AN ABSTRACT OF THE THESIS OF

W. D. Edwards for the M. Sc. in Entomology
(Name) (Degree) (Major)

Date Thesis presented May 20, 1936

Title Biology of Cnephasia longana Haworth, an Insect Pest of Several Important Crops in Oregon

Abstract Approved: [redacted]
(Major Professor)

The appearance of a new pest, Cnephasia longana Haworth, on two important Oregon crops during 1929 was responsible for considerable apprehension by growers and their associates. Studies on this pest starting in 1930 and continuing through 1935 are presented in the thesis.

A survey of the available literature is given to trace the synonomy and present taxonomic position of the moth.

Particular emphasis is placed upon the seasonal history and life habits of C. longana as it is with this knowledge that measures for control may be developed. The present known distribution and the host plants are recorded with a description of injury to the various hosts and also the economic importance, both actual and potential, is summarized.

Field observations on ecological factors and biological control, especially by insect parasites, are included in the discussion.

Species related to C. longana are mentioned and similarity in their habits are discussed. A bibliography of references is included which is, so far as the writer is aware, complete on the insect studied.

BIOLOGY OF CNEPHASIA LONGANA HAWORTH
AN INSECT PEST OF SEVERAL IMPORTANT CROPS IN OREGON

by

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A THESIS

submitted to the

OREGON STATE AGRICULTURAL COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1936

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ACKNOWLEDGMENTS

The writer wishes to express his sincere gratitude and appreciation to Dr. Don C. Mote, Head of the Department of Entomology, Oregon State College, for his suggestions and guidance during the conduct of these studies and the preparation of this thesis.

To Mr. K. W. Gray thanks are extended for his help in studies upon the life history of the insect and for his assistance in photographing and preparing the illustrations.

To Mr. L. P. Rockwood, Entomologist of the United States Bureau of Entomology and Plant Quarantine, is expressed the gratitude of the writer for data on this subject which he personally secured.

To workers in the Division of Insect Identification, United States Bureau of Entomology, especially Drs. Harold Morrison, C. F. W. Muesebeck, and August Busck, thanks are due for specific determination of insects connected with these studies.

To Mr. Joe Schuh the writer's appreciation is expressed for his assistance in life history studies and in translating literature written in the German language.

To Velma Mullen is tendered thanks for assistance during the course of these studies and especially for the typing of this thesis.

To Mr. James Roaf and Mr. Charles Cody the writer expresses his thanks for their assistance in the studies on the life history and habits of the insect.

To all others who have in many ways assisted in these studies the writer is extremely grateful.

BIOLOGY OF CNEPHASIA LONGANA HAWORTH

AN INSECT PEST OF SEVERAL IMPORTANT CROPS IN OREGON

INTRODUCTION AND HISTORICAL NOTES

During the season of 1929, specimens of larvae, which were tunneling into strawberries, were sent to the Department of Entomology by J. J. Inskeep, Clackamas County Agricultural Agent. As this was the first case of injury to strawberries of this type reported in Oregon, an attempt was made to rear the larvae to the adult stage so that specific identification of the pest could be made. Of the material received, one adult moth was reared and then sent to the Division of Insect Identification, United States Bureau of Entomology and Plant Quarantine, for determination. The insect was later reported by Mr. August Busck to be a male *Cnephasia longana* Haworth, a new form for North America, but one which had been described approximately one hundred years before in Europe.

Experimental workers of the United States Department of Agriculture collected lepidopterous larvae from Dutch bulbous iris in Portland also in 1929, reared them to the adult stage and had them determined as *C. longana* Haw.

The appearance of a new pest on two cultivated crops in Oregon, which was potentially extremely serious in an economic sense, caused considerable apprehension among growers and experimental workers. The desirability of conducting a study of the life history and habits of this insect was emphasized by the fact that very little literature was available in European publications, and this was confined almost entirely to its taxonomic position within the microlepidoptera.

The taxonomic position of *C. longana* Haw. has been somewhat irregular, the insect having been placed in at least four genera, and also having been described under seven specific names, six of which, of course, are synonymous. The true position of the species and examples of its synonomy are presented under the following heading.

TAXONOMIC POSITION OF CNEPHASIA LONGANA HAWORTH

Characters of the Family Tortricidae (After Forbes)

(With Eucosmidae, Grapholithidae, Epiblemidae, Olethreutidae)

Ocelli present (so far as looked for); antennae rarely pectinate (never in our species); the scaling confined to dorsum of antenna, but the outer row stronger and longer than the inner; ventral surface pubescent, more strongly so in the male; palpus moderate, upturned to middle of front, or rough and porrect, often triangular; tongue present, usually rather weak. Body slender; hind tibia hairy, the others smooth-scaled. Wings broad, the fore wing often abruptly widened at the base, giving the family its name of "bell moths" from the shape of the moths with their wings folded. Fore wing (Plate Ia) with R_5 rarely running to the costa; base of M simple (representing M_3) crossing the cell obliquely, or, more rarely, absent; accessory cell often ill defined; Cu_2 arising two-thirds way out on cell, or less; distant from Cu_1; 1st A free and weak at base, absent in a few reduced forms. Hind wing ample, with fringe markedly widened at anal angle; scaling soft.

Eggs flat. Larva with hooks of prolegs multiordinal, except in a few reduced forms; ninth segment of abdomen with tubercles II usually united, always approximate; IV and V on abdomen obliquely or vertically placed; VII of seventh segment, of two or more setae. Pupa with hooked spines either on last segment, or on the specialized cremaster, tongue well developed; maxillary palpi separating from tongue on dehiscence;

antennae reaching nearly to tip of wings.

IMAGO; KEY TO GENUS CNEPHASIA

(After Forbes)

1. No fringe on base of Cu of hind wing (often with loose hair below Cu, or with a fringe on base of 2nd A).
    2. Fore wing with R_4 and R_5 stalked halfway to apex; R_5 running to outer margin.
        3. R_3 arising from the same stalk . . . . Coelostathma
        3. R_3 arising from cell . . . . Adoxophyes
    2. R_4 and R_5 very shortly stalked or free.
        3. M_3 and Cu_1 of hind wing united . . . . Tortricodes
        3. M_3 and Cu_1 separate, rarely stalked.
            4. Fore wings with R_5 running to costa; apex more or less marked . . . . Peronea
            4. Fore wings with R_5 running to outer margin, or to the bluntly rounded apex.
                5. Palpi ascending; hind wing with R and M_1 approximate at base.
                    6. Thorax smooth-scaled; M_3 and Cu_1 connate or shortly stalked . . . . Archips
                5. Palpi porrect, rough above and below.
                    6. Hind wing with R and M_1 stalked; thorax normally smooth . . . . Cnephasia, Eulia

The genera Cnephasia and Eulia are best separated by comparison with the genus Tortrix. The characters of these genera follow.

CNEPHASIA Curtis

(Sciaphila, etc.; Tortrix, Capua, in part)

Very close to Tortrix; fore wing usually more pointed, with extended apex and convex costa, smoothly scaled; palpi beaklike, often long. Venation like that of Tortrix, but with R and M_1 of hind wing stalked. (Plate Ib).

As defined here, this is a heterogeneous group, apparently related to the lower members of Tortrix. Venational aberrations occur with R and M_1 free, but they can generally be identified by longer and more pointed wings than Tortrix.

TORTRIX Linnaeus

(Restricted; with Archips, etc., in part)

Head smoother scaled than in Eulia; thorax smooth-scaled, with scutellum rounded out, but no posterior tuft. Palpi with second joint porrect, more or less clavate, rough-hairy on upper side, and third joint porrect or beaklike. Fore wing with all veins separate (Plate Ic), Cu_1 arising close to M_3, strongly curved, Cu_2 from middle of cell nearly straight. Hind wing with R and M_1 approximate at origin, M_2 close to M_3 and Cu_1, which are connate at origin. Cu_2 straight, arising two-thirds way out on cell. Costal fold usually absent.

EULIA Hubner

(Lophoderus Stephens)

Like Tortrix, but more generally with convex costa; with a well-marked posterior tuft on thorax.

Original Description of Species longana. (After Haworth)

T. (The Long-winged) alis albo-cinereis longiusculis, fusco maculatim fasciatis.

HABITAT in Pascuis. Imago vix frequens.

EXPANSIO alarum 9-10 lin.

DISCRIPTIO. Alae anticae longiusculae seu certe longiores quam in caeteris ratione magnitudinus, apice rotundatae: cinereo-albae; maculis subtribus irregulariter confluentibus transversis fuscis ante medium; allisque tribus majoribus posticis, magisque confluentibus irregularibusque. Juxta apicem, alae subinde fusco reticulatae sunt. Posticae albicantes.

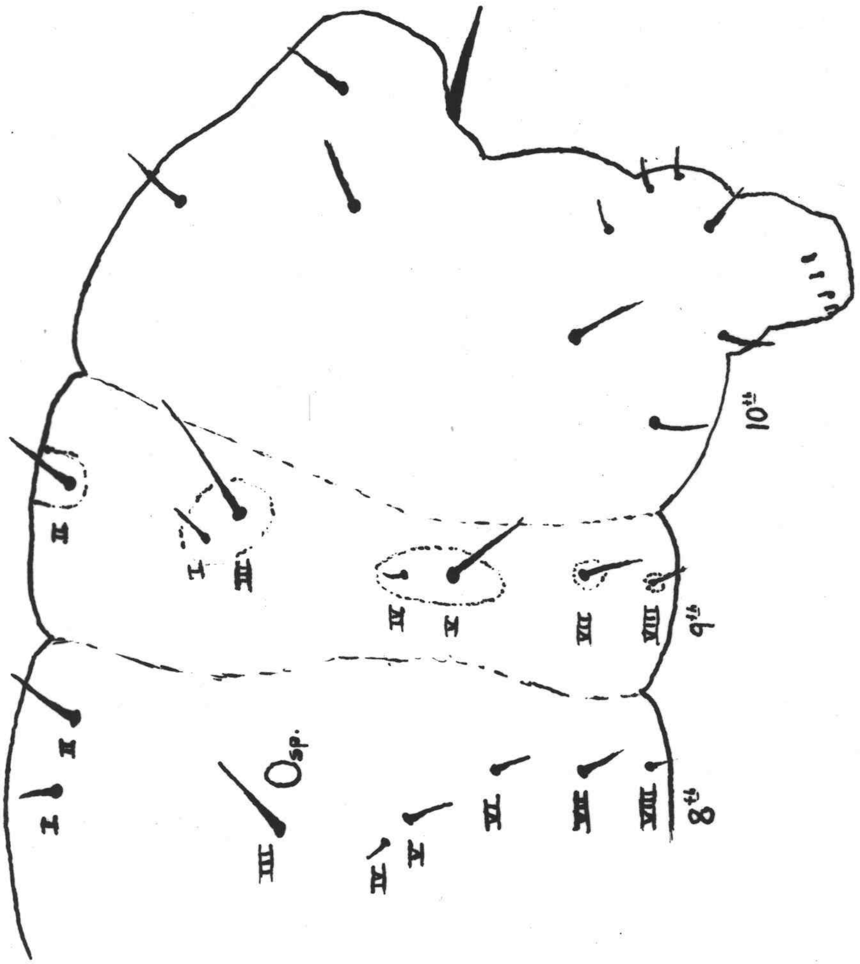
B. Omnino

B. Omnino pallidior maculis plus minus evanescentibus. Forte exemplarium senectum.

LARVA; KEY TO GENUS CNEPHASIA

(After Fracker)

1. Ninth segment of abdomen with seta i close to iii and usually on the same tubercle; not associated with ii.
   2. Seta vi absent on ninth segment; tubercles black; crochets uniordinal . . . . Cnephasia
   2. Seta vi present on ninth segment, usually associated with iv and v.



Seta Map of <u>Cnephasia longana</u> Haworth. Seta VI on 9th segment absent.

REFERENCES BY AUTHORS UNDER LONGANA AND SYNONYMIC NAMES

Ref. taken from:

Stephens, James Francis. Illustrations of British Entomology, etc. Haustellata. IV. London, 1827-1835. p. 127.

Genus CCXCII. - Cnephasia, Curtis

Palpi shorter than the head, ascending, densely clothed with long scales, especially on the upper edge of the second joint, the terminal joint exposed: maxillae short. Antennae rather long, slender, finely pubescent within the males, simple in the females: head small, with a tuft on the crown: eyes lateral, subglobose: thorax not crested: wings deflexed during repose; anterior somewhat lanceolate, rounded at the apex, and generally marked with transverse irregular bands, rarely immaculate; posterior ovatetriangular, entire: abdomen moderate, carinated on the back, and with a tuft at the apex; stouter and obtuse in the females: legs slender, short.

In this genus the anterior wings are somewhat narrower in proportion than in the other genera in this family (Tortricidae), and are rounded at the apex, the posterior margin being rather straight; they are generally adorned with interrupted or waved darker fasciae upon a light ground, though in some cases they are nearly immaculate; there is, however, a peculiarity of habit about the species, by which they may be more easily recognized than described.

