf-roller an examination was made of the letter files of the Entomology Department to see in what years more complaint had been made and to judge from this the years in which its ravages had been the worst. The following table gives the location of the infestation and the date, as well as the person making the complaint.

TABLE VII. DISTRIBUTION RECORDS

Name	Address	County	Date	
J. C. Mossman	Wichita	Sedgwick	Aug.	17,1908
N. J. Rasmussen	Stafford	Stafford	June	14,1910
Ed. Melcher	Ellingwood	Barton	June	14,1912
C. A. Finney	Ogden	Riley	April	30,1913
J. C. Irwin	Richmond	Franklin	May	19,1913
Adella Conway	Hutchinson	Reno	May	19,1913
Henry Gerding	Kansas City	Wyandotte	Sept.	25,1915
C. W. Vetter	Holton	Jackson	May	23,1918
Alfred Noyse	Steamboat Springs (Colorado)		July	7,1918
W. A. Bentley	Coffeyville	Montgomery	May	9,1919
J. C. Luft	Argentine	Johnson	June	2,1920
Nick Henry	Goff	Nemaha	May	23,1921
W. Finlayson	Washington	Washington	May	25,1921
R. F. Olinger	Altamont	Labette	June	2,1921
J. H. Skinner	Topeka	Shawnee	May	15,1922
W. W. Delton	Grantville	Jefferson	May	21,1922
Joe M. Goodwin	Oskaloosa	Jefferson	May	31,1922
Mrs. L. Plato	Topeka	Shawnee	June	28,1922
Mrs. M. J. Rusmisel	Stafford	Stafford	June	11,1924
Wm. Sapp	St. John	Stafford	April	11,1925
A. L. Peterson	Canton	McPherson	June	1,1927
Paul B. Gwin	Junction City	Geary	July	7,1927
Mrs. Marry McKee	Abilene	Dickinson	March	24,1928
A. C. Chase	Nicherson	Reno	May	15,1928
Mrs. P. W. Hoskin	St. John	Stafford	May	22,1928
A. L. Peterson	Canton	McPherson	May	22,1928
H. H. Carlin	Salina	Saline	May	29,1928
T. A. Zickefoose	Oskaloosa	Jefferson	June	5,1928

There are not enough letters of inquiry to furnish sufficient evidence or to warrant drawing any conclusions. It seems to indicate that weather conditions are not a determining factor as Smith (24) seemed to think they were.

There were some inquiries every year since 1908 except six years, and only two of these came consecutively. It would appear that if weather conditions played a very large part there would be more outstanding years of infestation. There being so many years in which inquiry was made, and representing a wide variation of weather conditions, and not many of them coming consecutively seems to indicate that weather conditions play a rather minor part.

Table VII shows the distribution over the state and also indicates the local nature of the infestations. It indicates further that the outbreaks seldom occur in the same place more than once in a rather long period of time

Figure 1 shows location of infestations obtained from letter files, and also localities studied for weather conditions.

Disease

On June 8 it was discovered that most of the larvae in the life history test were dead or missing. There had been a few days of wet weather at this time and for a few days previous. The leaves which had been folded or worked on by the leaf-roller looked as if they had been scalded with hot water. The dead larvae appeared to have died of some disease and a number of others looked as they were affected with a disease. The next day observations were made in the

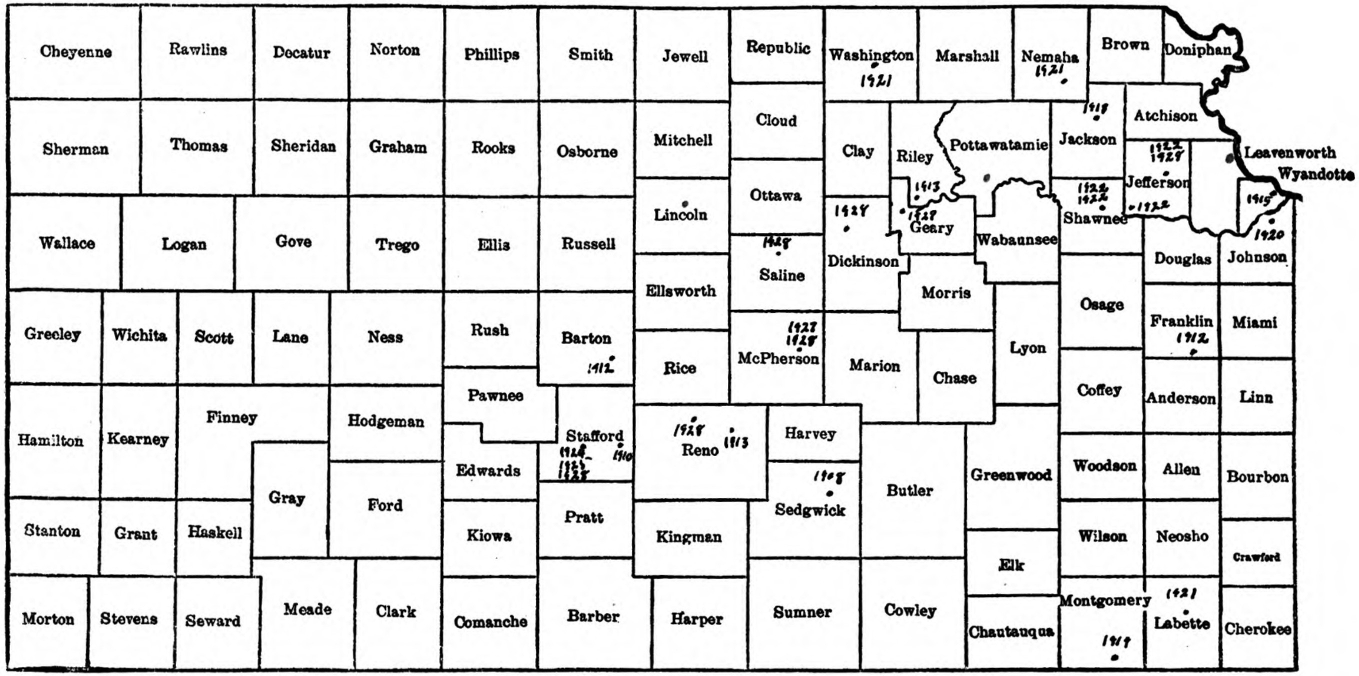

Figure 1.

Black dots show the location of the infestations as shown by the letter files.
Yellow dots show the locations of the localities studied for weather conditions.

fields and similar conditions were found to exist there, but to a much less degree. These facts seemed to indicate that a disease was playing a part in the activities of the strawberry leaf-roller. It will be recalled also from the review of literature that Smith (24) seemed to think that weather conditions played a considerable part and one might expect a disease to play a part when damp, cool weather conditions seemed to be an effective means of checking the activities of an insect, since these are usually the conditions which favor the development of disease. While this line of reasoning does not always work out that way it is at least indicative.

Dr. R. L. Parker suggested that the matter be taken up with Dr. O. H. Elmer of the Department of Botany and Plant Pathology. This was done and on the morning of June 10 he investigated the condition existing in the life history test and decided that a number of the caterpillars had died of what appeared to be a fungous disease. Further investigations were started that day. Upon microscopical examination of some of the caterpillars, spores of numerous fungi were found to be present among which conidia of Phycomycetous fungi were found to be present. Isolation of the organism was attempted by using bits of diseased larvae. Potato dextrose agar was used as a media. Isolations from three different caterpillars yielded growths which were similar and appeared to be the same fungus. This fungus was not determined. The attempts to isolate any of the phycomycetes were unsuccessful. They would not grow in any of the media used (which is a standard media).

At the suggestion of Dr. Elmer the writer started a test to determine the contagiousness of the disease. A number of the larvae which seemed to be affected with the disease were placed in a small porcelain pan and confined under a fruit jar lid, the top of which had been cut out and replaced with screen wire. Leaves of the strawberry plant were put around this lid in the pan and 100 apparently healthy caterpillars placed in the pan and the pan put in a humidity chamber. A check was made by placing 100 apparently healthy caterpillars in another moist chamber under similar conditions except no known diseased larvae were put in the check. Examinations were made at the end of each week, the test being discontinued at the end of the second week. Table VIII shows the results of the test.