Sp. 2. longana. Alis anticis luteo-albis fusco maculatim fasciatis. (Exp. Alar. 9-10½ lin.)

To. longana. Haworth.--Cn. longana. Steph. Catal. ii.180.No. 6994.

Anterior wings rather long, slightly rounded at the apex, ashy- or yellowish-white, with an irregular patch of brown clouds or spots in the middle, forming a fascia, and three other larger ones towards their apex, more confluent and irregular: hinder wings with brownish dots: posterior wings ashy white.

The apex of the anterior wings is sometimes faintly reticulated with brown; or the wings are pale, with the markings more or less conspicuous.

Taken occasionally in meadows and marshy places within the metropolitan district (London); not very common; found in the Isle of Dogs in June, and in the New Forest.

Sp. 3. ictericana. Alis anticis sordide flavicantibus immaculatis, posticis albidis. (Exp. Alar. 8-9½ lin.)

To. ictericana. Haworth.--Cn. ictericana. Steph. Catal. ii. 181. No. 6995.

Anterior wings dull yellowish, immaculate, the apex rounded; posterior whitish.

The anterior wings are sometimes whitish, and the posterior reddish-white: probably the result of age.

This is probably a scarce species: it is found in the meadows about Bow and Limehouse, and also in other places within the metropolitan district, towards the end of June.

Ref. taken from:

Meyrick, Edward. A Handbook of British Lepidoptera.

MacMillan and Co., London. 1895.

T. longana, Hw. (ictericana, Hw.) 17-21 mm. Antennal cilia of male short. Forewings elongate, costa hardly arched, R_5 to or close beneath apex; in male whitish-ochreous, unicolorous; in female pale greyish-ochreous, an angulated fascia at 1/3, central fascia with anterior edge excavated in middle and above dorsum, and costal patch suffusedly connected with it beneath costa brownish. Hindwings whitish-ochreous, more or less tinged or suffused with grey, R_5 and M_1 stalked.

Larva pale yellowish; dorsal and subdorsal lines greenish-grey; spots black; head and plate brown.

Taken from Herrich-Schaffer. Systematische Bearbeitung der Schmetterlinge von Europa als Text, Revision und Supplement zu Hubner. Vol. IV, p. 178. Loose translation.

Listed under Gen. Tortrix L., sub gen. Ablabia Steph.

108. Luridalbana Mann. -Sppl. 153-? Ictericana Wood 898- In June on meadows near London.-7-8L. Albida, capite, thorace and alarum anteriorum margine anteriore testaceis. A doubtful species, of which Mr. Mann sent me one male example, which he received from (Scheibwald) a part of the Roxalpe in Steyermark. Smaller than Pratana, with which it can be compared in habit, but anyway the edge is a little less turned and the fringes along the hind angle are not so long. Appearance or formation of the antennae, legs and ribs (sides) the same, palpi less bushy or tufted. Dirty white throughout, except the markings;

only head, thorax, edge and front margin of the fore wings appear to be a bit yellow, the fore wings are brownish-white beneath.

109. Insolatana m.-Sppl. 152-8L. Testacea, alis anteriorbus medio et apice obsolite ochraceomixtis. Perhaps only a fresher specimen of Luridalbana, a little bigger, with various ochra-yellow mixture. Head, thorax, end of the fringes, its dividing line, front margin, tip and an indefinite oblique band of the forewings plainly yellow. Hind wings somewhat grayish with yellowish base on the fringes.

In July in the Alps.

One male specimen from Sicily in Mr. Kaden's collection I described as follows: the antennae long square, plainly set off, likewise short ciliated; pale ochre-yellow, hind wings somewhat less gray. Two small oblique lines on the tips of the forewings, the dividing line which on the forewings has very broad fringes, and the fine edge line of the hind wings are rusty brown. Pale straw yellow beneath, the forewings grayer, edge line delicate dark. Size and appearance of Pratana, still the forewings are more of the same width, not so small at the base, and the colors much lighter.

Taken from Herrich-Schaffer, Systematische Bearbeitung der Schmetterlinge von Europa als Text, Revision und Supplement zu Hubner. Vol. IV, p. 202. Loose translation.

Listed under Gen. Tortrix L. sub gen. Sciaphila Tr.

189. Loewiana Zeller Isis 1847. pg. 25.- Sppl. 382.-9L.

Testacea, alarum anteriorum rete and signaturis fusco-ochraceis. Between Wahlbomiana and Communana in habit, the forewings much less pointed than in Stratana, hence with shorter, less slanting edge; the rusty brown atom piles run obliquely, both bands and the front edge spot much wider, the last only separated from the middle band by a small edge stripe. The underside of the forewings is lighter than in Stratana.

Mr. Law found four specimens of this species in April on Rhodos.

Also from Herrich-Schaffer. Vol. VI. p. 157.

178. Ictericana Haw. Two females from Mr. Schmidt from Norderny. Differs from Pratana, the edge of all the wings much less (curved)?, the tips therefore not so sharply (turned forward)?, their fringes not so white by far, with a sharp dark dividing line near the base (root). The ground color of the forewings more vividly clay or mud yellow, their markings very constant, different from fragrosaoa, segentana, stratana and loewiana Sppl. f 379-382.

This species forces me to also put pratana in the (category)? Sciaphila.

The male which apparently belongs to this species has a little wider wing spread, the forewings very evenly scaled all over with rusty yellow scales on a very yellow background, with a darker tip and dividing line of the fringes, the last not so sharply as in the female. Underneath like the female, but a little darker.

Here I must mention a male which Mr. Schmidt also brought from Norderney:

The wings plainly wider, the edge of the forewings hardly at all, the hind wings less (swung out)?, the fringes longer, hardly at all marked. Clay-yellow, hardly scaled darker. The hind wings lighter gray. Underneath as the foregoing. I no longer claim the original of my insolatana and luridalbana fig. 152-153, but hold (claim) gebenwartige (valid) species as identical with one of the two, at first with insolatana.

DESCRIPTION OF THE VARIOUS STAGES

Adult Male

The adult male is a Tortricid, measuring 9/32 of an inch in length and with a wing spread of 3/4 inch. In color the forewing, body, head, patagia, and collar are of a grayish-yellow; the rear wings appear slightly less yellow, due possibly to a lesser number of scales. The under side of the forewing appears to be darker than the upper side, while on the rear wing both sides are of the same shade. The anal margin of the hind wing, from apex to base, has a fringe of long gray hairs, which attain a length of almost half the width of the rear wing on that portion of the margin close to the base. The apexes of the wings are somewhat rounded, giving the appearance of the typical Tortricid.

The antennae are grayish-yellow, though somewhat darker than the wings. The palpi are covered with scales; broad at the tip; somewhat ascending; reaching slightly above the vertex of the head.

Front portion of the tibia and femur of the forelegs is washed with brown and the tarsi are dark brown. The femur and tibia of middle and hind legs are grayish-white; tibial spurs are yellowish-gray. Middle legs are clothed with scales except on the tibia where there is a brush of hairs.

The anal tuft is fan-shaped and yellowish-gray in color.

Adult Female

The female moth is similar in size and shape to the male but differs in color. The forewing is grayish with brown markings. The brown upon the forewing varies from a few mottled spots to, in extreme cases, practically covering the entire wings.

Pupa

The pupa is typically lepidopterous, 9/32 of an inch in length; abdomen somewhat lighter than the rest of the body. The first to sixth abdominal segments have a double row of short spines on the dorsal side. These spines grow smaller progressing posteriorly until they are mere indications on the sixth segment. The anterior of these two rows of spines start at a spiracle and run over the back, ending at the spiracle on the other side. On each side of the pupa, running parallel with the spines, there are three setae and another slightly ventral and anal in direction from the spiracle may be found.

Larva

The larva is a typically naked Tortricid about 7/16 of an inch long. The color changes as the larva grows. After hatching, the body retains the salmon color of the egg and this persists through the over-wintering period in the hibernaculum. Shortly after the resumption of activity in the spring, the insect's body varies from a light to dark gray and the head capsule and shield become very dark. When a length of from 1/4 to 3/8 inch is reached, a longitudinal stripe appears slightly to each side of the dorsal surface, though these disappear or become very faint shortly before pupation, and the larva turns to a creamy brown. The head capsule and shield become and remain tan in color after 1/4 of an inch is reached, except immediately after each molt when they are very light. There are five ocelli on each side of the head close to the base of the antennae and slightly lateral, that are arranged in a compact group. The mandibles are dark brown and small. One pair of true legs are found on each thoracic segment and a pair of prolegs on the 3rd, 4th, 5th, 6th, and 10th abdominal segments. Characteristic of the larvae of the genus *Cnephasia* is the absence of seta VI on the 9th abdominal segment.

Egg

The egg, when first deposited, is light salmon in color, but turns darker if the egg is fertile or lighter if infertile. It is about 1/32 inch in diameter, has no definite shape, though it is generally round but flattened at the point of attachment. During incubation the egg becomes somewhat irregular or collapsed in appearance.

LIFE HISTORY AND HABITS

EGGS

The eggs described above have not been found in the field due, probably, to their small size and to the fact that they are scattered promiscuously on plant material, soil, and debris. Under insectary conditions, however, many eggs have been observed and examined.

Development

When first deposited, it is possible to distinguish readily between fertile and infertile eggs by a marked difference in color. The infertile eggs are light straw colored and somewhat transparent, while fertile eggs are light salmon and become darker until they are a decided salmon red.

Development of the eggs depends upon the temperature during the incubation period, and varies with the season. The newly deposited egg is generally rounded but is flattened at the point of attachment. During the development of the embryo, the thin egg covering becomes uneven and wrinkled or shrunken. The first detailed structures visible through the egg membrane are the eyes which appear as dark spots and the general outline of the larvae may be seen as the darker portion of the egg contents. The head capsules and shields and definite segmentation of the larvae are visible through the opaque shell about four days before hatching and usually faint movements are noticeable. The minute larvae rupture the egg covering in about two weeks after the eggs are deposited.

Duration of Incubation Period

The period required for the development of the egg from the time of deposition to the time of hatching varied through the years in which records were kept (Table 1) from a minimum of 11 days to a maximum of 20 days, with the average for 3 years being 15.2 days. Seasonal differences in temperature, rainfall, sunlight, humidity, etc. during incubation are no doubt largely responsible for the above variation.

Cnephasia longana Haw.

Duration of Incubation Period of Eggs in Days

	1932	1933	1934	Average
Max.	17	14	20	17
Min.	11	16	13	13.3
Ave.	14.6	15	16.2	15.2

Table 1.

LARVAE

Newly-hatched Larvae

Data secured under insectary conditions shows a peculiar habit of the larvae of this species, which may also be common to the genus though no mention has been found in the very limited literature. The larvae, after hatching, have been observed to do no feeding, but crawl over plant material and debris until a somewhat sheltered place is found, and there they spin white webs or hibernacula around themselves, become quiescent, and overwinter in this condition. The time required for this procedure has been observed to be from 1 to 4 days during which no feeding is apparent.

Possibly the most remarkable habit of this insect is its apparent ability to live from the hatching period in late June or July through the cold winter weather, resuming activity in the spring with only the energy it has secured from the egg. It is all the more remarkable because the protection afforded by the hibernaculum is at best very slight since the webbing is not heavy but is so thin that the salmon colored larva may be plainly seen through the silken threads.

Resumption of Activity

With the coming of spring weather and longer days, the larvae have been observed in the insectary to leave their hibernacula and migrate in search of food. There is some variation from year to year in the time the larvae become active. The dates on which the larvae were first noticed in the field are given in Table 2.

Dates *C. longana* Haw. Larvae First Observed in Field

Year	Location	Host Plant	Approximate Length	Date
1932	Canby	Cultivated and wild strawberry *Rubus macropetalous*	1/8 to 1/4 inch	May 6
1933	Canby	Cultivated and wild strawberry	1/8 inch	May 12
1934	Woodburn	Dutch iris	1/4 inch	April 18
1935	Canby	Strawberry	1/8 to 1/4 inch	May 6

Table 2.

In 1934, the minute larvae were observed to leave their hibernacula on March 15, after being kept in glass test tubes stoppered with cotton and left in an insectary under temperature conditions similar to those in the field. Data secured in the spring of 1935, however, shows that the larvae left their hibernacula one month later on April 15 under similar conditions and in more protected surroundings on March 29.

Locating the larvae in the field during the first instar has never been accomplished, due probably to their small size of approximately 1 mm. and the wide dissemination over a large number of host plants. Under insectary conditions, however, larvae have been introduced to flowers such as mustard, and were observed to feed actively. Extreme difficulty has been experienced during the early spring with the minute larvae in finding flower hosts. Conditions in the insectary and laboratory appear to stimulate the larvae to activity before the normal time in the field when the host plants are beginning to bloom and to provide ample food.