TABLE VIII. DISEASE RECORDS

	Test Chamber	Check
Apparently dead of disease	12	5
Apparently diseased larvae	2	4
Apparently healthy larvae	32	19
Apparently normal pupae	32	40
Parasitized larvae	0	2
Drowned (crawled out in water)	9	5
Unaccounted for	13	25
Totals	100	100

<u>End of Second Week</u>

Apparently dead of disease	12	6
Apparently diseased larvae	1	0
Apparently healthy larvae	5	2
Apparently normal pupae	11	10
Parasitized larvae (pupae)	1	0
Drowned	2	0

Attention is called to the number which apparently died of disease in each of the chambers during the two weeks, a total of twenty-four for the test and eleven for the check. The evidence is not strong enough to be conclusive but seems to indicate that a disease did play a small part and that it is more or less contagious.

Parasites of *Ancylis comptana* Frohl.

It will be recalled from the review of literature that Webster (28) in his study of the leaf-roller rarely found a Braconid cocoon. Lewis (35) reports that in accounts of outbreaks at no time have parasites been mentioned as common. Little other mention is made of parasites in the literature. In Kansas the situation seems to be quite different. The fact that the outbreaks are rather sudden and local and that the infestations disappear and do not return even under certain weather conditions, seems to indicate that either weather conditions are not favorable for them and is responsible for the suppression of infestations or that something of a parasitic nature is responsible for this unusual behavior. The fact that there has been an infestation of leaf-rollers somewhere in the state practically every year since 1908 seems to indicate that weather conditions would hardly be responsible for such behavior. Smith's (24) conclusion did not seem to hold true for this section of Kansas in 1928, as shown by the infestation at Wamego especially and at Manhattan and other localities to some extent. At Wamego a heavy infestation occurred in the spring and early summer of 1928. The infestation grew lighter with each succeeding generation until by fall leaf-rollers in any stage were quite hard to find; yet it was a fairly wet summer and fall. As further evidence of the work of some factor of a parasitic nature during the latter part of May and early June of this year (1929) there seemed to be enough larvae hatched to cause a rather heavy infestation. About June 8 the infestation began to get lighter and in a very short time disappeared. A study of the conditions in the field at the time the infestation was becoming lighter revealed evidence of parasitism. Parasitized larvae and parasite pupa cases could be found in the folded leaves.

An attempt was made to discover whether or not the work of these parasites was important, whether there were but one or several species involved and to what species the parasites belonged.

The methods of study have been discussed previously, and need not be mentioned here.

Larvae of the leaf-rollers were collected from three localities, Manhattan, June 10 and 15; Wamego, June 11; and Leavenworth, June 14 and 15. The accompanying table gives the results of rearing the parasites, giving the locality from which the larvae were collected, and the number of parasites in each group.

It has been impossible to get the Hymenopterous parasites identified in time to be included in this paper, so an attempt has been made to divide them into groups represented by the letters of the alphabet. Each group is thought to be a single species. The Dipterous parasites were determined and found to consist of two species of the family Tachinidae and are therefore placed in two groups.

TABLE IX. PARASITE RECORDS

Group	Manhattan	Wamego	Leavenworth	Total
A	30	22		52
B	2	2	5	9
C		2	1	3
D			1	1
E	1	1		2
F			1	1
G	1			1
H	1	1		2
I		3		3
J		5		5
K		1		1
L		1		1
M		1	21	22
N	12	5	1	18
O	4	1	2	7
P		1		1
Q	3	8	15	26
R	3	10		13
S			4	4
T		2		2
U		1		1
V		6	1	7
W 1*	9	4	2	16

* Crawled out of cage and location not determined

Groups A to L, inclusive, belong to the family Braconidae.

Groups N to P, inclusive, belong to the family Ichneumonidae.

Groups Q to U, inclusive, belong to the family Chalcididae.

Groups V and W belong to the family Tachinidae.

Group V is Nemorilla maculosa Meig. and group W is Phorocera tortricis Coq.

According to Aldrich and Webber (33) the literature on Nemorilla maculosa Meig. in Europe is voluminous. They state that it has been reared many times in the United States, always from the larvae of moths and butterflies. It is also recorded from Canada.

The same authors give a list of rearing records of Phorocera tortricis Coq. in which the following is a list of hosts in which it is found: Mineola indiginella Ziller; a tortricid, Cacoecia cerasivorana Fitch; Peronea minuta Weiss; Cacoecia argyrospila Walker. From the same list the following known distribution of this insect is given: Missouri, Michigan, Massachusetts, Vermont, New Jersey and Arkansas.

It may be noted that the strawberry leaf-roller, Ancylis comptana Frohl. does not appear in the list of known distribution. No record has been found where this insect is mentioned as being parasitic on the strawberry leaf-roller.

Attention is called to the fact that of a total of 198 parasites reared, only 23 are Diptera and the remaining 175 are Hymenoptera of which 81 are Braconids, 48 Ichneumonids and 46 are Chalcids. The greatest single group is group A, the second largest is group Q, and the third largest is group M. Since group Q is fairly well divided between the localities, or between the eastern section of the state represented by Leavenworth and the central section represented by Wamego and Manhattan, this group will be discussed later. Attention is called to the fact that all of group A were taken from the central section while all but one of group M were taken at Leavenworth. This seems to indicate that for the central part of the state group A is the most abundant and probably more important parasite.

To determine which of these two is the more important would require further study, but a few points of interest brought out in the table may be pointed out. The first and most important is that in the section where group A is found the leaf-roller at present is not giving any serious trouble, while at Leavenworth where it is not found and where group M is found Professor Dean* reports that serious damage has been done this year. No conclusions can be drawn for it is not known whether or not the species of parasites represented in group A were present here last year at the time serious damage was done, nor can it be said that the results of the work of the species represented

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*Professor George A. Dean, Head of Department of Entomology, Kansas State Agricultural College.

in group M will be within the next year. The second fact to be noted is the greater number of group A as compared with group M. Again this may mean little or nothing. The number of larvae studied was not recorded and in order to keep the work of those being studied so that it could be attended to properly and yet to make it as effective as possible, a certain amount of selecting was practiced with the material collected at Wamego and Manhattan and many of the healthy larvae were discarded while none of the material from Leavenworth was discarded. That might have had something to do with the greater number of parasites in group A. Further, each parasite in group A does not represent a parasitized leaf-roller larvae for as many as nine were known to have come from one host. In the case of group M only one parasite was ever found to a single host, so that each parasite of this group represents a parasitized host. In this respect it may be the more effective. On the other hand, the fact that so many of group A may come from a single host probably means a much more rapid rate of multiplication and, hence, a more effective parasite. One other fact that group A seems to have in its favor is what seems to be an indication of a shorter life cycle. No attempt was made to keep records on the pupal stage but averaging the number of days from the date the material was brought into the laboratory until the date of emergence, the average for group A is 10.9 days while that for group M is 14.9 days. This seems to indicate that very probably the pupal stage is shorter for group A than for group M and if that be true probably the life cycle will be shorter. Further data would be necessary to determine this point. A number of factors would have to be studied before it could be decided which of these two parasites is the more effective, but since they occur in greater abundance in the localities they represent they very probably are the most important parasites in these localities.

Group Q as may be seen from the table are Chalcids and were reared from material from all three localities represented, which makes the group from any one locality smaller than that represented by groups A or M. A rather large number of them may also emerge from a single host larvae, so the same points hold true for it as for those of group A, namely, that each parasite does not represent a host destroyed but may represent a greater capacity for reproduction. There is some doubt, too, as to whether this is a primary or a secondary parasite. A large number of this group emerged from a leaf-roller pupa case. The parasites of group N did the same. The parasites of group N are much larger than those of group Q, making it probable that it is a primary parasite, but there remains a doubt as to whether those of group Q were parasitic on the leaf-roller or on a parasite of group N. Others of this same group emerged from small white cocoons, which seems to indicate that they are two distinct species, or that the little white cocoons were cocoons of some other parasite and the members of this group were parasitic on these.

Two of the members of group R emerged from a large white cocoon very much like those made by C and O and which was by far too large for insects of their size. These facts seem to indicate that groups Q and R and probably others of the Chalcids are secondary parasites.