Injury to the flowers of the host plants is not noticeable until the larvae reach a length of approximately 1/4 inch. Characteristically, the worms draw the petals down over the pollen with silk, fasten them, and feed under this protection. Injury is noticeable by the webbing of the petals upon host plants shortly after the Marshall strawberries begin to bloom. At the same time, or shortly after, the worms are found attacking wild strawberry and wild blackberry. The Dutch iris may be attacked when it is still furled and pushing out of its protective green sheath with feeding continuing as long as flowers are present.

Color Variations of Developing Larvae

As stated, the larvae are similar to the color of the eggs when newly hatched, the body being salmon colored and the head capsule and shield brown. By the second and third instars, the general body color becomes a light to a dark gray, while the head capsule and shield are black. Later, during subsequent molting and growing of the worms, the body becomes lighter except for a pair of longitudinal gray stripes on the dorsal surface, while the head capsules and shields turn to a tan or brown color when the larvae are about 3/8 of an inch long. Shortly before pupation, and when the length is about 1/2 inch, the longitudinal stripes are much less noticeable while the head capsule and shield remain brown or tan.

Number of Instars - Dyars Law

In determining the number of molts occurring during the growth of the larvae, the criterion presented by Dyar (13) was used. Stated briefly, Dyar's Law, or Dyar's Rule, as it is sometimes called, takes into consideration the fact that the chitinized head capsules of lepidopterous larvae do not grow during a stadium, interval between molts, and that the increase in sizes through the succeeding molts is in regular geometrical progression.

Measurements of the head capsule widths of larvae under observation were taken and averaged as follows:

Newly-hatched larvae	.141 mm.	1st instar
Overwintering larvae leaving hibernacula	.135 mm.	

Earliest larvae collected in field	.292 mm.
Subsequent observed measurements	.454 mm.
	.672 mm.
	1.019 mm.

By dividing each observed measurement by the one which precedes it, a ratio of increase in each instar is found. These are averaged and for the above the resulting ratio, using the measurement of the overwintering larvae (.135) is .167.

Starting with the first observed measurement (.135) and multiplying it with the average ratio, and then continuing with the result in each case, the following is obtained:

		Observed widths
Width observed in 1st instar		.135 mm.
Calculated width in 2nd instar (.135 x .167) =	.245	.292
Calculated width in 3rd instar (.245 x .167) =	.331	.454
Calculated width in 4th instar (.331 x .167) =	.552	.672
Calculated width in 5th instar (.552 x .167) =	.921	1.019

The calculated widths, while reasonably close, appear to indicate some discrepancy, so the procedure, when repeated, using the measurement of the newly-hatched larvae (.141), gives an average ratio of increase of .165 and the following data is obtained:

		Observed widths
Width observed in 1st instar		.141 mm.
Calculated width in 2nd instar (.141 x .165) =	.232	.292
Calculated width in 3rd instar (.232 x .165) =	.382	.454
Calculated width in 4th instar (.382 x .165) =	.630	.672
Calculated width in 5th instar (.630 x .165) =	1.039	1.019

Here again the calculated head widths are somewhat irregular when compared to the observed widths. The largest ratio of increase is between the first and second instars, and as this might be considered to distort the average ratio, it appears to be advisable to ignore the first measurements and derive the average ratio of increase starting with the second apparent instar measurement which is .292 mm. The average ratio of the 4 measurements is .151 mm. and this gives the following data:

		Observed Widths
Width observed in 2nd instar		.292 mm.
Calculated width in 3rd instar (.292 x .151)	= .440	.454
Calculated width in 4th instar (.440 x .151)	= .664	.672
Calculated width in 5th instar (.664 x .151)	=1.002	1.019

A study of the above data shows a very close agreement between the calculated and observed widths for the compared instars. Using the same average ratio (.151 mm.) and dividing instead of multiplying (reversing the procedure) the following is found:

		Observed Widths
Observed width in 2nd instar		.292 mm.
Calculated width in ? instar (.292 ÷ 1.51)	= .193	. ?
Calculated width in 1st instar (.193 ÷ 1.51)	= .127	(.141 (.135

It is at once apparent that one instar, the second, had not been observed and measured, and by the application of Dyar's Law its size can be determined. The following data shows the calculated and observed widths of the six instars of C. longana as derived above:

Calculated Width	Observed Widths
1st instar - .127 mm.	(.141 mm. (.135
2nd instar - .193	?
3rd instar - .292	.292
4th instar - .440	.454
5th instar - .664	.672
6th instar -1.002	1.019

The number of larval molts are somewhat variable within the species of some insects, according to available literature. Decker (9) writing his observations on the stalk borer Laspeyresia nebris nitela Guen., says: "When the larvae are supplied with an abundance of good succulent food, they normally complete development in seven or eight instars ...... but when the food is of poor quality (hard, dry, sour, or moldy), the rate of growth is reduced and the number of instars is increased." In this connection Decker observed individuals having from 9 to 15 instars. Decker (8) also found the influence of food on the number of molts very marked in studies on the four-lined borer, Luperina stipata (Morr.) while he failed to find any effect of temperature. Peterson and Haenssler (31) found that the number of instars of the oriental fruit moth was dependent not only on food but on temperature (season of the year).

Gaines and Campbell (19) working with the corn earworm, Heliothis obsoleta (Fab.) observed that the number of instars was six when the food plants were corn and hegari, but seven when the host plant was cotton. They also give strong evidence to the fact that high growth ratios are common in the early part of larval development, and that there is a tendency of many species to show diminishing ratios during development. These authors conclude that the use of Dyar's rule for corroborating the number of instars cannot be recommended.

Forbes (17) states that "there is still much room for the study of the exceptions and irregularities in this (Dyar's) Law."

Nevertheless, in the present case it is believed advisable to rely largely upon the application of Dyar's law, especially since there is a very close correlation between the observed and calculated measurements.

Pre-pupal Habits

The larvae of C. longana, after reaching maturity, either stay within the webbed plant material upon which feeding was done, or web together additional material providing shelter and protection for the pupal stage. This is followed by a period, in some cases, lasting two days during which the larvae do not feed but remain inactive within their webs. This inactivity is very marked with some larvae, as when touched or disturbed they merely wriggle and only early in this period will they drop from the plant or crawl away.

The following data on the change from larva to pupa was observed in June, 1932:

June 9, 1932 - During observations of C. longana, a larva was noticed to be going through its last molt. Almost immediately the larva began to assume the shape of a pupa, the change being so rapid that to the observer there was a sensation of movement especially as the wing pads developed. The process of change from larva to the characteristic external form of the pupa took place in about ten minutes and was complete about 9:30 A. M. The general color at this time was light cream.

At 11:30 A. M., the pupa had developed a brownish pink coloring on the dorsal surface.

At 4:00 P. M. the pupa had taken on a decided tan coloring, especially on the dorsal surface and wing pads.

June 10, 1932. At 8:30 A. M. the pupa had changed to a definite brown.

June 11, 1932. At 8:30 A. M. the pupa was only slightly darker but had developed the same coloring as older and more advanced pupae.

June 23, 1932. The adult moth emerged, the pupal period in this case being 14 days.

<u>Duration of the Larval Stage</u>

The larval period is continued from the time of hatching during late June or July until the following June and in some cases July. The total elapsed time of the larval stage constitutes almost 11 months of the year, with the balance of the year being taken up by the pupal, adult and egg stages. It is during the last 6 to 8 weeks of the larval period that the economic injury is done to cultivated crops. A summary of the length of the larval stage during the years of observation is shown in Table 3.

Cnephasia longana Haw.

Dates on Presence of Larvae on Economic Host Plants During Active Period

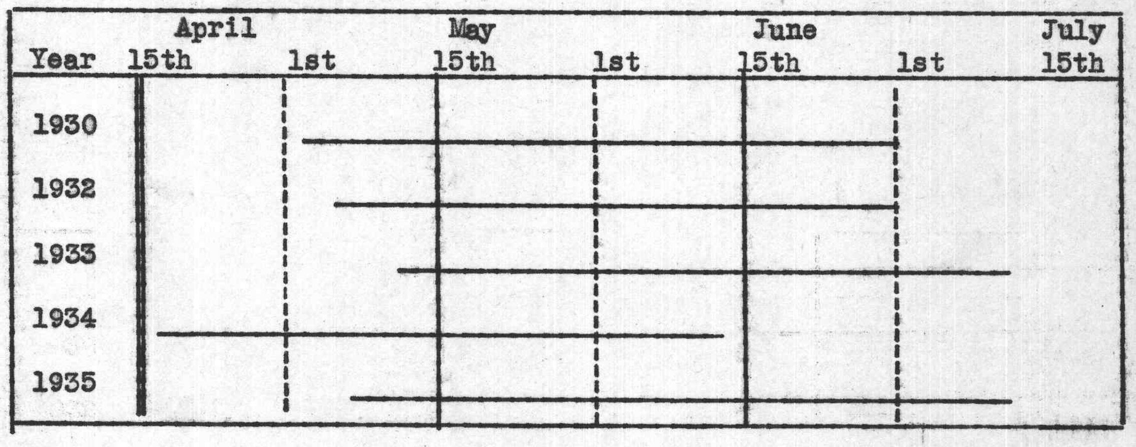


Table 3.

PUPAE

Location of Pupae

The pupae of C. longana have been found under field conditions in a variety of places upon the host plants. Upon strawberry they have been found under the cap of the fruit, within webbed leaves, among plant debris, etc. Upon flower hosts pupation usually occurs within the flower parts, leaves, or debris. In general, pupae are found wherever sufficient protection is available. In practically every case considerable webbing has been done by the larvae before pupation, which serves to provide protection to the insect during the pupal period.

Duration of Pupal Stage

The duration and dates of the pupal stage of C. longana have varied considerably during the years in which this insect has been under observation. The season of 1934, following a mild winter and spring, allowed pupation to start approximately one month earlier (May 3) than other years on which data was kept. Data are given by years on the length of time the pupae were observed in the field in Table 4.

Cnephasia longana Haw.

Dates on Presence of Pupae in Field

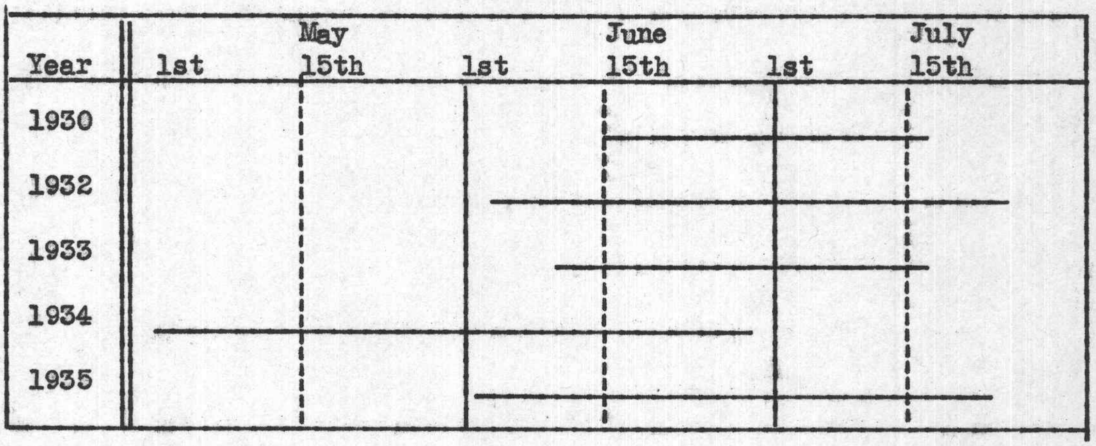


Table 4.

The pupal period in days for the insects is given for the following years:

	Minimum	Maximum	Average
1932	8	17	12.9
1933	12	18	14.5
1934	10	20	16.2
1935	12	17	14.5

Emergence

The following data were secured on June 8, 1934, on the emergence of an adult moth from the pupal case:

11:24 A. M. pupa observed to be wriggling vigorously.

11:26 A. M. pupal case split longitudinally along the dorsal surface posteriorly to the first abdominal segment and along the ventral surface almost as far as the tips of the wing covers and the moth had forced its way about one-half of the way out of the case.

11:27 A. M. the moth had worked itself entirely free of the pupal case. The wings were furled.

11:32 A. M. the forewings were about 3/4 distended and the hind wings could be seen developing under the forewings.

11:32½ A. M. fore and hind wings fully distended and the moth, a female, raised both pairs of wings to a vertical position.

11:38½ A. M. the moth lowered both pairs of wings to the normal position alongside and almost paralleling the body.

ADULTS

Feeding

The feeding habits of the adult moths have not been observed in the field, but it appears probable that they feed upon flower nectar since they fed readily upon a 50 per cent honey and water solution. In some cases there is evidence that this food prolonged the life of moths kept in the insectary.

Mating and Oviposition

In studies of these moths, mating has been observed only a few times and this during the early morning, so it appears probable that copulation occurs during the night or early in the day. Female moths in numerous cases have been observed to deposit eggs without mating, and in numbers approximately the same as females depositing fertile eggs.