A few things were observed in the study of parasites that seem to be worthy of mention. The work of the parasites in group A was quite distinct from the rest. The larvae of the leaf-roller in some cases could be found dead or almost dead and the larvae of the parasite which looks very much like maggots, could be seen crawling over the leaf-roller larva. By examining the dead or dying leaf-roller larvae holes could be observed in its skin where the parasite larvae had worked their way out. In other cases the leaf-roller larvae could be found dead with a number of pupa cases near by showing that the parasites had killed the leaf-roller larvae and had crawled out and pupated. This condition is shown in Plate I, figure 1. When parasitized by this parasite the leaf-roller larvae were never allowed to become fully grown.

The work of the Dipterous parasites was quite distinct, also. Larvae of the leaf-roller could be found with white spots or eggs about the head and thorax. These larvae would appear normal in other ways and would grow to maturity and apparently pupate normally. A day or two after pupation had taken place the parasite larva would work its way out of the leaf-roller pupa case and pupate either in the end of it or near by. This is shown in Plate I, figure 2.

In groups H and K the parasitized larvae would cease to grow and begin to dry up and turn brown. The middle portion would not shrivel as the ends did and finally the parasites emerged from this old dried skin. In this case the leaf-roller larvae did not reach full development.

In the case of group N the leaf-roller larvae grew to maturity and apparently pupated normally but instead of an adult leaf-roller emerging from the pupa case, an adult parasite emerged.

When it was learned that parasites and probably predi-tors were playing a rather large part in the suppression of the infestation of the leaf-roller an attempt was made to get some estimate of the part they were playing. Leaves which were folded were examined to see if it could be determined what had become of the larvae if it was not present. The first study of this kind was made at Wamego June 11 at which time very few, if any, of the adults had emerged. If normal emergence had taken place in most cases the pupa case is left in the leaf so that it could be accounted for. Four hundred leaves were examined from Wamego and of the first one hundred, 46 could not be accounted for, 48 of the second and of the third one hundred could not be accounted for and 39 of the fourth one hundred. This makes an average of 45.25 per one hundred that could not be accounted for.

From material collected at Manhattan 600 leaves were examined and the numbers of missing larvae from each 100 leaves were as follows: 82, 84, 73, 69, 67, 80 or a total of 455, an average of approximately 76 per hundred. For the 1000 leaves examined 636 could not be accounted for and it is known from the table that parasites were at least partly responsible for their not being there. There is strong evidence also that preditors are partly responsible for their disappearance. Whether or not any other factors were responsible is not known but indications are that parasites and preditors had a lot to do with destroying them.

A Few Distinctive Pupa Cases. In group A the pupa cases range from white to yellow in color depending upon the age and exposure. They are found in clusters of from two to nine. They are usually found near the dried skin of the leaf-roller larva which they killed.

The pupa cases of groups H and K are really the old larval skins of the leaf-roller. The head and some of the legs of the leaf-roller larva can be seen on the pupa case after the adult parasite has emerged.

The insects of group M have a distinct pupa case. It is composed of a parchment-like material and is a dark gray or smoky color. It is oblong in shape, about twice as long as thick. The insect emerges by making a hole in the end of the pupa case. The edges of the hole are not smooth, but are fringed with ends of fiber. These pupa cases are usually found in the folded leaf.

In group N the parasites pupate within the pupa case of the leaf-roller.

The insects of group Q emerged from two different pupa cases. In one case they emerged from white pupa cases, several being in a cluster. In the second case they emerged from the pupa case of the leaf-roller.

In group R only one pupa case was secured and this was too large for so small an insect.

In group S there was practically no pupa case, only a few strands of fiber, and the mortality of this group was very great so it is quite probable that the small amount of fiber secured is not the normal pupa case, but that conditions were such that they could not develop normally.

For the rest of the groups there was nothing unusual about the pupa cases or they were not secured. In a few instances the pupa cases were practically destroyed when the adult emerged.

Preditors

Some evidences were found which seemed to indicate that preditors also have a part in the control of the strawberry leaf-roller.

From the review of literature it will be recalled that Dunnam (38) found spiders abundant in the fields, which were thought to be feeding on the larvae of the leaf-roller. Webster (28) found no natural enemies in abundance. Smith (24) observed ground beetles in abundance but did not think that they could be of much importance.

Twice during the present study ants have given trouble in the cages where the leaf-rollers were confined. In the first instance they destroyed the pupa case before the adult emerged. In the second instance adults were eaten by the ants, but it is believed that the adults were either dead or in a very weakened condition. The pupa may have been dead also, though it appeared to be in good condition until the ants were discovered, at which time a hole had been eaten into the pupa case and the contents eaten out.

Nothing has been found to indicate that they are of any importance under field conditions.

On June 15 a dead larva of the leaf-roller was found in a folded leaf with a Chrysopid larva, and two more Chrysopid larvae were found in folded leaves. These were thought to have been feeding on the larvae of the strawberry leaf-roller.

On June 9, 10 and 15 small Hemipteron, Orius insidiosus Say., were found quite often in folded leaves with dead larvae of the leaf-roller. At first little attention was given these as there was some doubt as to whether or not they were preditors or only feeding on the dead larva after something else had killed it. Their small size, too, made it necessary to take them to the laboratory to determine just what they were. Later some were collected and larvae of the leaf-roller were put in the cage with them but as far as could be determined they did not feed while in the cage. Due to so many other things calling for attention at this time it was impossible to give this phase of the work as much attention as should have been given it.

June 12 a spider (away for identification) was observed with the larva of a leaf-roller in its mouth. Folded leaves had been gathered at Wamego the day before and when putting these larvae into vials and boxes for the study of parasites this spider was observed. The spider and leaf-roller larvae were placed in a vial but the larvae were not eaten. It is said to be quite difficult to get spiders to feed when they are confined. This may be responsible for the fact that the spider would not eat the larvae put in the vial.

Egg masses of spiders were often found in the folded leaves and on June 18 one of these masses was put in a lamp chimney cage and the little spiders allowed to hatch, which occurred June 30. Larvae of the leaf-roller were put into the cage. Feeding was never observed but the little spiders were often found in the folded leaf with the leaf-roller larva and the heads and other remains of leaf-roller larvae were found in the cage, so it is known that they were feeding on the leaf-roller larvae. Larvae of different sizes were put in the cage but only the smaller ones were eaten. The spiders are quite small too, and as they grow larger probably it will take a larger larvae to satisfy their hunger. One of the larger larvae put in the cage was found dead but something else may have been responsible for its death.

At this time this work is still being carried on and the little spiders seem to be doing well on their leaf-roller diet.

SUMMARY AND CONCLUSION

The results of this work may be summarized as follows:

The strawberry leaf-roller seems to have a preference for certain varieties, but no variety tried was abhorrent to the insect.

No substance was found that would attract the insect.

The size of the egg is 0.671 ± 0.0054 mm. by 0.440 ± 0.0034 mm.

The average length of the egg stage is 22.78 ± 0.668 days at a mean temperature of 56.8° F.

The average length of the larval stage is 37 days at an average daily temperature of 67.2° F.

The average length of the pupal stage is from 10 to 11 days.

Infestations may occur even during periods of cool, damp weather. These infestations are local and usually do not last for a very long period of time.

Disease may play a minor part in the activities but no definite proof of this part played or as to its size has been obtained.

A series of parasites, of 198 individuals were reared from the larvae of this insect, believed to represent twenty-three species, two of which are Diptera and the rest

Hymenoptera. There is some evidence that certain of the Hymenoptera are secondary parasites. Apparently, parasites are playing a very large part in the behavior of the leaf-roller in Kansas.

Evidence was secured that indicated that preditors were partly responsible for the local nature of the infestations of this insect.

The data presented herein seems to indicate (1) that there is considerable variation in the egg stage, due probably, to variation in temperature. The other stages in the life history are not greatly different from that of other workers and for other states.

(2) That parasites and preditors are playing a rather large part in the activities of the leaf-roller.

(3) That rainfall and temperature have not played a large part at the time and under the conditions this study was made in the various localities in Kansas.

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PLATE I

Figure 1.

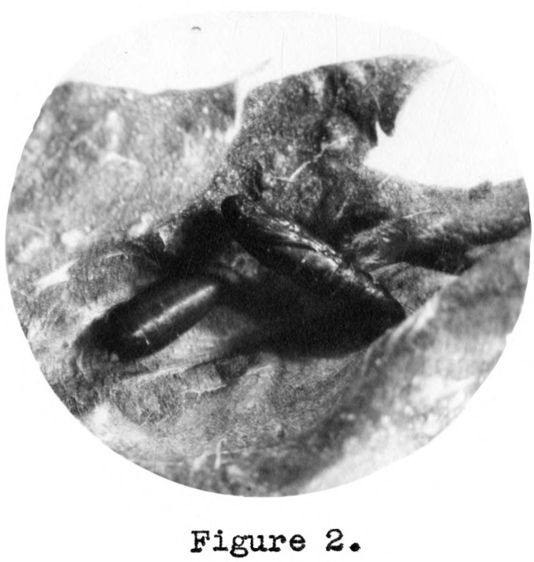

Figure 2.

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Supplement
to
Masters Thesis

The Biology and Synonomy of the Parasites of the Strawberry Leaf Roller, *Ancylis comptana* Froel. (Lepidoptera, Tortricidae), Found in Kansas [1]

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INTRODUCTION

While making a biological study of the strawberry leaf roller (*Ancylis comptana* Froel.) in 1929, it was found that the outbreaks of this insect had been quite local, that they appeared rather suddenly and were quite destructive and that infestations disappeared almost as suddenly as they appeared. Outbreaks seldom occurred twice in the same locality except where a considerable number of years had elapsed between the outbreaks. This suggested the possibility of parasites playing a rather large part in the fluctuations in numbers of this insect. In the spring of 1929, in the vicinities of Manhattan and Wamego, these leaf rollers were so plentiful that it appeared that great injury might be done to the strawberry fields. By the last of May the infestations were growing lighter and were materially reduced by June 8. By this time parasitized larvae and pupae could be found in the rolled leaves. Since evidence showed that parasites were playing an important part in the activities of this insect, a study was made to determine the species which were responsible for the beneficial results in the control of this leaf roller and if one species was more responsible for the reduction of leaf roller infestation than another. Eighteen hymenopterous and two dipterous parasites are discussed in this paper.

ECONOMIC IMPORTANCE

Webster (*109*), in his study of the strawberry leaf roller, rarely found a braconid cocoon. Lewis (*73*) reported that in accounts of outbreaks, parasites have not been mentioned as common. Little other mention is made of parasites in the literature. In Kansas the situation appears to have been somewhat different. The fact that infestations have been local, and seldom, if ever, occur twice in the same place without the lapse of several years and the fact that severe infestations disappear where no effort is made to stop them, indicates that under Kansas conditions parasites play a rather important part in keeping this leaf roller under control.

METHODS OF REARING PARASITES

Larvae of the strawberry leaf roller were collected for biological study from the strawberry fields and confined in cages with a small amount of strawberry leaf for food and a small amount of blotting paper to hold water to regulate the moisture. Life history studies ceased in the laboratory early in June, due to the fact that all or nearly all of the larval hosts were parasitized. Two types of cages were used and both types were very satisfactory. One type of cage

1. This paper is a partial fulfillment of work for a master of science degree and was done under the direction of Dr. R. L. Parker of the Kansas State College of Agriculture and Applied Science, to whom the writer wishes to express thanks for the general supervision of the work and for bibliographical work in the preparation of this paper, as well as suggestions and criticism of the paper. Credit is due Dr. Harold Morrison and his co-workers of the United States National Museum, Washington, D. C., for the determination of the species of parasitic Hymenoptera and for supplying certain information about them which could not be obtained from libraries. Credit is also due Mr. H. J. Reinhard of the Texas Agricultural Experiment Station for the determination of the two species of dipterous parasites.

2. Junior entomologist, Bureau of Entomology and Plant Quarantine.

was a small shell vial plugged with cotton. This type of cage permitted examination for detection of the emergence of parasites without opening the cage. The other type of cage was a one-ounce tin salve box. The strawberry leaf did not dry out so readily in this cage, but it was a little more difficult to examine the larvae without allowing any parasites, which had emerged, to escape. This was overcome by using a corrugated cardboard box (about 12" x 8" x 6") with a pane of glass (8" x 6") fastened in the top. Two holes were made in one end or on either side of the box to permit manipulation. A cloth flap covered the holes. This device can be improved by fastening extra pieces of cardboard or paper diagonally across the upper corners of the box on the inside, so that the sides would curve gradually to the glass instead of leaving corners in which the liberated parasite could hide. The inside of the box should be painted white to reflect light and form a background on which the black or brown insects would be easily seen. The tin boxes were examined in this trap to recapture escaping parasites. These cages were examined daily; moisture and fresh leaves, which had been carefully examined to see that no other insect was introduced, were added as needed. Only one larva was kept in each cage.

SYNONOMY

Discussion, Distribution and Hosts of Parasites

Apanteles canarsiae Ashmead (*7*). 1897. (Braconidae)

Musebeck (76) in 1921 gave the synonomy of this insect as follows:

Urogaster canarsiae Ashmead. Proc. Ent. Soc. Washington, 4, 127. 1897.

Apanteles (Apanteles) hausatannuckorum Viereck. Conn. Geol. and Nat. Hist. Survey, Bul. 22, 189 and 198. 1916.

Apanteles (Apanteles) maquinnai Viereck. Conn. Geol. and Nat. Hist, Survey, Bul. 22, 190 and 199. 1916.

Chittenden (*19*), Frost (*38*) and Hough (*51*) list *A. canarsiae* as a parasite of the red-banded leaf roller, though the latter did not rear it from this host. Johnson and Hammer (*65*) list it as a parasite of the grape-berry moth. Slingerland (*88*) states that it is parasitic on the apple leaf skeletonizer. Strauss (*90*) listed it as a parasite of the grape leaf folder.

Six specimens of this species were reared from strawberry leaf-roller larvae which were collected from Wamego.

Distribution: Illinois, Virginia, Iowa, Connecticut and the District of Columbia (all *76*).

Hosts:

Desmia funeralis Hubner	Grape-leaf folder.
Polychrosis viteana Clem.	Grape-berry moth.
Eulia velutinana Walk.	Red-banded leaf roller.
Psorosian hammondi Riley	————
Canarsia hammondi Riley	Apple leaf skeletonizer.

Brachymeria ovata (Say). 1824. (Chalcididae)

Dalla Torre (*29b*)[3] lists the synonomy of this insect as follows:

Chalcis flavipes Fab. Entom. System., II, 197. 1793.

Chalcis flavipes Fab. Syst. Piez., 167. 1804.

Chalcis flavipes Jurine. Nouv. Meth Chass. Hymen., 315. 1807.

Chalcis ovata Say. Keatings Narrat Exped., II, 326. 1824.

Chalcis annulipes (Laporte) Walker. Entom. Magaz., II, 29. 1834.

Chalcis ovata Leconte. Writ. of the Say Ento., I, 219. 1859.

Chalcis inerta Cresson. Proc. Entom. Soc. Phila., IV, 101. 1865.

Brachymeria panamensis Holmgren. Eugenies Reca. Insect., 437. 1868.
Chalcis ovata Cresson. Trans. Amer. Ent. Soc., IV, 59. 1872.
Chalcis ovata Lintner. 1st. Ann. Rep. Insects, New York, 86. 1882.
Chalcis flavipes W. F. Kirby. Jour. Linn. Soc. Zoöl., 17, 68. 1883.
Chalcis ovata Cameron. Biol. Cent. Amer., 31. Hymen., I, 99. 1884.
Chalcis ovata Provancher. Addit. Faun. Can. Hymen., 190. 1887.
Chalcis flavipes Howard. Scudder, Butterflies U. S. 88, 1889: Figs. 14-15.

There is considerable comment in the literature regarding the economic value of *B. ovata* (Say). Howard (*53*) listed *Chalcis flavipes* Fab. as a secondary parasite of *Tachina larvarum* L. which was being imported at that time as a primary parasite of the gypsy and brown-tail moths. In another paper (*54*) he speaks of importing *Chalcis flavipes* and liberating them, and in still another paper (*58*) he says, "*Chalcis ovata* Say has never been reared as a parasite of the gypsy moth, although it is not improbable that it will be found to attack it when the moth shall extend its range southward into territory where the chalcid is more common than it appears to be in eastern Massachusetts."