Moths kept in glass tubes under insectary conditions start laying fertile eggs generally about 2 days after introduction of a male. Oviposition may continue for a week in some cases, but the maximum egg laying usually occurs on the fourth or fifth day.

The number of eggs deposited per female is quite variable under insectary conditions. The highest total of eggs deposited by a fertile female under observation was 231, while an unfertilized female deposited 203 eggs. The average number of eggs per fertile female for the years of 1933 and 1934 was 107.8 eggs and for all laying moths, fertile and infertile, the average was 65.6 eggs.

Data secured during 1932 and 1933 on the sex ratio of adult moths under observation show a greater number of males than females. The ratio was 63 per cent males in 1932 and 53 per cent males in 1933.

Fertile female moths have been observed to deposit eggs, under insectary conditions, singly and in clusters in a variety of situations. When kept in close confinement, such as test tubes or lamp chimneys, eggs may be deposited upon the glass, cotton stoppers, and paper as well as plant material. In small wire screen cages the moths lay eggs upon plant debris, blossoms, leaves, and upon soil. From the above it would appear that under field conditions the moths oviposit generally on plant material and debris, both singly and in clusters, rather than in a definite location.

Evidence has been noted that the female moth may possess the faculty of attracting males over a considerable area, possibly by odor or chemotropism. When females have been confined in a wire cage, males have been observed to crawl over the outside of the cage attempting to enter. In some cases four or five males have been attracted to the cage when the surrounding area was found to be only lightly infested, which would indicate that the attractive faculty of the females is probably effective over some distance.

Periods of Activity

Curtis, who described and named the genus Cnephasia, states that the "name signifies 'flying in the dusk'". Observations on the activity of this moth substantiate this statement.

The moths remain practically motionless during the day, but shortly after 8:00 o'clock P. M. during June and July they become active, flying frequently about the cloth cages apparently seeking a place to escape. This activity may continue until it is completely dark and the moths cannot be seen.

Following is the egg laying record of a typical moth during 1934:

June 11 - Female and male, both 1 day old, were placed together.

June 12 - 6:30 A. M. - 1 egg
8:30 P. M. - 7 eggs
10:26 P. M. - 14 eggs

June 13 - 3:13 A. M. - 38 eggs
8:19 A. M. - 44 eggs
8:05 P. M. - 54 eggs

June 14 -11:35 A. M. - 117 eggs

June 15 -10:58 A. M. - 167 eggs - male dead

June 16 - 9:10 A. M. - 203 eggs

June 17 203 eggs - female dead

Another female was observed to be depositing eggs on a cloudy day at 10:45 A. M. June 15, 1934. The total number of eggs at that time was 12:

At 11:03 A. M. the number of eggs was 17.

At 11:50 A. M. the number of eggs was 35.

The following day, June 16, the total number of eggs at 9:16 A. M. was 137.

General observations of the egg laying periods allow the following summary: Oviposition generally occurs during the darker hours of the day, during the evening or early morning; however, in some cases it may occur later in the day when cloudy conditions prevail and light intensity is low.

Duration of Adult Stage

The early emerging moths are mostly males, but toward the end of the adult period the females are more numerous. Unevenness of the sex ratio during the adult stage, under insectary conditions, has made it impossible to arrange for the mating of all available females.

The general observation during the period of study of this moth is that the male lives from 1 to 2 days less than the female, which may live from a few days to nearly two weeks in an insectary.

The flight periods of the adult moths during the years 1932 to 1935 inclusive are presented in Table 5.

Cnephasia longana Haw.

Dates on Moth Flight Periods

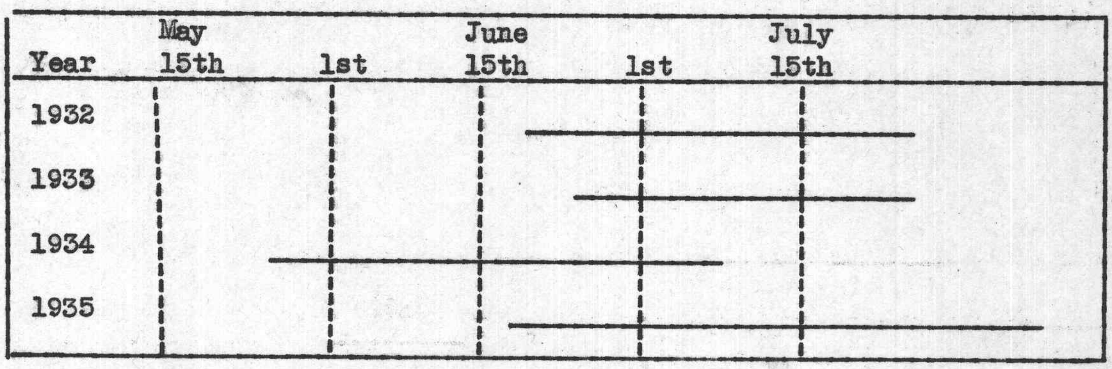
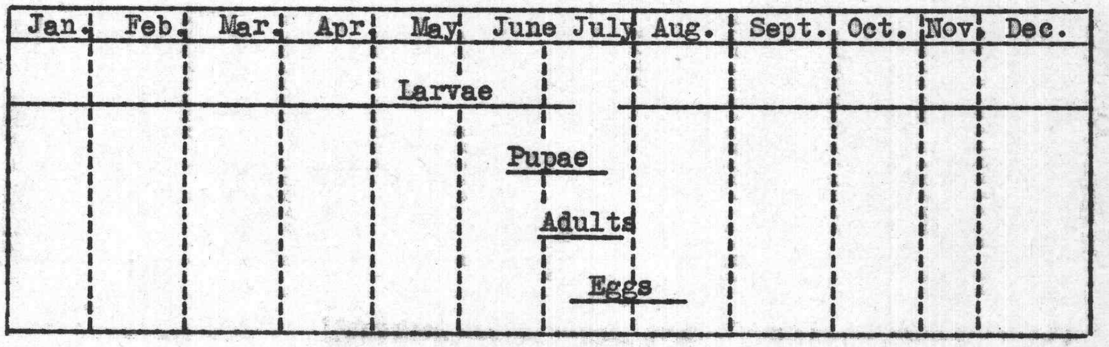


Table 5

Cnephasia *longana* Haw.

Seasonal History Chart for 1933



Cnephasia *longana* Haw.

Seasonal History Chart for 1934

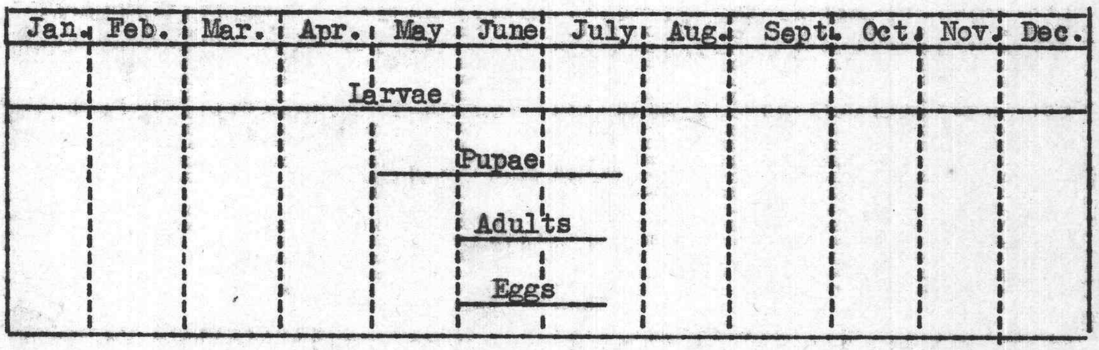


Table 6.

DISTRIBUTION

When *C. longana* Haw. was first reported in Oregon, records were available only from Multnomah and Clackamas counties. During subsequent studies, this pest has been collected and reared from practically the entire Willamette Valley. Collections have been made as far south as Creswell and extending from the foothills of the Coast Range to the lower slopes of the Cascades, so it appears probable that this insect may be found generally wherever host plants are grown within this area. Reports of injury have been received which indicate that the worm may be present on strawberries in the vicinity of Klamath Falls.

In the State of Washington the strawberry fruit worm is known to occur at Battle Ground and in the fruit district of Puyallup.

The distribution in Europe is given by Meyrick (27) as England, Holland, southern Europe, and the Canary Islands.

It has not been determined whether or not the range of this insect is increasing, but the available data strongly indicate this possibility.

HOST PLANTS

The known host plants of *C. longana* Haw. are distributed in eleven plant families, and constitute 23 common plants. In addition, it appears probable that several, if not many more, plants will be found supporting this insect. The host list follows without regard to importance or extent of infestation:

Graminaceae

Wheat - _Triticum satirum_

Convallariaceae

Asparagus - _Asparagus officinale_, reported by J. F. Bock, Horticultural Inspector, Clackamas County.

Iridaceae

Bulbous and root stock iris - _Iris_ spp.

Betulaceae

Filbert - _Corylus_ spp.

Moraceae

Hops - _Humulus lupulus_

Papaveraceae

California poppy - _Eschscholtzia californica_

Cruciferae

Mustard - _Brassica compestris_

Wild radish - _Raphanus raphanistrum_

Rosaceae

Strawberry - _Fragaria_ spp.

Rose - _Rosa_ spp.

Wild blackberry - _Rubus macropetalus_

Five finger - _Potentilla gracilis_

Leguminaceae

Clover; alsike, white, and red - _Trifolium hybridum_, _T. repens_, _T. pratense_

Vetch - _Vicia_ spp.

Peas - _Pisum sativum_

Leguminaceae - continued

Alfalfa - Medicago sativa

Linaceae

Flax - Linum usitatissimum

Compositae

False dandelion - Hypochaeris radicata

Bachelor button - Centaurea cyanus

Ox-eye daisy - Chrysanthemum leucanthemum L. var. pinnatifidum

Wild sunflower - Wyethia angustifolia

Woolly sunflower - Eriophyllum lanatum

Yarrow - Achillea millefolium

INJURY

The typical injury to several economic host plants is described below:

Strawberry

The injury is done to both blossoms and fruit. The larvae appear soon after the blossoms unfold, and after webbing the petals over the center of the flower for protection they feed upon the pollen. This feeding destroys both the pollen and the developing fruit, or at least, removes any possibility of a normal berry. Upon the fruit the injury consists of tunnels which penetrate the berry starting generally under the cap. The amount of tunneling varies greatly; in some cases the fruit is riddled, while in others only a small amount of feeding is done and the injury might aptly be called a "sting". The tunnels within the berry are usually filled with frass and excrement, even when the larvae are no longer present.

Dutch Iris

Damage to the bulbous iris is confined to the flower parts. Generally the feeding is mostly upon the pollen, though in some cases additional feeding is done. Occasionally the worms enter the blossoms before it has unfurled and the injury later gives the iris a "shot-hole" appearance. So far as is known the bulb of the iris is not attacked.

Flax

The larvae of *C. longana* Haw., by their feeding upon flax, are at least a potentially serious pest of this crop. By webbing and feeding on the tender growing tips of the flax, the worms cause a cessation of growth of these parts and the plant then sends out one, two, or more lateral shoots below the injury. The result of this feeding consists of shortened fibers and a decided lowering of quality of the ultimate product. The flower is also attacked and in cases of severe infestation this may result in a lower yield of flax seed.

Peas

Feeding by the larvae on this host is mainly upon the flower parts and occasionally upon the developing pod. If the injury to peas occurs early in their development, a reduction in yield may be expected.

Wheat

The first record of *C. longana* Haw. feeding on wheat was received in the season of 1935. The wheat kernels, while in the soft dough stage, were attacked and mostly consumed, and this injury was accompanied by webbing and considerable frass. Mr. L. P. Rockwood, Entomologist, Bureau of Entomology and Plant Quarantine, investigated a field of wheat attacked by these worms and estimated that about 5 per cent of the heads of wheat were damaged.

Hops

The injury to hops is that of a typical leaf-roller, consisting of webbing leaves together and feeding within this protection. If the feeding is done on the terminal buds, growth is probably retarded until lateral shoots develop. It is very doubtful, however,that the yield is affected as the larvae have pupated and become adults before the hop clusters are formed.

Filbert

The damage of the larvae on filberts is comparable to that on hops; webbing the leaves and feeding on them. The possibility of serious damage also depends upon the portion of the plant attacked and in general it appears that, while the tender leaves are especially attractive, serious injury is not likely unless the larvae are numerous.

Clover, Vetch, and Alfalfa

In some localities, the worms have been found to be numerous upon the blossoms of alsike, white, and red clover. The feeding should cause little damage to these crops except in the case of seed production, which may be reduced by the destruction of the blossoms.

The larvae have been observed to attack both wild and cultivated vetch in numbers and alfalfa to a lesser degree. Damage to these crops appears to be temporary and the host plants overcome the loss after the larvae leave the plants.