According to Britton (*11*) Howard, in 1895, reported that ninety percent of the white marked tussock moths were killed by parasites, and *B. ovata* was rated second in the list. Tucker (*97*), reporting on the elegant looper, states that a large proportion of the pupae are killed by parasites and that *Chalcis ovata* proved to be the prevalent parasite. Watson (*107*) states that *C. ovata* prevents the okra caterpillar from becoming a greater pest. Horton (*52*) states that *C. ovata* frequently attacks a butterfly which is injurious to orange trees in California. Fracker (*36*) gives *C. ovata* and two other parasites the credit for reducing to a minimum a species of tussock moth which was doing serious damage in 1922. Walcott (*116* and *117*) reports that the cotton worm is largely kept in check in Puerto Rico by parasites which include *Chalcis inerta* Cress.

This species did not appear to be of great importance as a parasite of the strawberry leaf roller in 1929.

Distribution: New Mexico (*1*); Tenn. (*2*); Conn. (*11*); La. & Texas (*30*); La. (*97*); Wis. (*36*); Calif.(*52*); Texas (*59*); N. Y. (*72*); Va. (*84*); N. C. (*89*); Neb. (*92*); Fla. (*107*).

Hosts:

Hemileuca sp.	Hemileuca moth
Pyrausta penitalis Grote	Lotus borer
Anticarsia gemmatilis Hubner	Velvet bean caterpillar
Cosmophila erosa Hubner	Okra or mallow caterpillar
Olene leucophaea A. & S.	Tussock moth sp.
Hemerocampa leucostigma S. & A.	White marked tussock moth
Papilio zolicaon Boisd	A swallow-tail butterfly
Thyridopteryx ephemeraeformis Haw	Bagworm sp.
Alabama agrillacea Hubner	Cotton worm
Tachina larvarum L.	Tachinid fly
Hemileuca oliviae Ckll	New Mexico range caterpillar
Diaphania nitidalis Stoll	Pickle worm
Philtraea elegantaria Hy. Edw.	Elegant looper
Eurymus eurythema Boisd	Alfalfa caterpillar

3. Attention is called to the fact that there is some doubt about the synonomy of these names (see synonomy listed above). Dr. Harold Morrison, of the United States National Museum, states (in personal letter) "Dalla Torre's catalogue is not to be followed in the synonomy of the species." There seems to be no publication at this time that is reliable for the synonomy of this species. Where there is no later publication giving the synonomy, Dalla Torre's catalogue is referred to.

Casinaria infesta (Cresson) (*23*). 1872. (Ichneumonidae)

Gahan (*40*) gives the following synonyms:

Limneria infesta Cresson. Amer. Ent. Soc., 4, 172. 1872.
Limnerium sessilis Ashmead. Proc. U. S. Nat. Mus., 12, 433. 1890.
Limnerium erythrogaster Ashmead. Proc. U. S. Nat. Mus., 13, 434. 1890.
Limnerium ashmeadi Dalla Torre. Cat. Hymen., 3, 90. 1901.
Anempheres diaphaniac Viereck. Proc. U. S. Nat. Mus., 4, 188. 1912.
Amorphota orgyiae Howard.
Chittenden (20) used *Amorphota infesta* Cresson.

Hamlin (*48*) listed *C. infesta* as the foremost parasite of *Mimorista flavidissimalis*. There seems to be some doubt as to the species. Swezey (*95*) says this parasite cannot be considered of much importance in Hawaii, since the hosts which it attacks are largely kept under control by other native parasites. He says, however, that when a larva of any one of nine different pyralids is found to be parasitized, it is more often parasitized by *C. infesta* than any other species. Viereck (*100*) says this species was bred from a pupa of *Diaphania hyalinata*.

In this work only one specimen was reared from the strawberry leaf roller, *Ancylis comptana*, and therefore did not appear to be of very great importance for this host under Kansas conditions.

Distribution: D. C. (*6*); Alabama (*6*); N. C. (*100*); Cal. (*20*); Texas (*48*); and Hawaii (*95*); Florida to Maryland and west to Kansas and Texas (*95*).

Hosts:

Phlyctaenia rubigalis Green	The celery leaf-tyer
Mimorista flavidissimalis Grot	————
Diaphania hyalinata L	Melon worm
Hymenia fascialis Cr	Hawaiian beet webworm

Chorinaeus n. sp. (Ichneumonidae)

Seventeen specimens of this species were reared from the strawberry leaf roller larvae collected at Leavenworth. The species was determined as new at the United States National Museum and fifteen of the specimens were retained; the other two are in the collection of the Kansas State College.

The larvae which were parasitized by this parasite grew to maturity and apparently pupated normally, but instead of an adult leaf roller emerging from the pupae, an adult parasite emerged. There were some indications that this species probably is a primary parasite of the leaf roller and that it in turn was parasitized by *Horiamenus microgaster* (Ashmead).

Clinocentrus sp. (Braconidae)

Three specimens of this species were reared from the strawberry leaf roller which came from Wamego, Kan., all of which are in the United States National Museum.

The larvae which were parasitized by this parasite did not reach maturity. They would cease growing and begin to shrivel at the ends and turn brown. The parasite emerged from this dried unshriveled middle portion. In other words, the old dried up larval skin of the host became the puparium of the parasite and in some cases the head and legs of the host larvae could be seen on the puparium after the adult parasite emerged.

Cremastus cookii Weed. 1888. (Ichneumonidae)

Temelucha cookii Ashmead.

Webster (*109*) reported this insect as a parasite of the strawberry leaf roller in Iowa. Lewis (*73*) just makes mention of it. Fink (*34*) says that fifteen percent of the larvae of the strawberry leaf roller in New Jersey were parasitized by this species. According to his observations its habit of parasitizing the host resembles that of *Macrocentrus ancylivora* Rohwer.

This was one of the more important species encounted during these studies. It appeared to be the predominating species in the vicinity of Leavenworth. All of the specimens except one came from that locality. Probably there were as many parasitized host larvae represented by this species as of any of the other species, as this species was solitary in habit while many of the others were gregarious.

Distribution: New Jersey (*34*); Ohio (*73*); Iowa (*109*).

Host:

Ancylis comptana Froel.

Oncophanes atriceps (Ashmead). (*5*). 1888. (Braconidae)

Rhyssalus atriceps Ashmead. Proc. U. S. Nat. Mus., 11, 628. 1888.
Oncophanes atriceps (Ashm). Annals, Ent. Soc. Amer., 28, 241-243. 1935.

Hough (*51*), while studying the biology of the red-banded leaf roller, found this species to be the most common parasite of this host. Frost (*39*) reported having reared it from the dusky leaf roller on several occasions.

This was the predominating species of parasites of strawberry leaf roller around Wamego and Manhattan. More specimens of this species were taken than any other during these studies. However, since several parasites usually live at the expense of a single host larva, no more larvae may have been parasitized by this species than some of the other species. Nine parasites were secured from one host larva. Lewis (*73*) secured ten specimens from one larva of a different host. Where this species was abundant the infestation of leaf rollers generally was on the decline; however, it was the second year of the infestation in these localities which may partly explain their effectiveness.

Distribution: Michigan (*60*); Ohio (*19*); Penn. (*38* and *39*); Virginia (*51*), and N. Y. (*72*).

Hosts:

Amorbia humerosana Clem.	Dusky leaf roller
Archips rosaceana Harris	————
Cacoecia rosaceana Harris	Oblique-banded leaf roller
Gelechia confusella Cham	Striped peach worm
Eulia velutiana Walk	Red-banded leaf roller
Ancylis comptana Froel	Strawberry leaf roller

Lewis (*73*) reared ten specimens from an undetermined host larvae, probably either *Playnota flavedana* Clem. or *Cacoecia paralellela* Rob.

Epiurus indagator (Cresson) (*22*). 1870. (Ichneumonidae)

Pimpla indagatrix Walsh. Trans. Am. Ent. Soc., 3, 146. 1870.
Pimpla indagatrix Walsh. Trans. Acad. Sci. St. Louis, 3, 141. 1873.
Scambus indigator Walsh. Psyche. 19, 97, 1922; and Proc. Ent. Soc., Nova Scotia, 3, 67. 1918.

In addition to these synonyms Dalls Tore (29a) lists:

Pimpla indigatrix Riley. Fourth Ann. Rept. Insects Mo., 43. 1872.
Pimpla indigatrix Provancher. Natural Canad., 12, 37. 1880.
Pimpla indigatrix Provancher. Faun. Entom. Canada Hymen, 460. 1883.

According to information from Cushman, the name "indagator" originated with Walsh, but Cresson was the first to publish it and to describe the species. Cresson is therefore the author.

Payne (*81*) and Hartzell (*50*) list this species as a pupal parasite. Johnson and Hammar (*65*), Porter and Garman, (*85*), Newcomer and Whitcomb (*79*), and Cushman (*28*) list it as a larval parasite. Cushman and also Porter and Garman say that oviposition takes place in the large or full-grown larvae and the parasite emerges from the host cocoon. Cushman further states: "This species is solitary; the cocoon consists of a thin silken lining to the burrow of the host." Balduf (*8*) gives a very interesting paper on the relation of this insect to a cynipid gall maker, *Disholcaspis mamma* (Walsh). Here he presents evidence to show that probably this insect requires a certain amount of plant tissue to balance the diet secured from its animal host, as is shown by a certain amount of feeding, just before pupation, on the gall of its host. Other authors are cited who concur in this opinion. He also brings out the possibility of a required alternate host and that when *D. mamma* is the host the parasite passes the winter as a larva in the host larva. McConnell (*74*) reporting on the parasites of the oriental fruit month, *Grapholitha molesta* Busck, in western Maryland, names two species of parasites of which *Epiurus indagator* is one, which are recovered in greater numbers than any others and says they have been reared from over-wintering larvae and observed throughout the season in limited numbers. Woods (*118*) discussing a fruit caterpillar, *Epinotia sp.*, "This insect was rather abundant in 1913, but was extensively parasitized which so reduced its numbers that it was quite rare in 1914 and had not appreciably reëstablished itself in 1915." This author gives some notes on the biology of this parasite and says that it is beyond doubt a larval parasite.

Only two specimens of this species were taken during these studies, and, while it is reported by Fink (*34*) as a parasite af the strawberry leaf roller, in neither case was it sufficiently abundant to be classed as of much importance.

Distribution: Canada (*8*), Missouri (*19*), N. J. (*34*), Colorado (*42*), Virginia (*51 and 74*), Michigan (*60*), Penn. (*17*), Ohio and N. Y. (*65*), Washington (*79*), and Nova Scotia (*81*), Conn. (*85*), Eastern half of United States and Southern Canada (*28*), Maine (*118*).

Hosts:

Mineola indigenella Zeller	———
Polychrosis viteana Clem	Grape-berry moth
Archips argyrospila Walk	Fruit-tree leaf roller
Notolophus antiqua L	Rusty tussock moth
Eulia pinatubana Kearfott	Pine tube moth
Hemerophila pariana (Clerck)	Apple and thorn skeletonizer
Gelechia confusella Chambers	Striped peach worm
Eulia velutinana Walk	Red-banded leaf roller
Carpocapsa pomonella L	Codling moth
Rhyacionia frustrana (Comstock)	Pine tip moth
Grapholitha molesta Busck	Oriental fruit moth
Phthorimaea glochinella Zell	———

Hosts—*Concluded.*

Phthorimaea operculella Zell	Potato-tuber moth
Ancylis comptana Froel	Strawberry leaf roller
Hemerocampa leucostigma S. & A	White marked tussock moth
Epinotia sp	Fruit caterpillar

Hoplocryptus incertulus Cushman.[4] (Ichneumonidae)

Hoplocryptus incertulus was first described by Cresson as *Cryptus incertus*. This name was preoccupied by *C. incertus* Ratz. "The name *incertulus* was devised by Viereck, but apparently was never published." Cushman (*27*) was the first to properly name the species and publish it.

Cryptus incertus Cresson (not Ratzenburg). Proc. Ent. Soc. Phil., 3, 306. 1864.
Phygadenon latus (Prov.). Dalla Torre. Catalogus Hymenopterorum., 3. 1901.
Itamplex incertulus Vier. Listed in Dalla Torre, but the paper seems to have been lost or was never published. (R. A. Cushman.)

Dunnam (*32*), McConnell (*75*), and Lewis (*73*) all reared this parasite from the strawberry leaf roller. McConnell (*75*) also states that it is a common parasite of this host and of the oriental fruit moth.

Six specimens of this species from all three localities were reared during these studies.

Distribution: Iowa (*32*), Maryland (*75*), Ohio (*73*), and Delaware (*106*).

Hosts:

Ancylis comptana Froel	Strawberry leaf roller
Grapholitha molesta Busck	Oriental fruit moth

Horismenus microgaster (Ashmead). (*4*). 1888. (Chalcididae)

Holcopelte microgaster. Ashmead (*4*). 1888.

All of the literature found which deals with this insect is concerning the catalpa sphinx, *Ceratomia catalpae* Bd. and its parasites. *Apanteles catalpae* Riley seems to be the predominating primary parasite and *Horismenus microgaster* Ashm. as a secondary parasite. In some cases the secondary parasite outnumbered the primary parasite four to one and it was thought that this secondary parasite prevented the primary parasite from being more effective in keeping the catalpa sphinx under control.

This species showed considerable evidence of being a secondary parasite and appeared to be parasitic on more than one of the other species obtained. The presence of this hyperparasite probably offers some explanation as to why parasites are not more effective than they are in holding the strawberry leaf roller in subjection. Apparently *Horismenus microgaster* was a hyperparasite on *Chroinaeus* n. sp. By a further study of the pupa cases from which this species emerged other hosts might be fairly definitely established, but this material was not available to the writer. This species was obtained from all three of the localities studied.

Distribution: Missouri (*4*), Ohio (*14, 15, 21*). This parasite probably occurs wherever the catalpa sphinx occurs, and Howard and Chittenden (*57*) give that as covering all of the United States from Texas and the Dakotas eastward.

Hosts:

Ceratomia catalpae Bd	Catalpa sphinx, indirect host
Apanteles catalpae Riley, direct host	———
Microgaster sp	———

4. Much of the information on this species has been supplied by Dr. Harold Morrison of the U. S. Nat. Mus. and his coworkers.

Meteorus trachynotus Viereck (102). 1912. (Braconidae)

Meteorus trachynotus Viereck. Proc. U. S. Nat. Mus., 42, 142. 1912.
Meteorus archipsidis Viereck. Proc. U. S. Nat. Mus., 43, 579. 1912.

Lewis (*73*) listed this species as a probable parasite of the strawberry leaf roller, *Ancylis comptana* Froel., having reared it from folded strawberry leaves. Dunnam (*32*) reared it from this host.

During these studies only one specimen of this species was reared from the strawberry leaf roller.

Distribution: Muesbeck (*77*); "Canada, New York, Pennsylvania, New Jersey, California, Colorado, Utah, Vancouver Island, Louisiana, Massachusetts, New Hampshire, Maine, Florida; probably occurs throughout the United States and at least southern Canada." In addition to this list it is recorded from Ohio (*73*) and Iowa (*32*).

Hosts:

Tortrix fumiferana Clemens	Spruce bud-worm
Archips argyrospila Walk	Fruit-tree leaf roller
Cacoecia argyrospila (Viereck)	Fruit-tree leaf roller
Ancylis comptana Froel	Strawberry leaf roller
Ania limbata Harv	————
Ancylis sp. and *Wilsonia* sp	————

Microbracon gelechiae (Ashmead). (*5*). 1888. (Braconidae)

Muesebeck (*78*) listed the following synonyms:

Bracon gelechiae Ashmead. Proc. U. S. Nat. Mus., 11, 623. 1889 (1888).
Bracon notaticeps Ashmead. Proc. U. S. Nat. Mus., 11, 624. 1889 (1888).
Bracon sp. Riley and Howard. Insect Life, 2, 349. 1890.
Habrobracon gelechiae Johnson. Ent. News, 6, 324. 1895.
Bracon sp. Johannsen and Patch. Maine Agr. Exp. Sta., 195, 243. 1912.
Habrobracon johannseni Viereck. Proc. U. S. Nat. Mus., 42, 622. 1913.
Habrobracon tetralophae Viereck. Proc. U. S. Nat. Mus., 42, 623. 1913.
Habrobracon gelechiae Cushman. Proc. Ent. Soc. Wash., 16, 106. 1914.
Habrobracon johannseni Cushman. Proc. Ent. Soc. Wash., 16, 107. 1914.
Habrobarcon gelechiae Stearns. Jour. Econ Ent., 12, 348. 1919.