Wild Flowers

Injury to the various wild flower hosts is quite similar. The flowers are webbed together and the pollen grains, as well as the other flower parts, may be eaten.

While the wild flowers are not of economic importance, they provide a source of food and continuing infestation for cultivated crops.

ECONOMIC IMPORTANCE

In a discussion of the economic importance of a pest, there are many factors to be considered. The host plant or plants, current price of the crop, chemical damage of insecticides to the plants, edibility of the crop if poisons are to be used, life history of the pest, climatic conditions during control period, type of control and method of application, availability and cost of control materials and machinery, competition from uninfested districts, organization of unified control procedure among growers, quarantine laws, embargoes, and other man-made restrictions to mention only a few have a distinct bearing upon a pest's economic importance.

Naturally, the importance of this insect in an economic sense depends upon the plant attacked. Considering the strawberry as the host plant, the importance of *C. longana* is very apparent. The presence of the worms within the berries or the excrement-filled tunnels, even without the worm being present, results in unmarketable fruit. The following data on the infestation of strawberry fruit was secured in a patch on the heights above West Linn, Oregon. The counts were made after many of the worms had left the berries and changed into the pupal stage:

Plant	Uninjured	Berries Injured	Worms Present
1	25	7	0
2	29	15	2
3	72	8	1 (pupa)
4	37	5	3
5	29	10	0
6	32	8	2
Totals:	224	53	8

Per cent injured - 19.1 per cent

With a percentage of injury of approximately 20 per cent, the loss to the grower would amount to from $40 to $50 an acre during an average year's production and price.

The potential seriousness of this pest is entirely a matter of conjecture, especially upon strawberry which, being intended for human consumption, cannot be protected by arsenicals or other poisonous materials commonly used for the control of foliage-feeding insects. If later developments cause the employment of embargoes upon the shipment of fruit or young strawberry plants out of Oregon, the strawberry industry in the state would be forced to produce only such amounts as could be consumed locally.

The damage to Dutch iris, as has been mentioned, consists of feeding upon the blossoms and in most cases ruining their decorative value. The injury to varieties of iris which bloom early is particularly severe as the attack is frequently made before the flower is unfurled and the entrance hole results in a "shot-hole" appearance of the bloom. The infestation of iris has been observed to be very great on iris as is indicated by the following count secured at Canby, Oregon: Of 52 flowers examined, 32 had larvae present, 5 more showed injury while only 15 were uninjured, giving a percentage of injured flowers of approximately 71 per cent.

With a large host list, it is possible that this insect may be considered to be of less importance than if it were confined to a specific plant. Brues, in "Insects and Human Welfare", page 45, says: "From the agricultural standpoint, monophagous insects upon the crop plants are usually the most destructive." The host plant list of approximately 25 and others which will probably be found may serve to be of assistance in preventing serious damage by this insect.

ECOLOGICAL OBSERVATIONS AND BIOLOGICAL CONTROL

The observations on this insect of an ecological nature have been more in line of general observations upon the relation of the moth with its environment. No ecological apparatus has been used and no accurate data secured except such generalizations as were possible under field conditions.

Upon strawberries the population of _C. longana_ appears to be greater in patches located upon sandy type soils. While it is impossible to account for their greater numbers upon soils of this type, it may be that light, sandy soil enables the larvae to overwinter with a better degree of protection.

The number of adjacent wild flower hosts, providing a continuing source of infestation, may be proportional to the insect population upon cultivated crops. General observations tend to substantiate this, but other factors such as wind direction, topography, and elevation may have a distinct bearing as well as the fact that this insect may not have reached its maximum distribution.

Biological control of this pest has been noticed to exert considerable influence upon its relative abundance. Five species of insect parasites have been recorded as attacking C. longana - three species of Ichneumonidae and two species of Braconidae. The determined species are listed as follows:

Phytodietus burgessi (Cress.)

Glypta sp.

Dioctes eureka (Ashm.)

Microbracon hyslopi Vier.

Microbracon gelechiae (Ashm.)

Of the insect parasites, the last named species appears to be far more important in controlling the larvae of C. longana. In some cases, during studies late in the larval period of the pest, it has been extremely difficult to find a worm which had not been parasitized by M. gelechiae. This parasite has been observed attacking the larvae on the majority of the known host plants. Whether or not any of these parasites will reach a status of parasitism sufficient to hold the pest in check is a matter of conjecture. In some localities parasitism has been observed to reach approximately 20 per cent, and in others no parasites have been found.

On occasions, larvae have been observed in the field to be attacked by a disease which is either bacterial or is caused by a fungus.

This condition is manifested by a dark discoloration accompanied by inactivity and ultimate death of the larvae. Following death, the worm under humid conditions becomes softened and the body tissues assume a "stringy" consistency.

The possibilities of control by the various parasites, while they appear promising, do not at present warrant any great amount of study. Quite likely the biological control of this pest is comparable to that of the average insect; under favorable conditions the rate of parasitism is high while the reverse is true under unfavorable conditions.

NOTES ON RELATED SPECIES

The literature available during these studies contains but few references to the species C. longana, and these are confined almost entirely to references of taxonomic study or systematic position. Apparently the only economic data is presented in the present paper and that by Edwards, Gray, and Mote (14). The apparent lack of economic information on this pest is difficult to explain in the light of its behavior, since it was first recorded in the Northwest. In the past six years, C. longana has established itself as a serious pest, at least potentially, of a number of cultivated crops.

Only one species of the genus, Cnephasia wahlbomiana L. has been observed to be mentioned sufficiently to establish it as an economic pest. This species has not been recorded in the United States, and is apparently confined to Europe. In a survey of the literature it has been found to occur on the following host plants:

Clover, tobacco, and alfalfa (Boning (5))

Hops (Duffield (11))

Clover (Filip'er (15))

Hemp (Goidanich (20))

Market garden and ornamentals (Marchal and Prillieux (25))

Chrysanthemum (Naumann (30))

Flax (Ozols (31))

Sugar beet (Rambousek (34))

Flax (Stranak (39))

Strawberries (Tullgren (41))

Peas (van Poeteren (42))

Poppies (Woroniecka (45))

Papaver (poppy) (Zacher (46))

In looking over the host list of C. wahlbomiana L. it becomes apparent that there is a great similarity to the host plants of C. longana Haw. So many host plants are attacked by both insects as to suggest possible confusion in nomenclature, or that the species might be identical. A study of the genitalia of both species as pictured by Pierce and Metcalf (33) shows no particular similarity and these authors suggest (page 15) that wahlbomiana is a synonym of branderiana L., and both belong in the genus Argyroploce. However, wahlbomiana is still found in the literature under the genus Cnephasia and it appears that their suggestions have not been adopted.

There are only a few members of the genus Cnephasia in the United States, and of these only C. longana is known to occur in Oregon. Barnes and McDunnough (4) list the following species under the genus Cnephasia:

7401 osseana Scop.
(niveosana Pack.)

7402 argentana Cl.
(georgiella Hlst.)

7403 fernaldana Wlshm.

7404 arizonana Wlshm.

7405 horariana Wlshm.

7406 basiplagana Wlshm.

7407 indivisana Wlk.

7407, 1 oleraceana Gibson

Forbes (16) lists the members of the genus as follows:

C. argentana Clerck

C. osseana niveosana Packard

C. moeschleriana Wocke

C. listerana Kearfott

C. peritana Clemens

C. virescana Clemens

There appears to be some discrepancy between these two lists which were published within a space of six years, even though the scope of Forbes' work was concerned mainly with the Lepidoptera of New York. Only two species are mentioned on both lists, and if these are accurate, the total number of determined species of the genus in the United States would be 12 including C. longana Haw.

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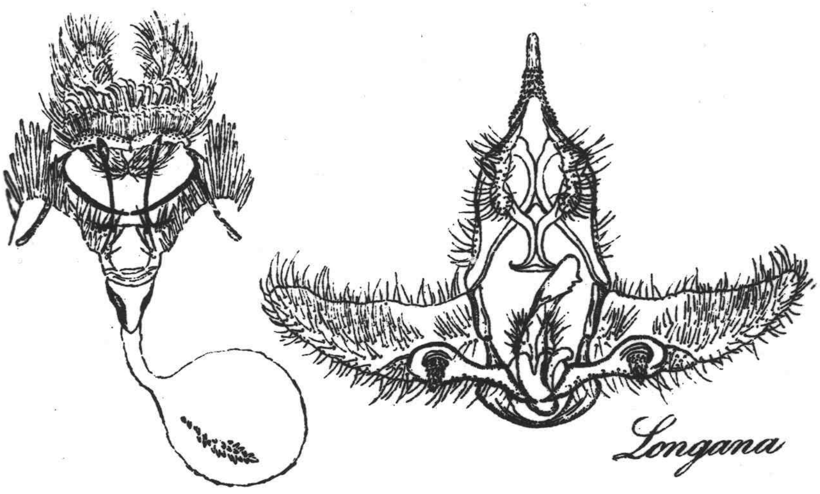
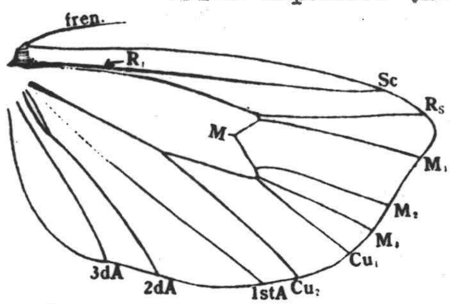
Plate I.



Genitalia of C. longana Haw.
(after Pierce and Metcalfe (33))

Fig. c - Hind wing of Tortrix
Veins separate (after Forbes (16))



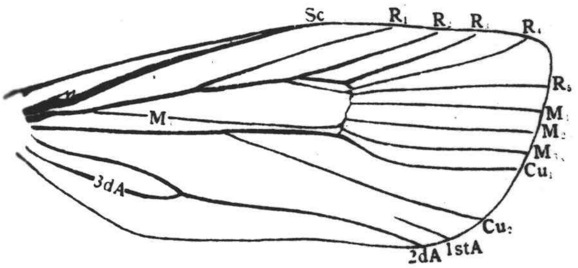


Fig. a - Typical forewing of
Tortricidae
(after Forbes (16))

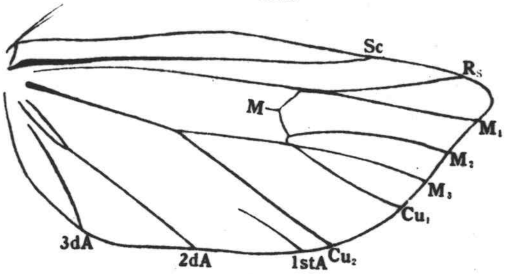


Fig. b - Hind wing of Cnephasia
Rs and M_1 stalked
(after Forbes (16))

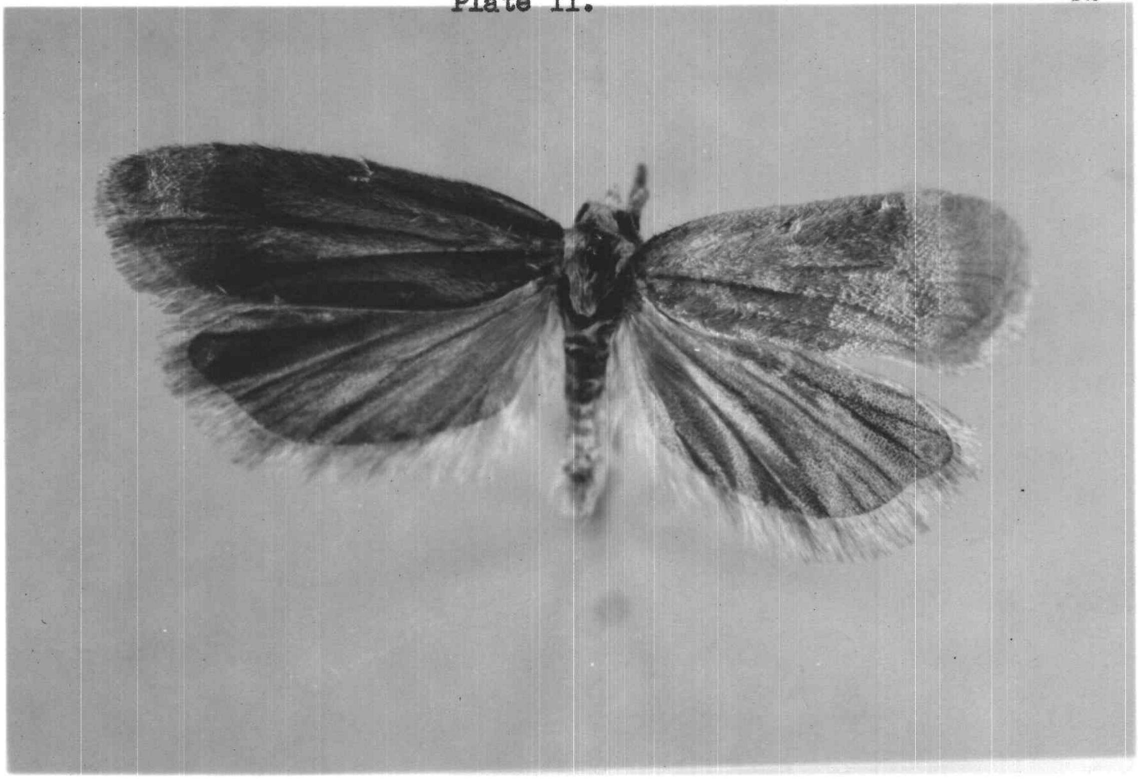


Fig. a - Adult Male C. longana Haw.

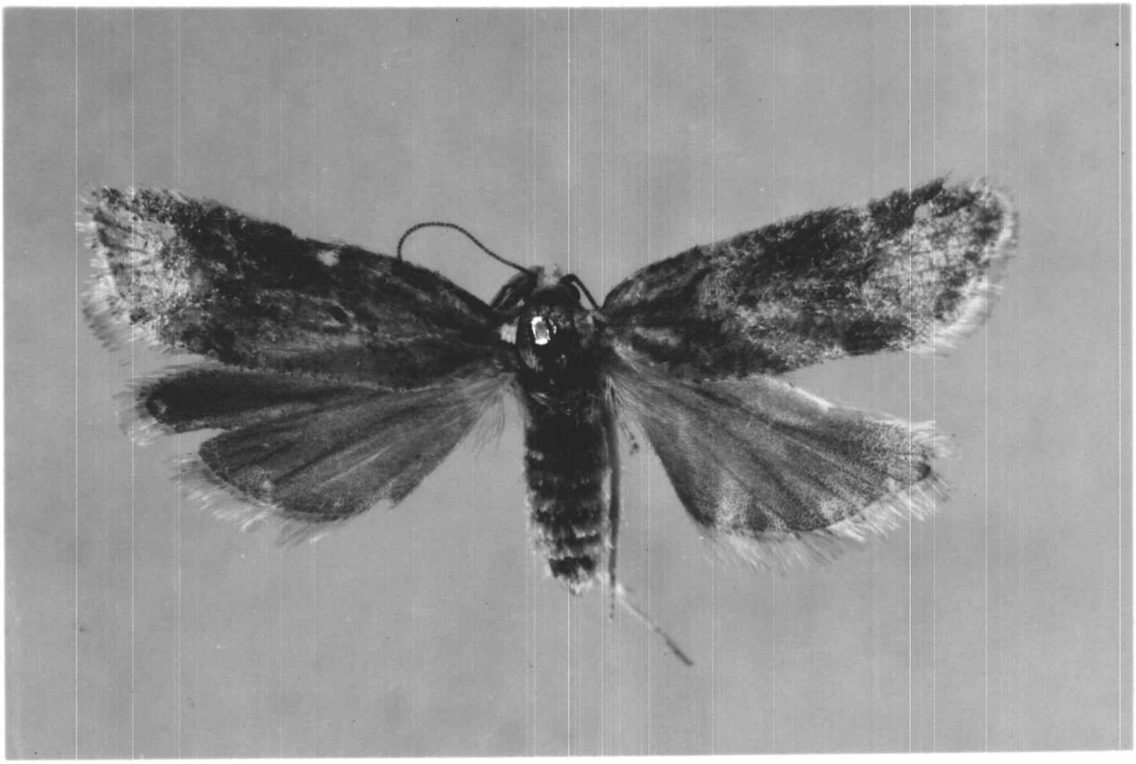


Fig. b - Adult Female C. longana Haw.

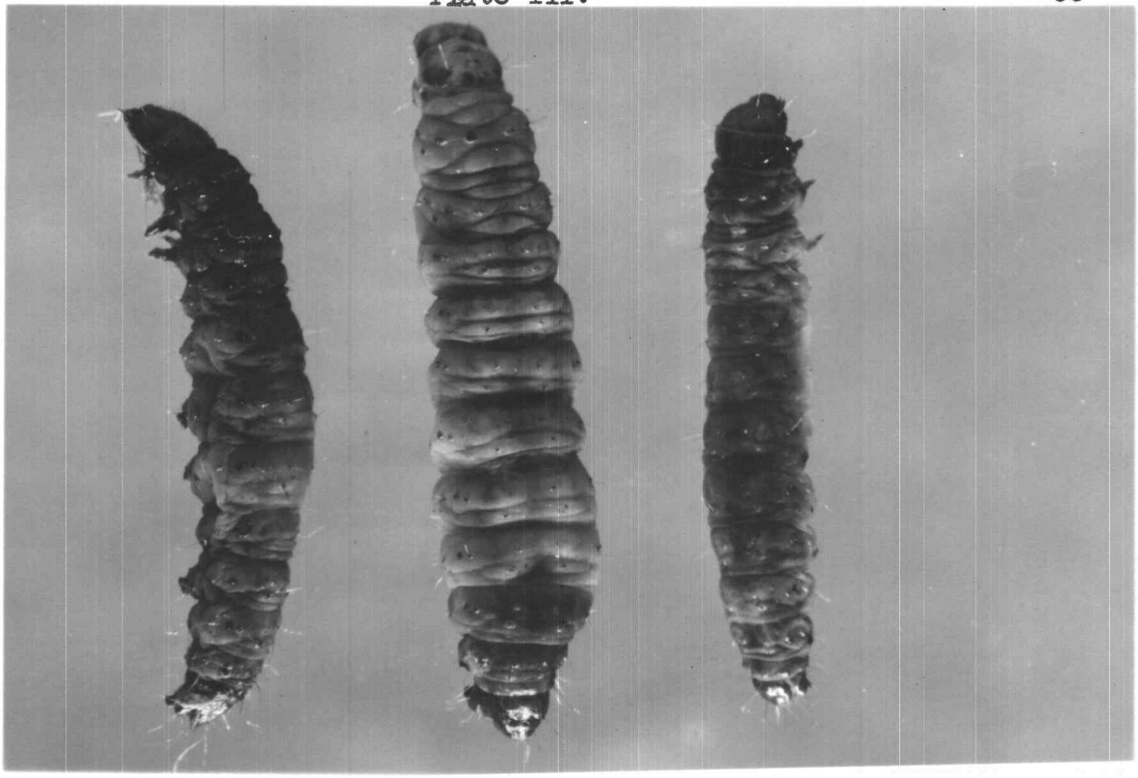


Fig. a - Larvae of C. longana Haw.

Fig. b - Pupae of C. longana Haw.