Graf (*46*) listed this species as first in importance in 1914, but as fifth in 1915 as a parasite of the potato tuber moth. He also gives some information on the biology of this insect. Stearns (*91*) records, for the first time, this insect as a parasite of the oriental fruit moth and says that it attacks this host in the larval stage. Howard (*56*) calls attention to a very interesting discovery of Mr. B. Trouvelat with regard to the way this species feeds on the body fluids of the larvae of the potato tuber moth. Porter and Garman (*85*) reported this species as a larval parasite of the apple and thorn skeletonizer and they say these larvae collapse before reaching maturity. Cushman (*28*) classed it as a larval parasite of the pine tip moth, and adds that it is gregarious. Poos and Peters (*83*) give a list of native parasites for Virginia and this species heads the list. In 1928 Poos (*84*) reported this species as the most important parasite of the potato tuber moth during the early part of the year, while another parasite became more important in the latter part of the year. Flanders (*35*) found the larvae of the lima bean pod borer to be 5.3 percent parasitized while the same host was 40 percent parasitized on wild pea by this parasite.

This parasite did not seem to be of much importance as a parasite of the strawberry leaf roller at the places and during the time these studies were made. Only six specimens were reared, but this seems to be the first time that it has been recorded as a parasite of this host.

Distribution: Throughout United States; several foreign countries.

Hosts:

Galechiae sp. (Ashmead)	———
(*Gelechiae*) *Phlhorimaea cinerella* Murtfeldt (Ashmead)	Oak-leaf skeletonizer
(*Tetralopha*) *Wanda baptisiella* Fernald (Viereck)	Four spotted oak-leaf tyer
(*Gelechia*) *Aristotelia roseosuffusella* Clemens (Riley and Howard)	———
Canarsia hammondi Riley	———
Pyrausta nubilalis Hubner	European corn borer
Grapholitha molesta Busck	Oriental fruit moth
Gelechia hibiscella Busck	———
Phthorimaea operculella Zeller	Potato tuber moth
Papaipema sp. (in pinks)	Common stalk borer
Desmia funeralis Hubner	Grape-leaf folder
Polychrosis viteana Clemens	Grape-berry moth
Archips argyrospila Walker	Fruit-tree leaf roller
Hemerophila pariana (Clerck)	Apple and thorn skeletonizer
Rhyacionia frustrana (Comstock)	Pine tip moth
Phthorimaea glochinella Zell	———
Bedellia somnulentella Zell	———
Diatraece zeacolella Dyar	———
Etiella schisticolor Zeller	Legume pod moth
Ancylis comptana Froel	Strawberry leaf roller

Microbracon politiventris (Cushman). (*25*). 1919. (Braconidae)

Habrobracon politiventris Cushman. Proc. U. S. Nat. Mus., 55, 517. 1919.

According to Muesebeck (*78*), "The parasite is gregarious, several individuals developing on a single host." There seems to be nothing in the literature on this insect as to its economic importance.

Seven specimens of this species were reared during these studies. These were fairly evenly divided between the three localities studied.

Distribution: "From Maine to Virginia and west to Iowa," Muesebeck (*78*). Cushman (*25*) gives northeast Pennsylvania as the type locality.

Hosts:

Polychrosis viteana Clemens	Grape-berry moth
Eulia triferane Walker	———
Archips paralella Robinson	———
Pandemis lamprosana Robinson	———
Conotrachelus nenuphar Hbst	Plum curculio
Grapholitha molesta Busck	Oriental fruit moth

Microgaster comptanae Viereck (100). 1911. (Braconidae)

Lewis (*73*): "This parasite was taken in the fall of 1923 and was common throughout the season of 1924. It was also reared from the over-wintering generation and was taken from both larvae and pupae . . ."

Only four specimens of this species were taken, three from Wamego and one from Leavenworth.

Distribution: Ohio (*73*) and Colorado (*100*).

Hosts:

The strawberry leaf roller, *Ancylis comptana* Froel., was the host from which the type specimen was reared and no other host has been recorded.

Perisierola sp. (Bethylidae)

Four specimens of this species were reared from the strawberry leaf roller. They did not seem to respond so well to the methods used in these studies as did the other species. The pupa cases were thin, and the mortality was rather high.

Pleurotropis sexdentatus (Girault). 1916. (Eulophidae)

Pseudacrias sexdentatus Girault. Societas Entomolgica, Zurich., 31, 36. 1916.

Lewis (*73*), "*Pleurotropis sexdentatus* Gir.: as high as seven specimens were reached from a single leaf roller. It is possible that this may be a hyperparasite." Fink (*34*) placed this insect in a list of the lesser important parasites of the strawberry leaf roller, the more important ones having been discussed separately.

Fourteen specimens of this species from all three localities were reared during these studies. Several specimens emerged from a single host, sometimes a pupa of the leaf roller and sometimes from a white, typical parasite cocoon. At the time this work was done this species was confused with *Horismenus microgaster* (Ashm.) and may account for the difference in the host, but it was thought at the time that they were secondary parasites, though no definite proof was secured.

Distribution: Ohio (*73*), New Jersey (*34*).

Hosts:

Ancylis comptana Froel..........................	Strawberry leaf roller
Gnorimoschema gallaesolidaginis Riley..............	Goldenrod gall maker

These are probably secondary hosts and some other parasite larvae serve as primary hosts.

Spilochalcis albifrons (Walsh). 1861. (Chalcididae)

Dalla Torre (*29b*) gives the following synonomy:

Chalcis albifrons Walsh. Trans. Ill. State Agr. Soc., 4, 37. 1861.
Chalcis albifrons Riley. 2d Ann. Rpt. Insects of Mo., 52. 1870.
Smicra albifrons Cresson. Trans. Amer. Ent. Soc., 4, 39. 1872.
Chalcis albifrons Thomas. 10th Rpt. State Ent., Ill., 40. 1888.
Spilochalcis albifrons Howard. Descriptions North American Chalcidae, 7. 1885.

There is very little in the literature on this insect as to its economic importance. Dunnan (*32*) stated that he reared it from the strawberry leaf roller and that the pupal stage of this parasite lasted from five to nine days.

Only one specimen of this species was reared during these studies and that was from material collected at Wamego.

Distribution: Conn. (*10*), Tenn. (*45*), and Iowa (*32*).

Hosts:

Heliophila unipuncta Haw........................	Army worm
Apanteles militaris Walsh.........................	————
Ancylis comptana Froel..........................	Strawberry leaf roller

Sympiesis n. sp. (Eulophidae)

Only one specimen of this species was reared during these studies, which was retained by the U. S. National Museum.

Nemorilla floralis Fallen. 1820. (Tachinidae)

Fallen. Monographia Muscidum, Diptera Sveciae, vol. 2, p. 36; 1820.

Aldrich and Webber (*3*) give the following synonomy:

Tachina maculosa Meigen. Syst. Beschr. Zweifl. Ins., vol. 4, p. 266; 1824.

Nemorilla maculosa Rondani. Dipt. Ital. Prod., vol. 3, p. 101; 1859. Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 4, pl. 1, fig. 12, 1889; pt. 5, p. 328, 1891.

Tachina pyste Walker. List. Dipt. Ins., vol. 4, p. 754; 1849.

Tachina (Exorista) phycitae LeBaron. Second Rpt. State Ent. Ill., p. 123; 1872.

Exorista scudderi Williston, in Scudder's Butterflies of New England, vol 3, p. 1921; 1889.

Exorista pyste Coquillett. Revision Tachin., p. 93; 1897. Greene. Proc. U. S. Nat. Mus., vol. 60, p. 11; 1922, fig. 34, puparium. Reinhard. Ent. News, vol. 30, p. 281; 1919.