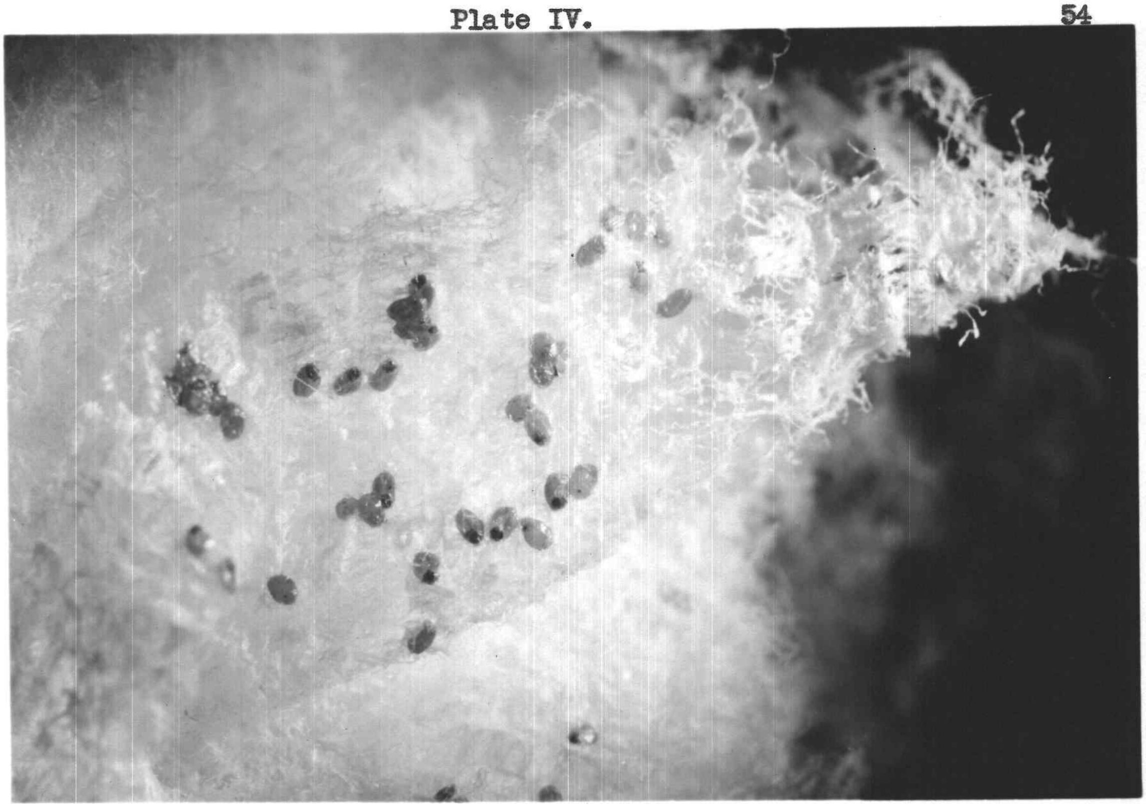


Fig. a - Larvae in Hibernacula on Cellucotton Stopper

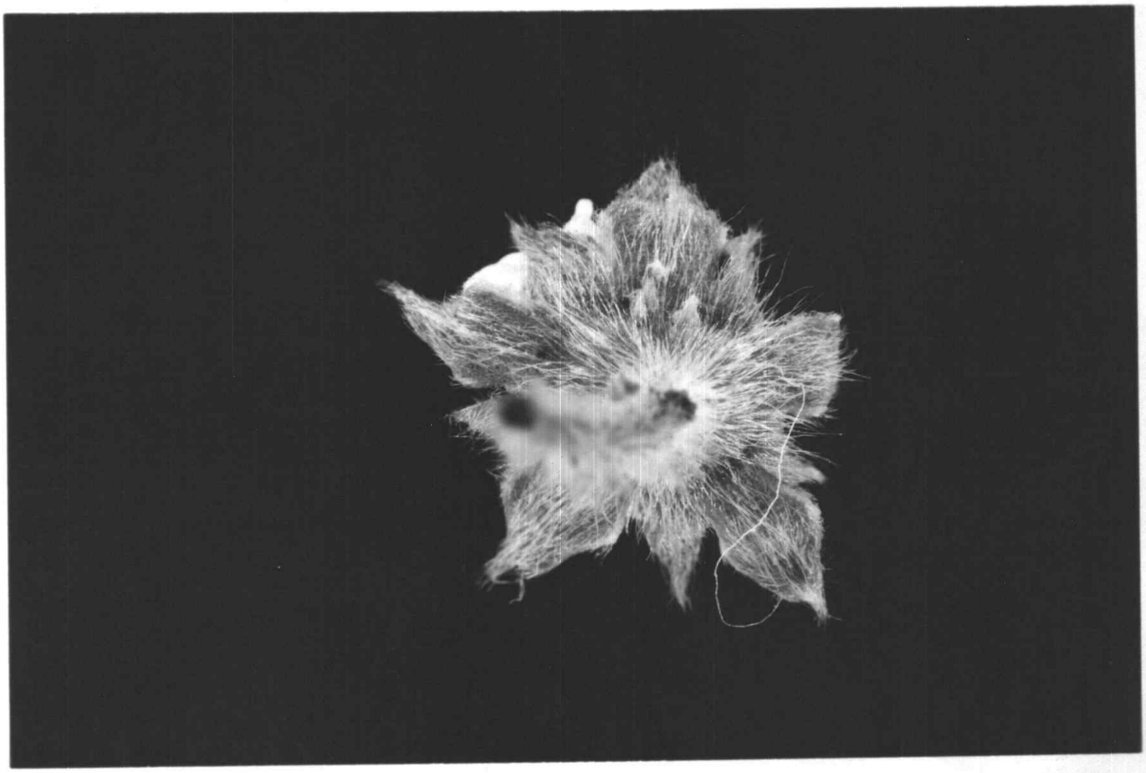


Fig. b - Larvae in Hibernacula on Strawberry Blossom

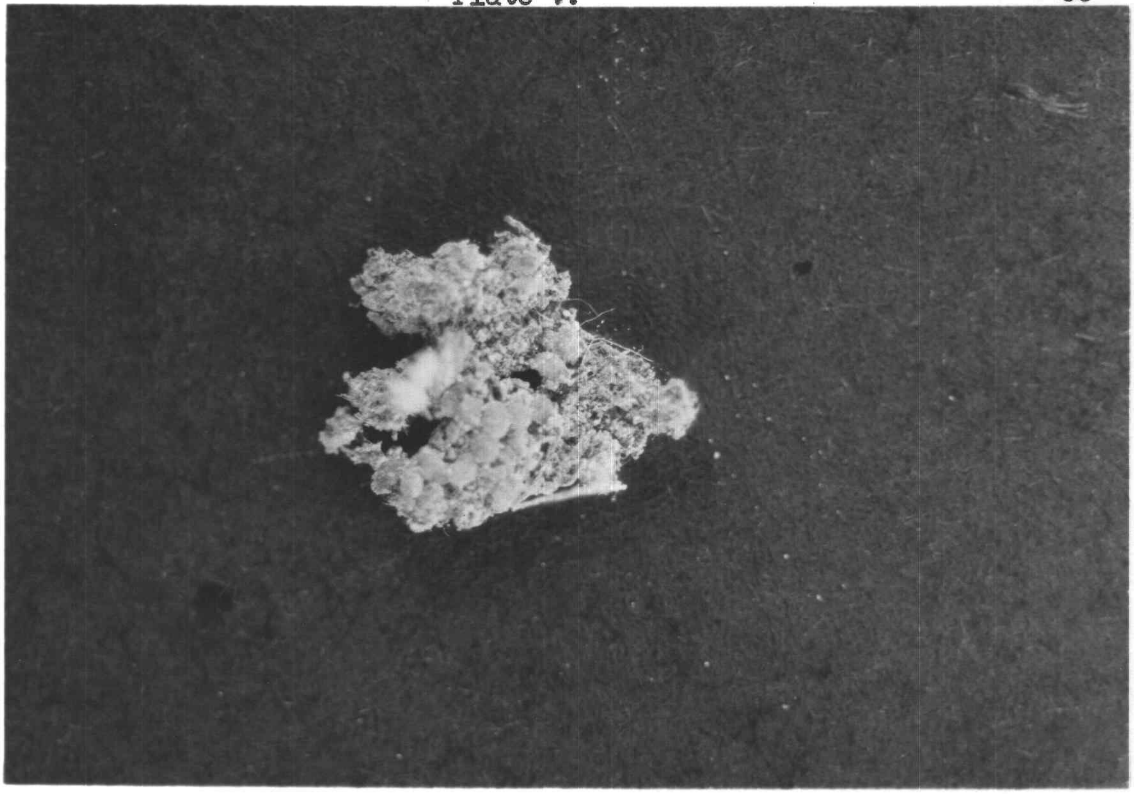


Fig. a - C. longana Haw. Eggs on Soil

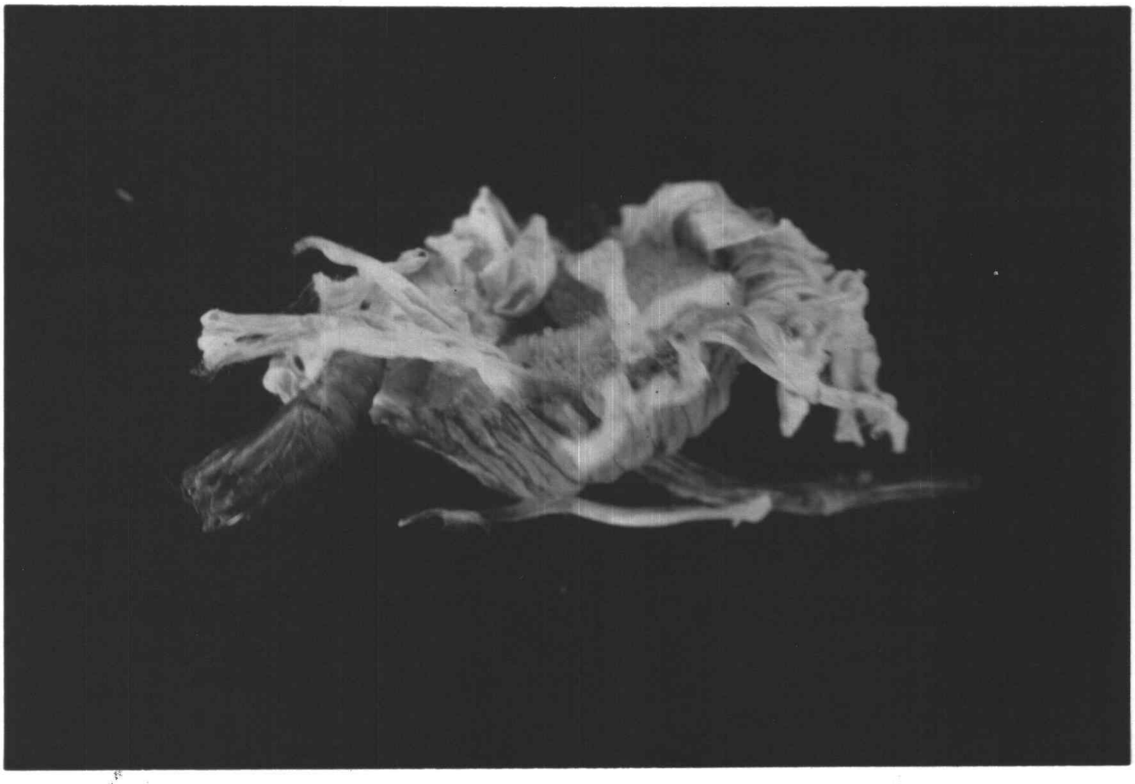


Fig. b - C. longana Haw. Pupal Case on Ox-eye Daisy

Plate VI - Parasites of C. longana Haw.

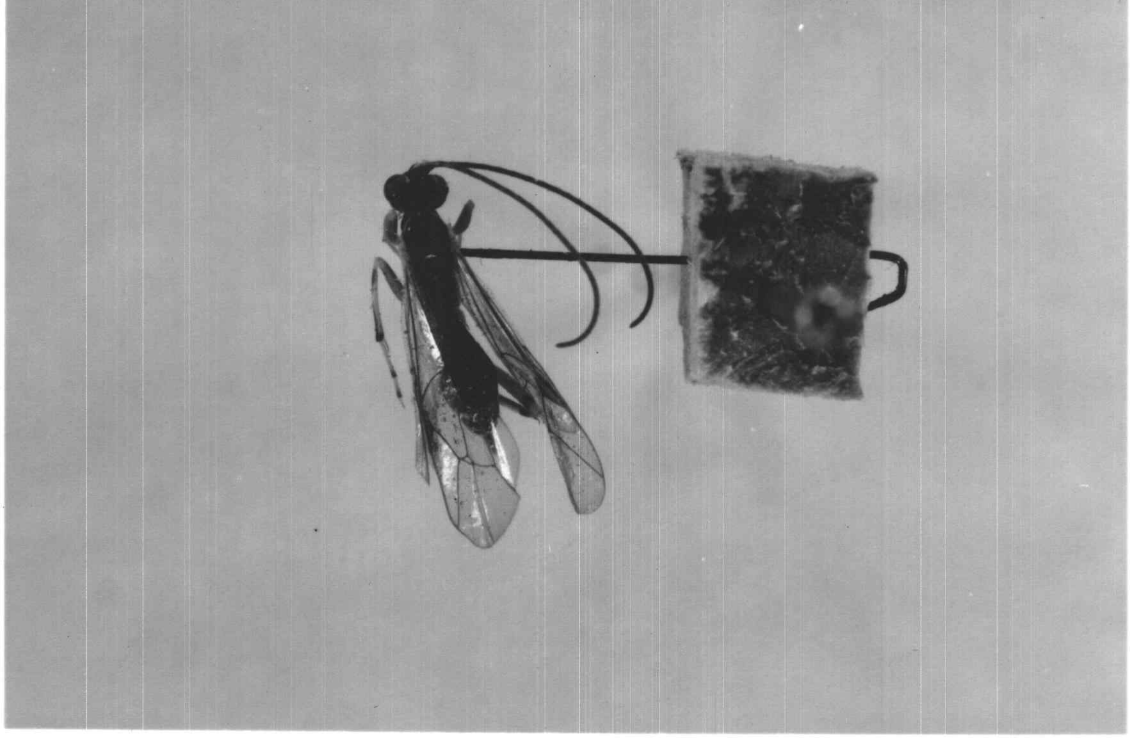


Fig. a - Phytodietus burgessi (Cress.)

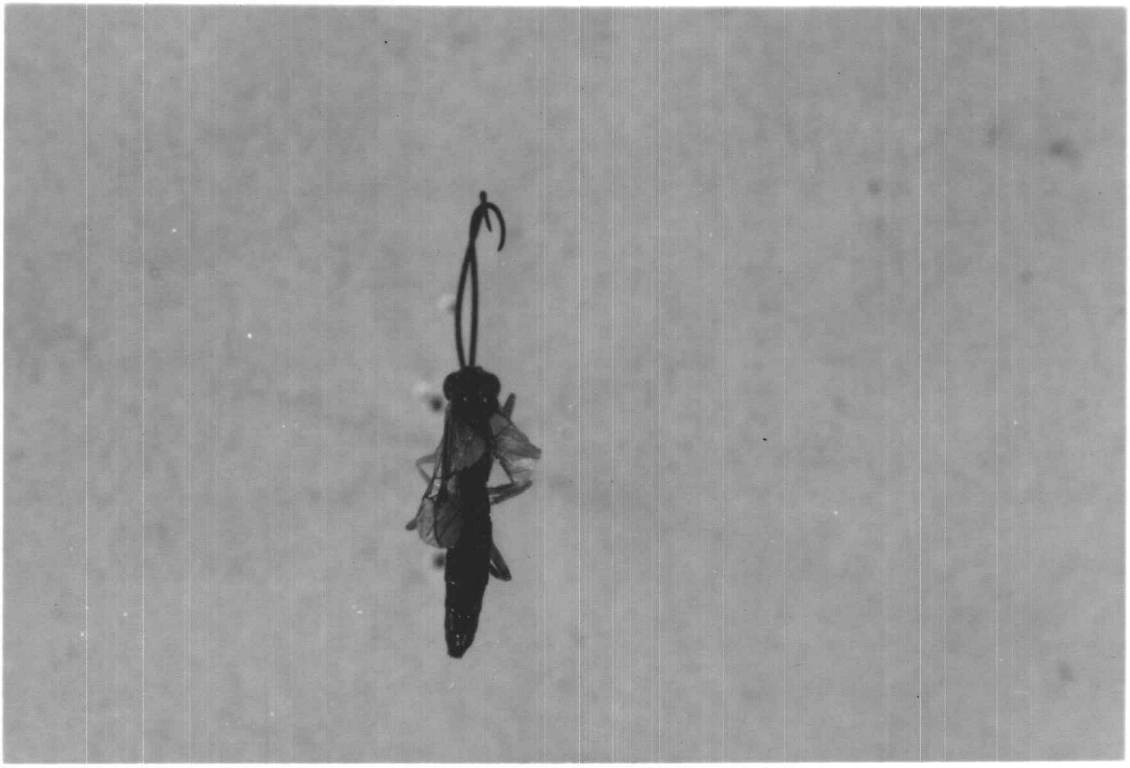


Fig. b - Glypta sp.

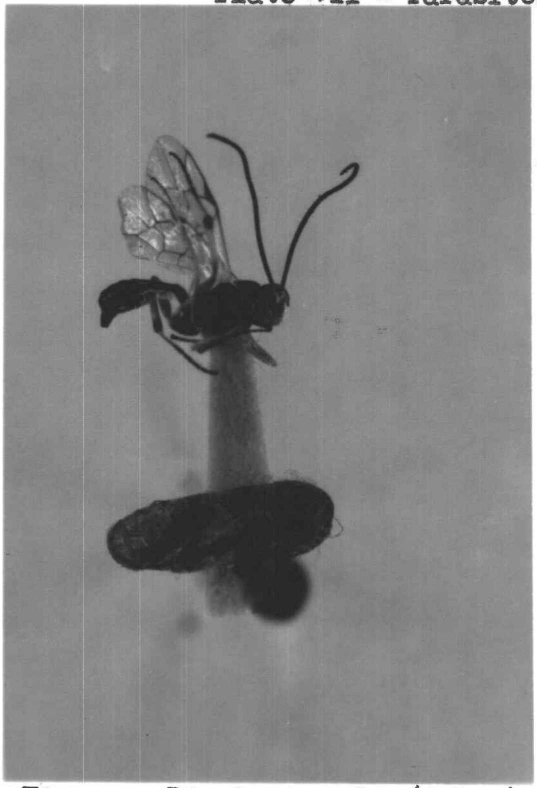


Fig. a - Dioctes eureka (Ashm.)