Titus (*96*), speaking of the sugar-beet crown-borer, *Hulstea undulatella* Clemens, says many of the larvae or pupae were parasitized by this parasite. Chittenden and Marsh (*18*), "*Exorista pyste* Walk. . . . has been repeatedly reared from the caterpillar of *Hellula undalis* (Imported cabbage webworm) from July 27 to as late as October 27." Walden (*105*) reports that 18 out of 53, or 34 percent of the larvae of *Archips rosana* L. were parasitized by this parasite. Strauss (*90*) reporting on the grape-leaf folder says that fly parasites were taken only in small numbers, but lists this one as the most abundant. Turner, Spooner and Chittenden (*98*) reporting on the pecan-nut case-bearer, *Acrobasis hebescella* Hulst, "The natural enemies of this species appear to control it more efficiently than is the case with any other important insect attacking pecans." They further state that in 1916 25.5 percent of the larvae of the first generation were detroyed by *E. pyste* Walk. and that the second generation was much less abundant than the first. They rate it as being the most important enemy of the nut case-bearer. Gill (*44*) reporting on the same host, "The most effective parasite is the Tachinid fly, *Exorista pyste* Walk., which was reared in large numbers from the larvae and is, no doubt, a very important factor in the natural control of this pest." Caffrey (*16*) reporting on the European corn borer, says that a small percent of the larvae were parasitized by three flies and gives *E. pyste* second place in the list. He also discusses to some extent the biology of this fly. Vinal and Caffrey (*104*) reporting on the same host say that the percent of parasitism is very small but only dipterous parasites have been found and again list *E. pyste* in the second place. Felt (*33*) discussing the apple and thorn skeletonizer, *Hemerophila pariana* (Clerck), after rearing *E. pyste* Walk. from this host expressed hope that eventually native enemies will prove of considerable service in preventing the undue multiplication of this pest. Wilson (*115*) reports 12½ percent parasitism of the southern beet webworm, *Pachyzancla bipunctatis* Fab. by *E. pyste*. Harned (*49*) reported *N. maculosa* Meigen as doing effective work on *Pyraausta tyralis*, a budworm of dahlia. Leiby (*71*) working on the pecan shoot-borer, *Acrobasis carvae* Grote, lists three species of parasites and says of these *N. maculosa* is by far the most common, as high as 30 percent of the pupae being parasitized by this species in some seasons. Lewis (*73*) gave the first report found of this species as a parasite of the strawberry leaf roller, *Ancylis comptana* Froel., and gives a description of the different stages of development. Fink (*34*) reports a parasitism of 5 percent of the strawberry leaf roller by *E. pyste* Walk. He also gives a description of the egg, the entrance of the larva into the host and other information on its biology. Aldrich and Webber (*3*) say, "The species has a voluminous literature in Europe."

Six specimens were reared from material collected at Wamego and one from material collected at Leavenworth. At the time these studies were carried on the writer was unable to distinguish between the two species of flies obtained and as far as was determined their method of parasitizing was the same. The larvae parasitized by either of these flies were easily discovered, due to the presence of the eggs on or near the head of the larvae. The larvae seemed to pupate normally and in a few hours after pupation the larva of the parasite would make a hole in the host pupa and come out and pupate, sometimes the pupa case of the parasite protruded from the hole in the host pupa.

Distribution: California (*96*), Connecticut (*70, 105, 12, 13, 85*), Colorado and New Mexico (*42*), Puerto Rico (*66*), D. C. (*90*), Florida (*43*), Michigan (*60*), Georgia (*98*), Massachusetts (*16, 37*), Texas (*86*), New York (*33*), Mississippi (*49*), North Carolina (*71*), Maryland (*75*), New Jersey (*111*), Nova Scotia (*112*).

Hosts:

Hulstea undulatella Clemens	Sugar-beet crown borer
Hellula undalis Fab	Imported cabbage webworm
Acrobasis carvae Grote	Pecan shoot borer
Archips argyrospila Walk	Fruit-tree leaf roller
Archips rosana L	Privet leaf roller
Peronea minuta (Rob.)	Dry-bog fireworm
Pachyzancla bipunctalis Fab	Southern beet webworm
Desmia funeralis Hub	Grape lear roller
Acrobasis nebulella Riley	Pecan leaf case-bearer
Gelechia confusella Cham	Striped peach worm
Pyrausta nubilalis Hubner	European corn borer
Hemerophila pariana (Clerck)	Apple and thorn skeletonizer
Mineola indiginella Zell	Apple leaf crumpler
Pyrausta tyralis Gn	Budworm of dahlia
Arcobasis hebescella Hulst	Pecan nut case bearer
Ancylis comptana Froel	Strawberry leaf roller
Pilocrocis tripunctata Fab	Sweet potato leaf roller
Humenia facialis Cramer	Hawaiian beet webworm
Grapholitha molesta Busck	Oriental fruit moth
Cacoecia rosana (L.)	Currant leaf roller

Phorocera torticis Coquillett. 1897. (Tachinidae)

Neopales tortricis Johnson, according to Aldrich and Webber (3).

There is very little in the literature on this insect. Porter and Garman (*85*) say, "According to Wallingford the life history is similar to that of *Exorista pyste* (*Nemorilla maculosa* Meig.)." Greene (*47*) gives a technical description of the puparium. The rest of the literature deals with technical descriptions of the insect and records hosts and distribution.

Sixteen specimens of this species were reared during these studies which is more than twice as many as of *Nemorilla floralis*. This seems to indicate that at the time and places where these studies were made, *P. tortricis* was of considerable more importance than *N. floralis*. This appears to be the first time that this species has been reported as a parasite of the strawberry leaf roller. This is also the first time it has been reported from Kansas, though it has been reported from adjoining states. This is the farthest west it has been reported.

PARASITES REARED FROM *Ancylis comptana*

The following table summarizes the parasites reared during these studies:

HYMENOPTEROUS PARASITES.	Family.	Number specimens.	Locality.
Apanteles canarsiae Ashmead	Braconidae	6	Wamego
Brachymeria ovata (Say)	Chalcididae	1	Wamego
Casinaria infesta (Cresson)	Ichneumonidae	1	Manhattan
Chorinaeus, n. sp	Ichneumonidae	17	Leavenworth
Clinocentrus sp	Braconidae	3	———
Cremastus cookii Weed	Ichneumonidae	22	Leavenworth and Wamego
Oncophanes atriceps (Ashmead)	Braconidae	54	Wamego and Manhattan
Epiurus indagator (Cresson)	Ichneumonidae	2	Wamego
Hoplocryptus incertulus Cushman	Ichneumonidae	6	Wamego, Manhattan and Leavenworth
Horismenus microgaster (Ashmead)	Chalcididae	23	Wamego, Manhattan and Leavenworth
Meteorus trachynotus Viereck	Braconidae	1	Wamego
Microbracon gelechiae (Ashmead)	Braconidae	6	Wamego
Microbracon politiventris (Cushman)	Braconidae	7	Wamego, Manhattan and Leavenworth
Microgaster comptanae Viereck	Braconidae	4	Wamego and Leavenworth
Perisierola sp	Bethylidae	4	Leavenworth
Pleurotropis sexdentatus (Girault)	Eulophidae	14	Wamego, Manhattan and Leavenworth
Spilochalcis albifrons (Walsh)	Chalcididae	1	Wamego
Sympiesis, n. sp	Eulophidae	1	———
DIPTEROUS PARASITES.			
Nemorilla floralsis Fallen	Tachinidae	7	Wamego, Manhattan and Leavenworth
Phorocera tortricis Coquillett	Tachinidae	16	Wamego, Manhattan and Leavenworth

A portion of these parasites are in the United States National Museum and the rest are in the collection of the Department of Entomology of the Kansas State College of Agriculture and Applied Sciences.

Distribution: Vermont (*66*), New Jersey (*3, 81, 110*), Connecticut (*12, 85*), North Carolina (*9*), Missouri, Michigan, Massachusetts and Arkansas (*3*).

Hosts:

Archips cerasivorana Fitch	Cherry-tree ugly-nest
Peronea minuta Rob	Dry-bog fireworm
Mineola indiginella Zell	Leaf crumpler
Cacoecia argyrospila Walker	Fruit-tree leaf roller
Hemerophila perinna Clerck	Apple and thorn skeletonizer

SUMMARY AND CONCLUSIONS

During these studies twenty species of parasites were reared from the strawberry leaf roller. Eighteen of these were Hymenoptrous and two were Dipterous parasites. Two of these species are new to science. Nine of these species had previously been listed as parasites of this host and eleven are new host records. No literature was found that definitely placed any of these insects on record as occurring in Kansas, though the distribution of some of them was such that it would have been assumed that they did occurr there.

Some evidence has been presented to show that under Kansas conditions parasites do play a considerable part in keeping the strawberry leaf roller under control.

No one species appears to be dominant for the state, although one species may predominate in a locality, as was the case of *Cremastus cookii* Weed in the vicinity of Leavenworth.

Horismenus microgaster (Ashmead) and *Pleurotropis sexdentatus* (Girault) probably are secondary parasites and therefore hinder in the control of the strawberry leaf roller.

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