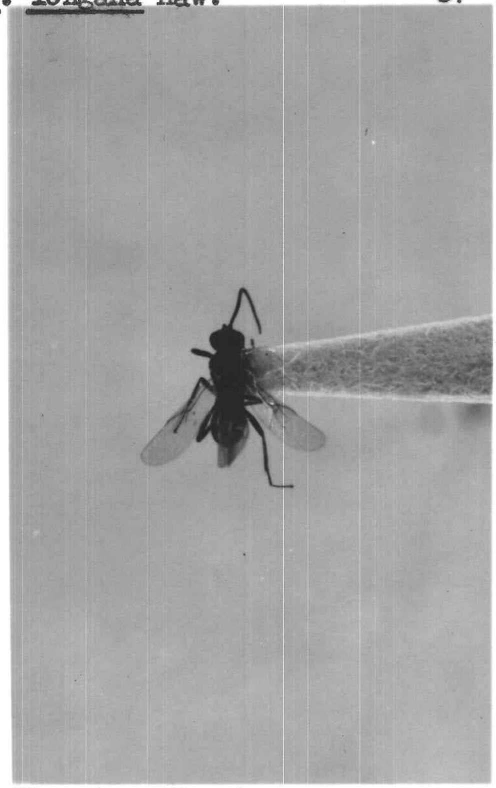


Fig. b - Microbracon gelechiae (Ashm.)

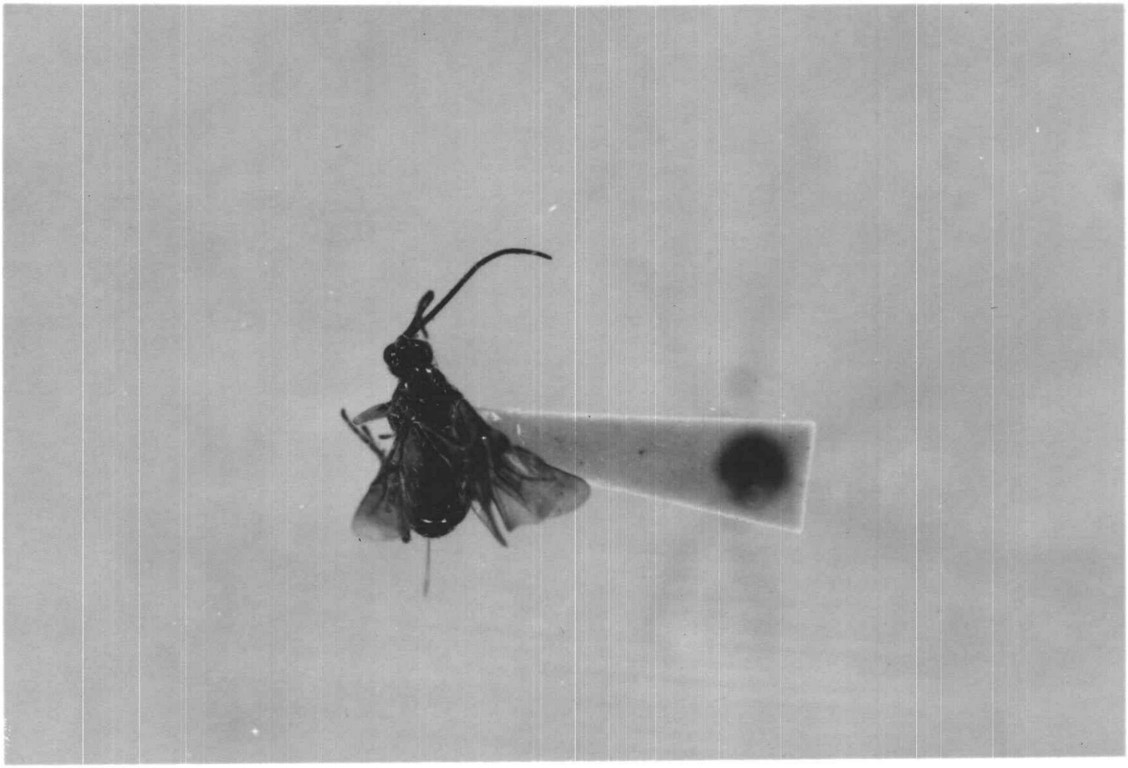
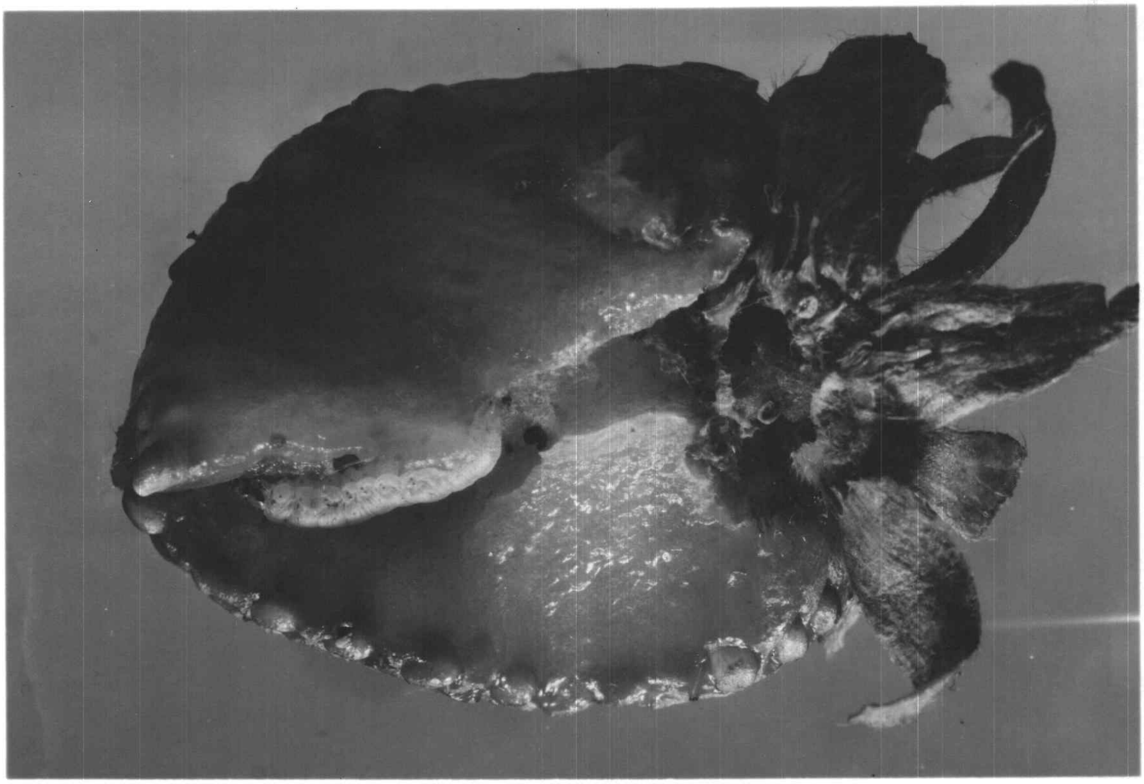


Fig. c - Microbracon hyslopi Vier.



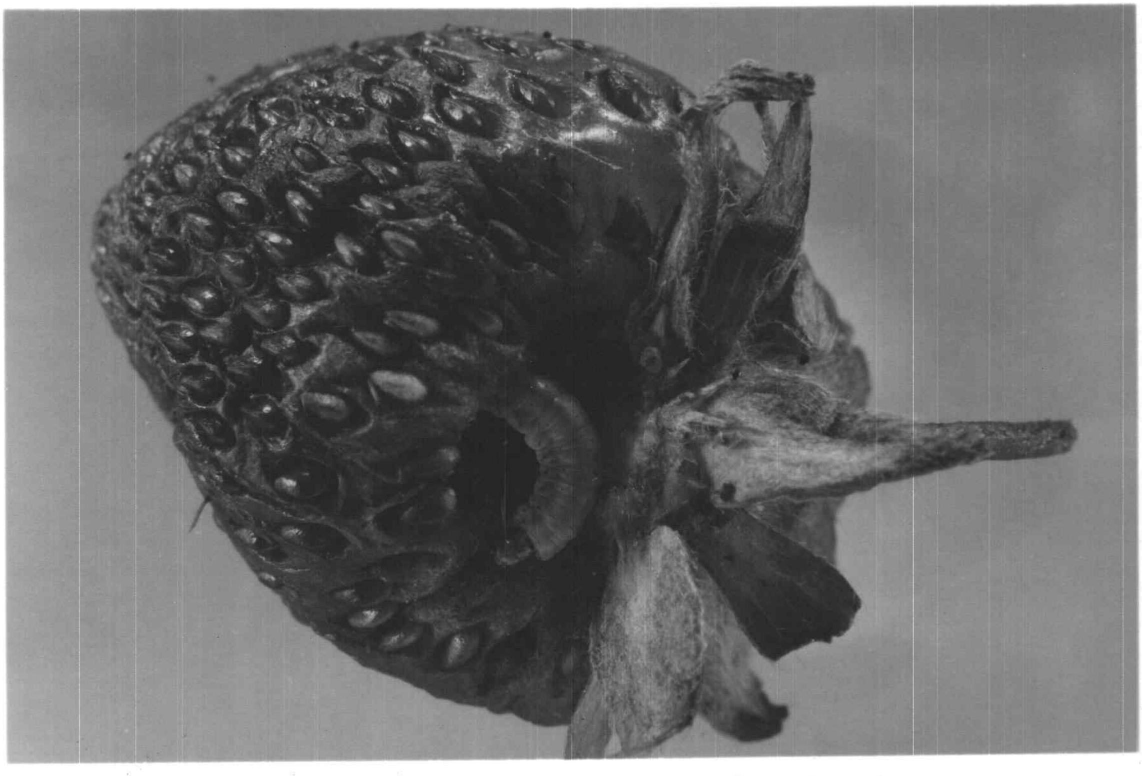


Plate VIII - Larvae and Injury to Strawberries

Plate IX.

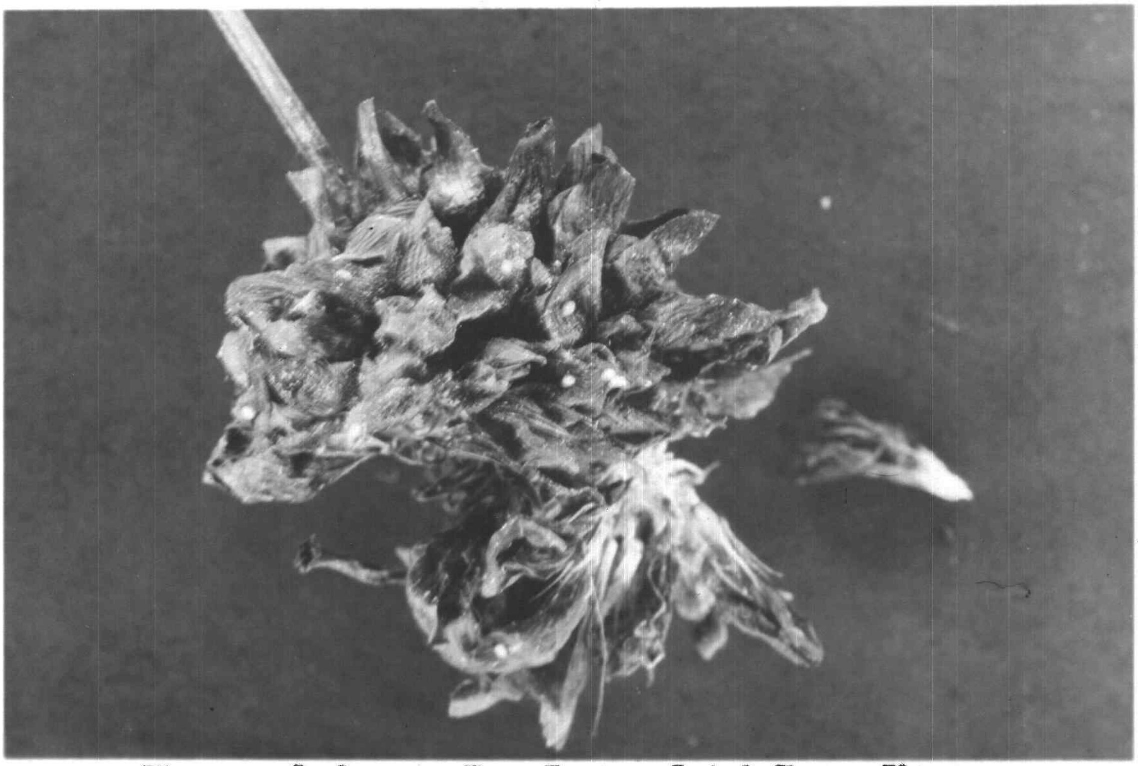


Fig. a - C. longana Haw. Eggs on Dried Clover Blossom

Fig. b - Typical Webbing of Petals by C. longana Haw. Larvae

Fig. a - Early Injury to Dutch Iris by Larvae

Fig. b - "Shothole" Injury Resulting from Larval Feeding

Plate XI.

Fig. a - Wild Flower Hosts Attacked by Larvae

Fig. b - Larval Injury to Wild Rose